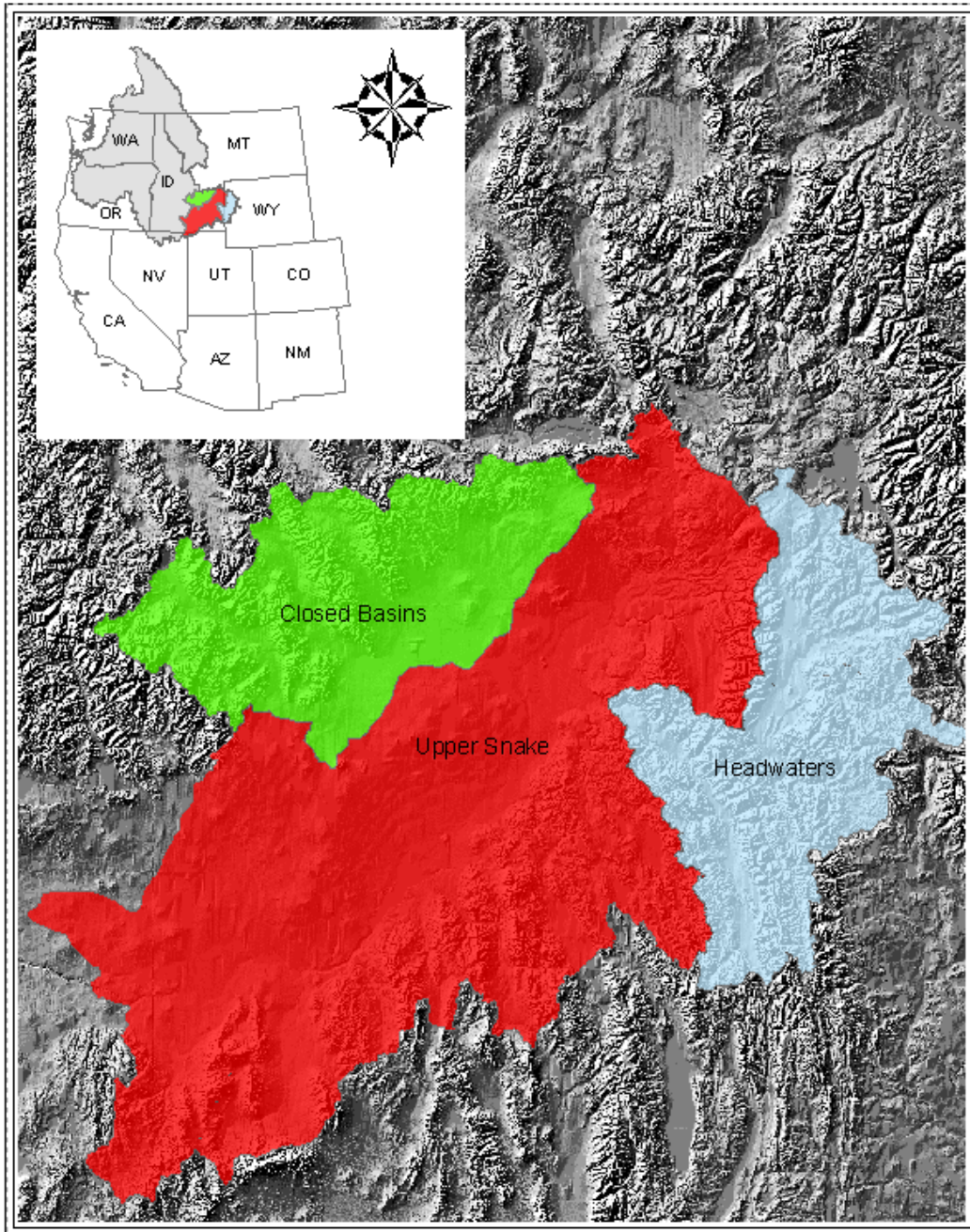


Upper Snake Province Assessment

Prepared for the
Northwest Power and Conservation Council



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1 Overview

1.1 Background

In 1980, Congress authorized creation of the Northwest Power Planning Council (or NPCC, which in 2003 became the Northwest Power and Conservation Council, or NPCC) to give the states of Idaho, Montana, Oregon, and Washington a political voice in managing the federal hydropower system located in the Columbia River basin. In addition, the NPCC was directed to develop a program—the Columbia River Basin Fish and Wildlife Program—to protect, mitigate, and enhance fish and wildlife communities and populations affected by the Columbia River hydropower system.

In past years, the NPCC and Columbia Basin Fish and Wildlife Authority (local managers of fish and wildlife resources) reviewed proposals submitted for on-the-ground projects and research. The Bonneville Power Administration then funded approved projects. Recently, independent scientific review panels recommended that subbasin plans be developed to better guide the review, selection, and funding of projects that implement the NPCC's Columbia River Basin Fish and Wildlife Program. In an effort to refine this program, a new review and selection process has begun. This process includes subbasin summaries (interim information), assessments, and management plans, which provide a base of information and direction on conditions, limiting factors, and needs in the basin.

Creation of these documents is followed by a rolling review of proposals by an Independent Scientific Review Panel, the Columbia Basin Fish and Wildlife Authority, and the NPCC. Under the rolling provincial review, project proposals from a given subbasin will only be reviewed once every three years.

1.2 Assessment Conceptual Framework

The NPCC has outlined eight scientific principles to guide the operation of its Columbia River Basin Fish and Wildlife Program.

These principles frame the assessment of the Upper Snake province.

1.2.1 Scientific Principles

Eight scientific principles guide the operation of the NPCC's Columbia River Basin Fish and Wildlife Program. These principles served as the foundation for the fisheries and terrestrial technical teams that were formed to provide input to this technical assessment for the Upper Snake province. These principles are as follows:

1. The abundance, productivity, and diversity of organisms are integrally linked to the characteristics of their ecosystems.
2. Ecosystems are dynamic and resilient, and they develop over time.
3. Biological systems operate on various spatial and time scales that can be organized hierarchically.
4. Habitats develop through and are maintained by physical and biological processes.
5. Species play key roles in developing and maintaining ecological conditions.
6. Biological diversity allows ecosystems to persist despite environmental variation.
7. Ecological management is adaptive and experimental.
8. Ecosystem function, habitat structure, and biological performance are affected by human actions.

As the NPCC's scientific principles indicate, the relationships of ecosystems, habitats, and populations of fish, wildlife, and plants are very complex. In most cases, these relationships are both undefined and interrelated. Changes resulting from weather, fire, flood, disease, or habitat loss may not only directly reduce or increase fish and wildlife populations, but they may also indirectly perturb relationships and interactions between and among fish, wildlife, and their ecosystems to the same or greater extent than the direct effects.

In the Upper Snake Province, we defined seven limiting factors, or environmental bottlenecks, that may limit fish, wildlife, and their habitats. These factors, in relation to their causes and their manifestations, provide a simplistic working picture of how we evaluated focal populations, focal habitats, and ecosystems in this assessment (Figure 1-1).

These limiting factors may act exclusively, such as when a fire eliminates old growth forest habitat necessary for old growth-dependent species such as the fisher (*Martes pennanti*). Or they may act simultaneously or in a composite, such as when aquatic habitat quantity is reduced by water diversion, the remaining water in the stream is reduced in quality by increased water temperatures, and population linkage between aquatic species and the amount of water in the stream is reduced or eliminated.

Each limiting factor may manifest itself differently, depending on the status of the

species or habitat, the scale of the effect, and the cause of the limiting factor. For example, wolf predation of elk calves may locally limit elk population growth, especially in an area of low habitat quality but will not threaten elk rangewide. In this assessment, our simplistic model suggests causes of limiting factors affecting focal species and habitats and the manifestation of the limiting factor in a focal species, habitat, or ecosystem (Figure 1-1).

Our model is scale independent. And it does not represent whether invasive exotic weeds are a competitive or habitat quality limiting factor or both, and it does not imply that fish, wildlife, and ecosystem relationships are as linear and simplistic as shown.

In this assessment, we assume that each of the ecosystems, habitats, and species we assessed originated and functioned optimally prior to anthropogenic influence (Figure 1-2). Pre-anthropogenic optimum function is assumed to be resilience of fish and wildlife systems and sustainability of populations within the range of natural variability. We suggest that increasing anthropogenic effects have exaggerated the limiting factors beyond the range of natural variability and that this pressure has simplified interactions and relationships and reduced the resilience of focal habitats and species, leading to long-term decline (Figure 1-2). Ongoing declines in focal habitats or species have unknown consequences at best and lead to extinction for one or more species at worst.

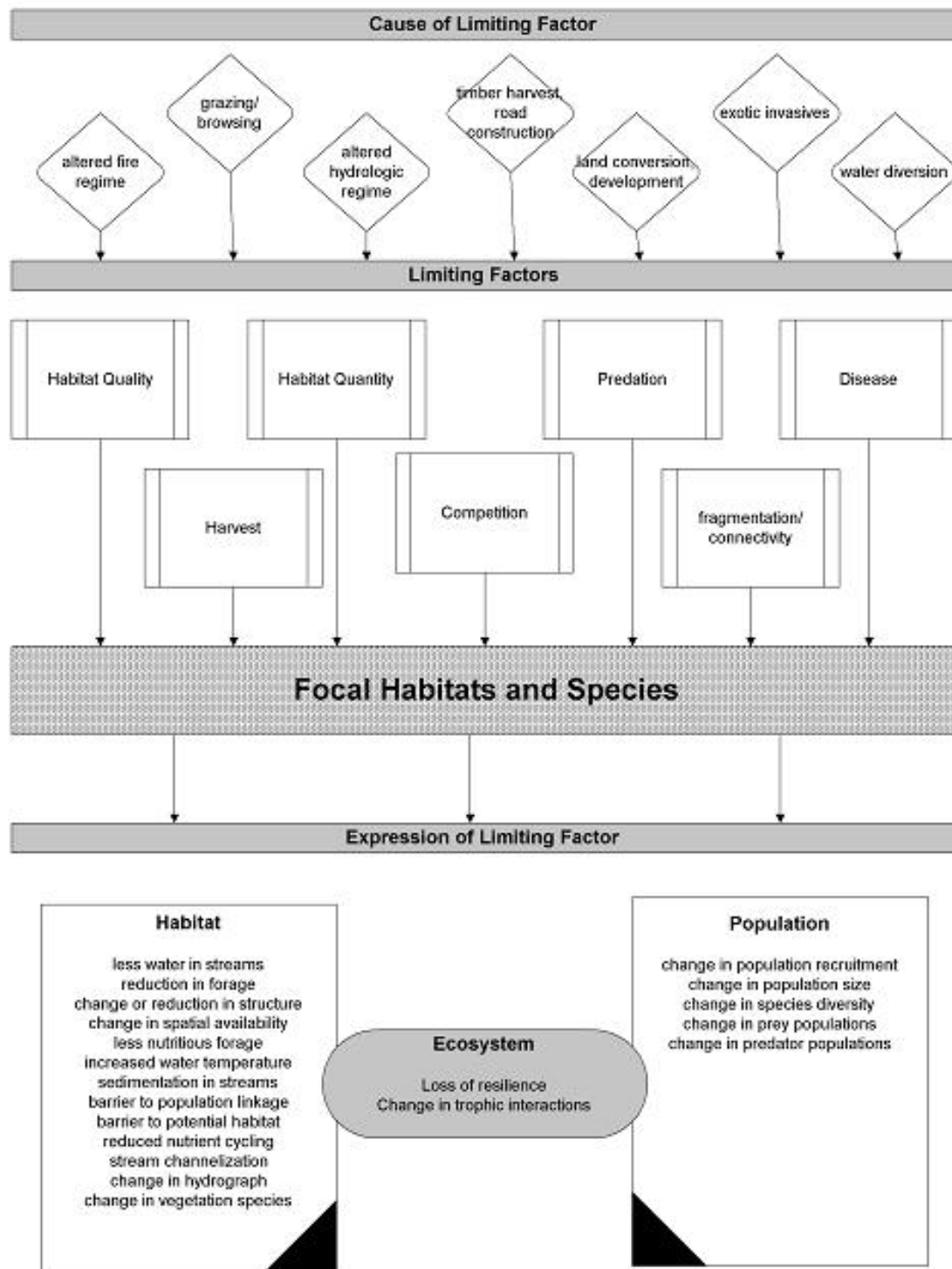


Figure 1-1. Simple model for evaluating relationships between fish and wildlife and their ecosystems for the Upper Snake province.

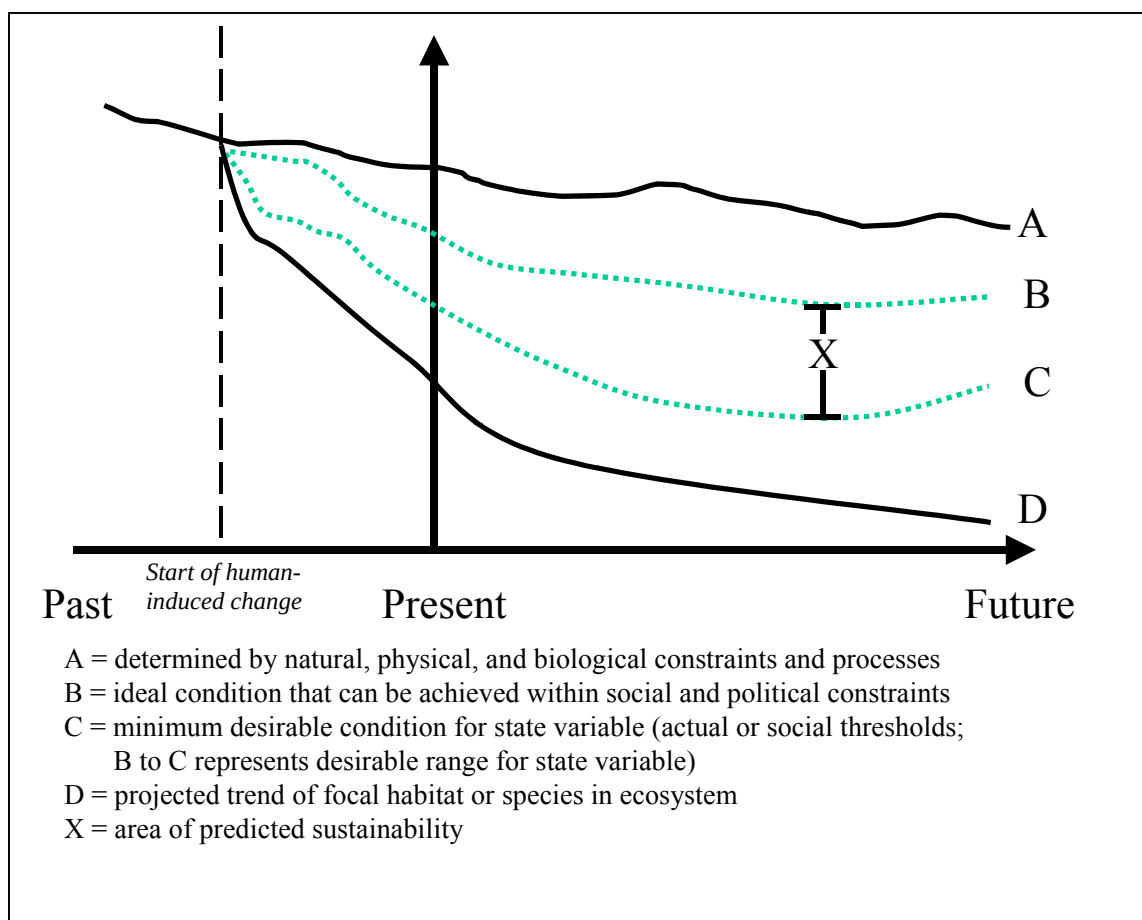


Figure 1-2. Schematic representation of a sustainable restoration scenario (adapted from National Academy of Sciences, 1992)

Through definition of limiting factors and their causes, we identify strategies to relieve or eliminate the limiting factors and increase the trend and status of focal species, habitats, and ecosystems. We use the best available information to select focal species, define the status of each focal fish and wildlife species or habitat, and then synthesize this information into working hypothesis to direct effective relief of limiting factors. Implementation of management strategies will ideally move the trend or status of focal species or habitats upward toward the acceptable and sustainable levels defined by

the biological objectives in the provincial plan. Monitoring and evaluation of strategy implementation is necessary to test the hypothesis of the management experiment, the effectiveness of the strategy, and increase learning through management actions.

1.2.2 Provincial Null Hypotheses

Scientific methodology incorporates hypothesis testing by first assuming a specified action has no effect or impact on the parameter in question. This is called the null hypothesis (H_0). From the provincial

perspective, the broadest null hypothesis is that fish and wildlife species and their habitats are not limited in the Upper Snake province. The broadest alternative hypothesis (H_A) states fish and wildlife species and their habitats are limited by one or more of seven identified limiting factors. More specifically, we begin our assessment with the following null hypotheses.

Hypothesis A

Ho: Habitat quantity does not limit the abundance, distribution, life history, and ecological relationships of focal species and habitats.

Hypothesis B

Ho: Habitat quality does not limit the abundance, distribution, life history, and ecological relationships of focal species and habitats.

Hypothesis C

Ho: Population harvest does not limit the abundance, distribution, life history, and ecological relationships of focal species and habitats.

Hypothesis D

Ho: Competition among and between fish and wildlife species and habitats does not limit the abundance, distribution, life history, and ecological relationships of focal species and habitats.

Hypothesis E

Ho: Predation does not limit the abundance, distribution, life history, and ecological relationships of focal species and habitats.

Hypothesis F

Ho: Disease does not limit the abundance, distribution, life history, and ecological relationships of focal species and habitats.

Hypothesis G

Ho: Population and habitat fragmentation and loss of connectivity does not limit the abundance, distribution, life history, and ecological relationships of focal species and habitats.

The alternative or working hypothesis (H_A) is the opposite of the null hypothesis (Ho). It may be developed intuitively or be based on data and information. The alternative or working hypothesis is refuted based on data and information collected using scientific methodology during designed actions.

Our assessment begins by presuming seven stated null hypotheses based on our simplistic model (Figure 1-1) and ends by statement of alternative hypothesis H_A developed through synthesis of the information on fish, wildlife, habitats, environmental conditions, and limiting factors we gathered during the assessment. Management and monitoring strategies designed to change the influence of the identified limiting factor on focal species or habitats and measure that change can reinforce or refute these working or alternative hypotheses.

1.3 General Description

1.3.1 Province Location

The Upper Snake province is the uppermost province of the Snake River system and includes areas within Idaho, Wyoming, Utah, and Nevada (Figure 1-3). It includes the Snake River and all its tributaries from Shoshone Falls, Idaho, to its headwaters in Wyoming, as well as the closed basins on the northern edge of the Snake River Plain. The

Upper Snake province is divided into three subbasins: the Upper Snake, Snake

Headwaters, and Closed Basin (Figure 1-4).

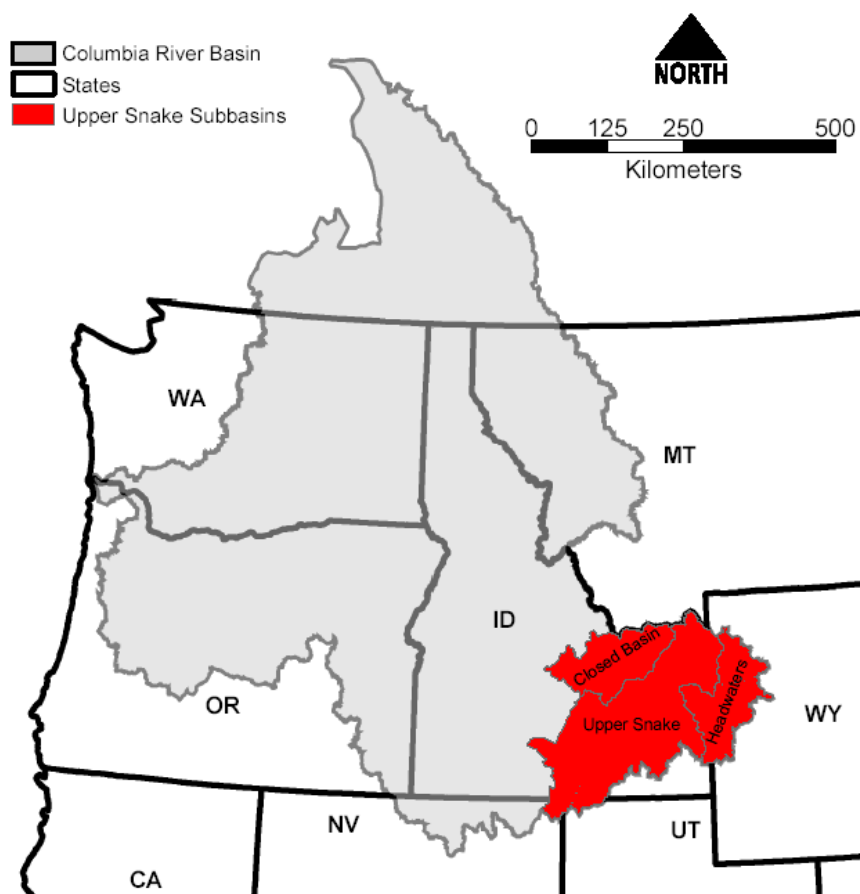


Figure 1-3. Location of the Upper Snake province and its three subbasins within the Columbia River basin.

1.3.2 Snake Headwaters Subbasin

The Snake Headwaters subbasin encompasses some of the most pristine terrestrial and aquatic temperate montane ecosystems in the Columbia River basin system. This subbasin lies within the heart of the northern Rocky Mountain region, straddling the border between southeastern Idaho and western Wyoming (Figure 1-3). The key rivers that are a part of or feed into the Snake Headwaters subbasin include the Snake, Salt, Greys-Hoback, and Gros Ventre rivers. Some of the most important cottonwood gallery

forests in the Intermountain West exist within this river parkway. Lakes and reservoirs within the drainages include Jackson Lake, Palisades Reservoir, and Ririe Reservoir. The Snake River itself harbors one of the few fluvial populations of Yellowstone cutthroat trout in Idaho.

The forested areas of the Snake Headwaters are home to diverse mammalian and avian species, including the largest population of nesting bald eagles in the Greater Yellowstone Ecosystem (an area including the Snake Headwaters subbasin and with broad-

reaching environmental and ecological oversight). National Forests within the Snake Headwaters subbasin include the Targhee-Caribou and Bridger-Teton. The subbasin also includes Grand Teton National Park, Jackson Hole Elk Refuge, Jackson National Fish Hatchery, and Gros Ventre Wilderness.

1.3.3 Upper Snake Subbasin

The Upper Snake subbasin includes the Blackfoot River, Portneuf River, and Henrys Fork watersheds and numerous tributaries across this area of southeastern Idaho. The Henrys Fork and Teton River watersheds of the Upper Snake subbasin have been well known for trout fishing and other recreational opportunities since the 1880s. The area provides one of the most important rainbow trout (*Oncorhynchus mykiss*) fisheries in the state in terms of habitat, fish populations, and angler use (IDFG 2001). In addition, rich agricultural land along the lower reaches of the Henrys Fork provides the world's largest seed potato production area (Van Kirk and Griffin 1997). An estimated 75% of the economy of southern Idaho is driven by agricultural business in this area. Streamflow of the Snake River and its major tributaries is highly regulated by dams and diversions. Over the past two decades, water and other natural resource management issues in the subbasin have received national attention, for both the intensity of conflicts over them and the eventual success of collaborative subbasin research and management efforts.

1.3.4 Closed Basin Subbasin

The Closed Basin subbasin occupies a remote and sparsely populated area of east-central Idaho. This subbasin is distinct in that the major flowing waters in the subbasin, such as the Big Lost and Little Lost rivers, percolate through the volcanic flows of the Snake River

Plain and disappear. Through discharge of the Snake River aquifer, the flows emerge in springs along the Snake River. More than 70% of the roadless areas greater than 199,908 acres (809 km²) in the lower 48 states are in this subbasin. Because of the remoteness and areas of limited accessibility, most wildlife populations are in reasonably good condition. Exceptions include the greater sage grouse (*Centrocercus urophasianus*), some Neotropical migrant birds, and other birds experiencing rangewide declines stemming from changes outside the provincial boundaries. Fish populations and aquatic habitats in this subbasin are more impacted by anthropogenic activities, including water use and historical fish management and stocking practices. Basinwide information is lacking for a number of taxa, notably nongame species, including songbirds, amphibians, reptiles, and bats and other small mammals.

1.4 Physical Description

The Upper Snake province is 18,497,568 acres (74,857 km²) (Table 1-1) and composed of 22 watersheds (Figure 1-4). The province incorporates lands within the boundaries of Idaho, Wyoming, Utah, and Nevada. Elevations in the province range from the summit of the Grand Teton at 14,436 ft (4,400 m) to Shoshone Falls at 2,625 ft (800 m). This province contains the origins of the Snake River, the largest tributary to the Columbia River. The Snake River origins are on the Continental Divide south of Yellowstone National Park boundary and at nearly the most northern point of Grand Teton National Park. The water originating in the Closed Basin subbasin of the Upper Snake province enters the Snake River at Thousand Springs, below the Shoshone Falls boundary of the Upper Snake province.

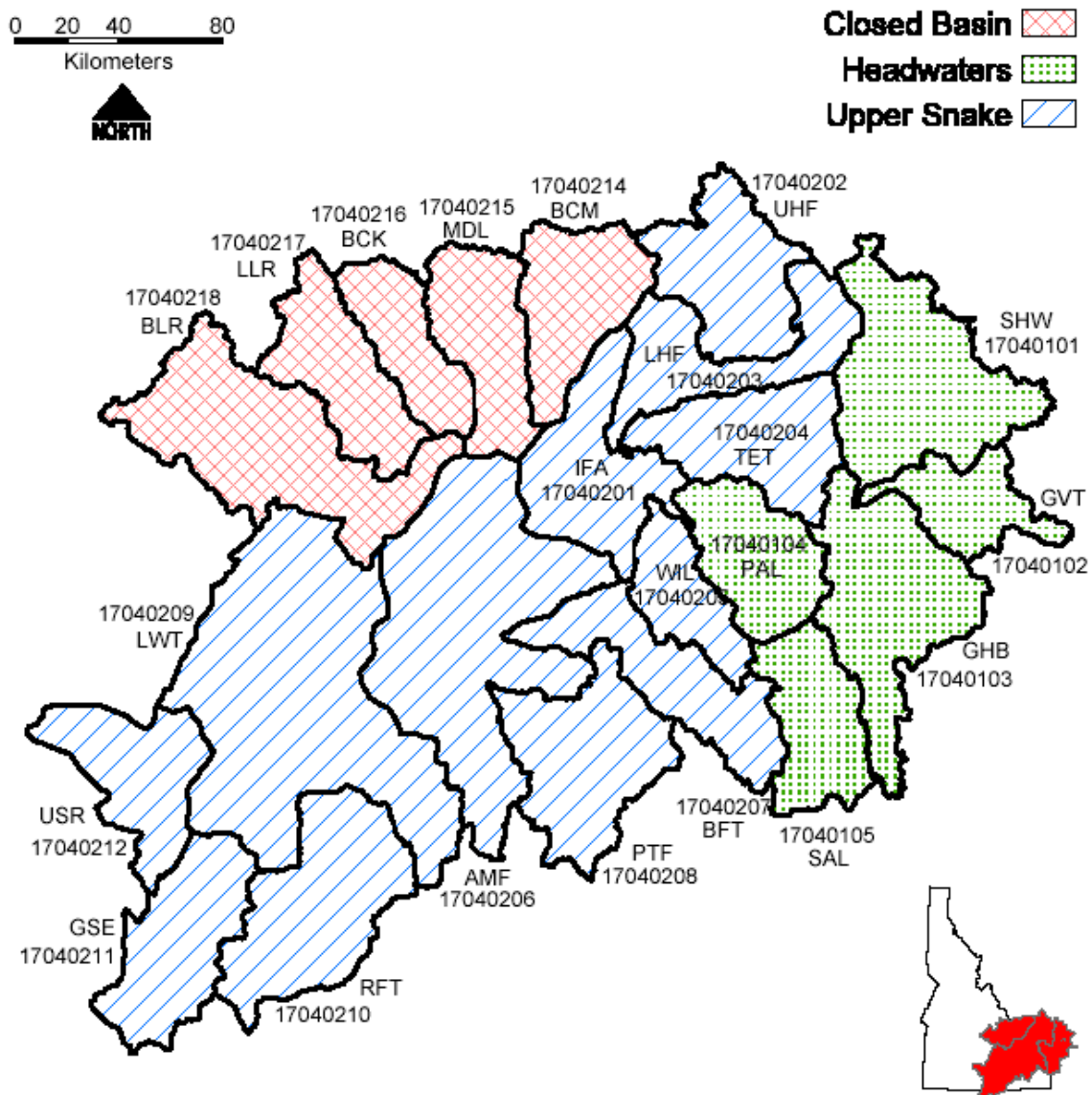


Figure 1-4. Major hydrologic units (22 watersheds) within the Upper Snake province.

Table 1-1. Drainage areas, numbers of named streams, and their total stream kilometers for the 22 major hydrologic units (watersheds) within the Upper Snake province (source: IFWIS 2003).

Watershed	Code	Hydrologic Unit Code	State	Drainage Area (km ²)	Number of Named Streams	Total Stream km
Snake Headwaters subbasin						
Greys-Hoback	GHB	17040103	Wyoming	4,062	311	1,161
Gros Ventre	GVT	17040102	Wyoming	1,663	195	576
Palisades	PAL	17040104	Idaho/Wyoming	2,395	170	896

Watershed	Code	Hydrologic Unit Code	State	Drainage Area (km ²)	Number of Named Streams	Total Stream km
Salt	SAL	17040105	Idaho/Wyoming	2,303	231	939
Snake Headwaters	SHW	17040101	Wyoming	4,405	232	1,080
Subbasin Totals				14,828	1,139	4,652
Upper Snake subbasin						
American Falls	AMF	17040206	Idaho	7,544	136	1,004
Blackfoot	BFT	17040207	Idaho	2,842	141	984
Goose	GSE	17040211	Idaho/Utah/ Nevada	2,898	215	1,113
Idaho Falls	IFA	17040201	Idaho	2,975	48	485
Lower Henrys Fork	LHF	17040203	Idaho/Wyoming	2,666	108	761
Portneuf	PTF	17040208	Idaho	3,441	300	1,455
Raft	RFT	17040210	Idaho/Utah	3,915	232	1,342
Teton	TET	17040204	Idaho/Wyoming	2,857	159	1,163
Upper Henrys Fork	UHF	17040202	Idaho/Wyoming	2,873	223	1,242
Upper Snake–Rock	USR	17040212	Idaho	2,530	39	347
Lake Walcott	LWT	17040209	Idaho	9,283	142	865
Willow	WIL	17040205	Idaho	1,682	83	611
Subbasin Totals				45,506	1,826	11,372
Closed Basin subbasin						
Beaver–Camas	BCM	17040214	Idaho	2,576	177	898
Birch Creek	BCK	17040216	Idaho	1,864	123	737
Big Lost River	BLR	17040218	Idaho	5,139	474	2,161
Little Lost River	LLR	17040217	Idaho	2,516	157	894
Medicine Lodge	MDL	17040215	Idaho	2,428	98	603
Subbasin Totals				14,523	1,029	5,293
Province Totals				74,858	3,994	21,317

The Snake Headwaters subbasin of the Upper Snake province lies within the northern Rocky Mountains and straddles the border between southeastern Idaho and western Wyoming (Figure 1-3). The subbasin occurs within portions of the Northwest Basin and Range, Snake River Basalts, Yellowstone Highlands, and Over thrust Mountains ecoregional sections (McNab and Avers 1994). The 3,664,079 acres (14,828-km²)

subbasin encompasses five watersheds: Greys–Hoback, Gros Ventre, Palisades, Salt, and Snake Headwaters. The Greys–Hoback, Gros Ventre, and Snake Headwaters watersheds are all located in Wyoming. The Salt watershed lies between the borders of Wyoming and Idaho. The majority of the Palisades watershed is located in Idaho, with only a small portion in Wyoming.

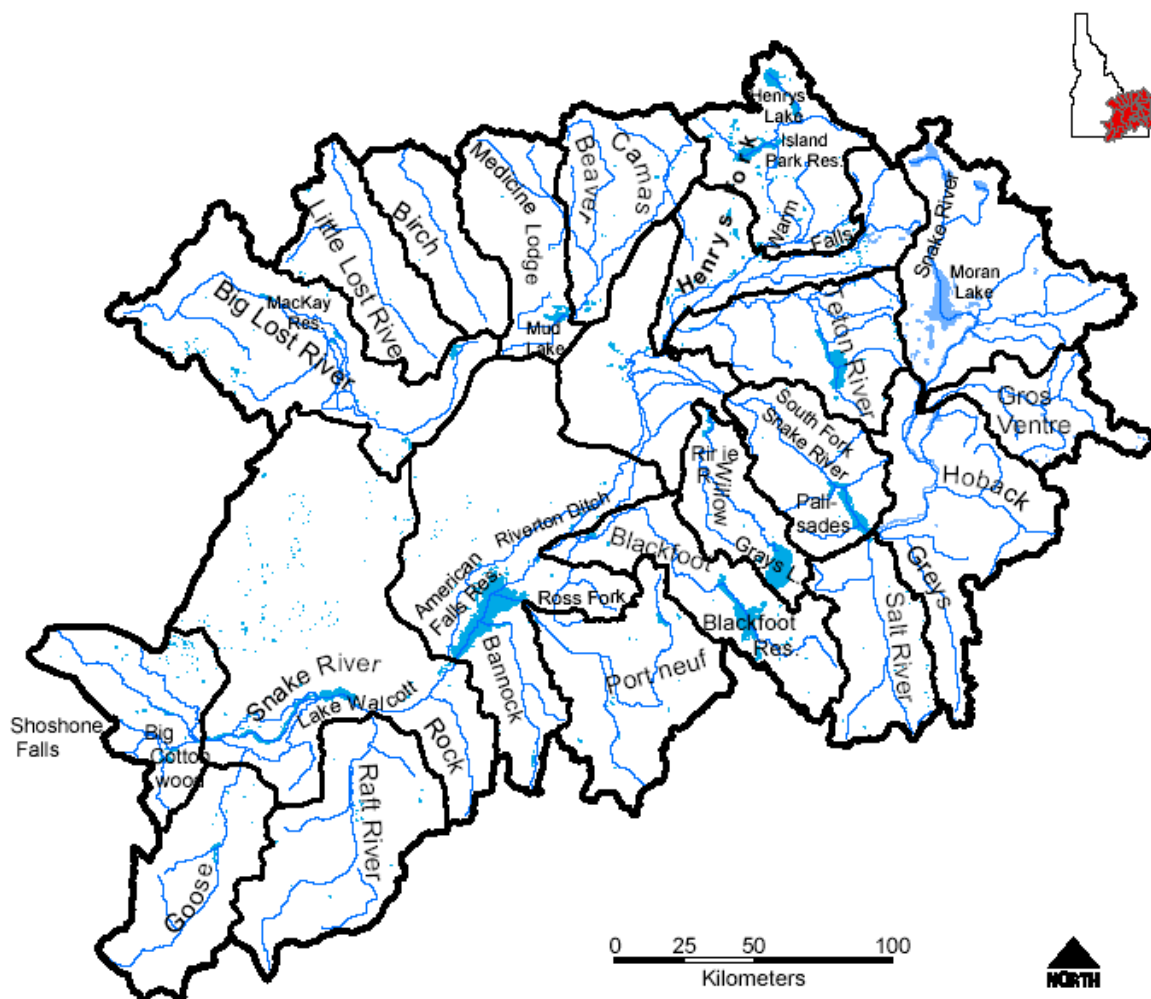


Figure 1-5. Major waterways within the 22 watersheds of the Upper Snake province.

The Upper Snake subbasin is located in eastern Idaho and encompasses 12 watersheds (Figure 1-4): American Falls, Blackfoot, Goose, Idaho Falls, Lower Henrys Fork, Portneuf, Raft, Teton, Upper Henrys Fork, Upper Snake–Rock, Lake Walcott, and Willow. Watersheds that include areas in both Idaho and Wyoming are the Lower Henrys Fork, Upper Henrys Fork, and Teton watersheds. Both the Goose and Raft watersheds include areas in both Idaho and Utah. The Goose watershed also includes area within Nevada. Land surface elevation above sea level ranges from 13,451 ft (4,100 m) in

the headwaters of the Snake River to 800 m at Shoshone Falls. Most streams in the subbasin originate in the foothills or montane regions that are between 5,906 and 9,843 ft (1,800 to 3,000 m) in elevation. Major tributaries include the Blackfoot, Portneuf, and Raft rivers and Goose and Big Cottonwood creeks (Figure 1-5).

The Closed Basin subbasin encompasses five watersheds in east central Idaho (Figure 1-4): the Big Lost, Little Lost, Birch, Medicine Lodge, and Beaver–Camas. These headwater streams originate in the mountains of

southeastern and south-central Idaho and terminate on the Snake River Plain. Although these streams are located within the Snake River basin, the immense lava formations of the upper Snake River Plain prevent them from forming an overland connection with other streams in the basin. During the Pleistocene, increased streamflows from these rivers combined to form Lake Terretion (Pierce and Scott 1982). This period was likely the most recent connection that these waters had with other streams. Today, and for the past 12,000 years, waters from these drainages sink into the lava along the northern edge of the Snake River Plain and contribute recharge to the Snake River Plain aquifer system from surface flow onto the plain and as underflow from the respective watersheds. The aquifer resurfaces and discharges to the middle Snake River at Thousand Springs near Hagerman, Idaho, approximately 124 miles (200 km) from the terminus of the Closed Basin subbasin watercourses.

1.4.1 Drainage Area

Some of the major drainage systems in the province are the Big Lost, Little Lost, Blackfoot, Portneuf, Raft, Greys-Hoback, Palisades, Henrys Fork, and Beaver-Camas (Table 1-1). Major water impoundments within the province include American Falls Reservoir, Lake Walcott, Palisades Reservoir, Jackson Lake, Mud Lake, Blackfoot Reservoir, Grays Lake, Henrys Lake, Moran Lake, Mackay Reservoir, and Island Park Reservoir (Figure 1-5).

1.4.1.1 Snake Headwaters Subbasin

The Greys-Hoback watershed is located in the southeastern section of the Snake Headwaters subbasin in Wyoming. The watershed contains a total area of 1,003,742 acres (4,062 km²) (Table 1-1). This watershed links the tributaries of the Snake River, Jackson Lake Reservoir, the Hoback River

(which flows from the east and joins the Snake River at Hoback Junction, Wyoming), and waters that originate in the Bridger-Teton National Forest. All waters confluence and flow south to Palisades Reservoir.

The Salt watershed is located in the southwestern section of the Snake Headwaters subbasin (Figure 1-4) in an area known as Star Valley. The watershed contains a total area of 569,084 acres (2,303 km²) (Table 1-1) and is comprised of the drainage and tributaries of the Salt River originating in the Bridger-Teton National Forest and eventually meandering through Star Valley to join the Greys River near Alpine, Wyoming. This subbasin's waters originate in the Bridger-Teton National Forest.

The Palisades watershed is located midway down the Idaho-Wyoming border. Approximately 10% of the watershed is in Wyoming. This watershed contains a total area of 591,817 acres (2,395 km²) (Table 1-1) and is comprised of the drainage and tributaries of the South Fork Snake River from Palisades Reservoir at the southeast corner of the watershed, through the small communities of Swan Valley (Figure 1-6) and Irwin, Idaho, to the U.S. Geological Survey gauging station at Heise, Idaho.

The Snake Headwaters and Gros Ventre watersheds are the only two watersheds in the subbasin that are entirely located in the State of Wyoming. The Snake Headwaters watershed is the largest watershed in the subbasin with a total area of 1,088,499 acres (4,405 km²) and 232 named streams (Table 1-1). The Gros Ventre watershed is the smallest in the subbasin with a total area of 410,936 acres (1,663 km²) and 195 named streams.

1.4.1.2 Upper Snake Subbasin

The Upper Snake subbasin contains over 7,022 miles (11,300 km) of streams (Table 1-

1). Streamflow in the Snake River and its major tributaries is highly regulated by dams and diversions, primarily for agricultural use and hydroelectric power generation. Irrigation projects have resulted in about 5,717 miles (9,200 km) of canals and 1,305 miles (2,100 km) of drains in the subbasin, and water transfer from one river watershed to irrigate crops in another is common practice.

However, as available surface-water supplies have diminished, use of ground water in the Upper Snake subbasin has increased. From 1980 to 1990, annual ground-water use increased to 2.6 million acre-feet (Maupin 1995). At Heise, upstream from nearly all irrigation uses, the average annual flow of the Snake River approximates 6,900 cubic feet per second (cfs). A significant amount of the river flow below Heise is lost to groundwater and naturally recharges the eastern Snake River Plain aquifer. Streamflows are reduced by irrigation diversions to an average flow of 3,450 cfs at Milner Dam. A portion of the water that is diverted for agriculture percolates into the aquifer. Some of this groundwater returns to the Snake River in other reaches, such as the reach between the cities of Blackfoot and American Falls, Idaho.

The Lower Henrys Fork, Upper Henrys Fork, and Teton watersheds drain areas of 658,783; 709,934; and 705,980 acres, respectively (2,666; 2,873; and 2,857 km², respectively (658,783, 709,934, and 705,980 acres, respectively) (Table 1-1). Major tributaries in the watersheds are Henrys Lake Outlet and the Buffalo, Warm, Falls, and Teton rivers (Figure 1-5). Our listing of Henrys Lake Outlet as a tributary follows the convention that the Henrys Fork begins at the confluence of Henrys Lake Outlet and Big Springs (Van Kirk and Benjamin 2000). Most maps list the stream segment between Henrys Lake and Big Springs as the “Henrys Fork,” but local usage refers to this stream as “Henrys Lake Outlet.” In 2001, the name of this stream

segment was officially changed to “Henrys Lake Outlet” to be consistent with local usage and with the fact that in terms of total annual discharge, Big Springs, and not Henrys Lake, is the source of the Henrys Fork. The Upper Henrys Fork watershed consists of the Henrys Fork and its tributaries upstream of Ashton Reservoir. The Lower Henrys Fork watershed contains the river and its tributaries from Ashton Reservoir downstream to its confluence with the Snake River, excluding the Teton River. This hydrologic unit consists primarily of the Falls River drainage. The Teton watershed includes the Teton River and its tributaries (Figure 1-5).

The Raft watershed encompasses an area of about 963,711 acres (3,900 km²), about 95% of this area is in Idaho and the rest in Utah. The headwaters originate on the east side of the Albion Mountains southeast of the town of Oakley, Idaho. Perennially flowing headwater tributaries originating from the Albion Mountains near the City of Rocks National Reserve include Almo Creek and Edwards Creek. Tributary streams originating on the west side of the Black Pine Mountains include Sixmile Creek and Eightmile Creek. Farther downstream near the town of Malta, Cassia Creek enters the Raft River, which enters the Snake River at about 14 miles (23 km) downriver of Massacre Rocks State Park.

Located to the west of the Raft watershed, the Goose watershed has an estimated area of 716,111 acres (2,898 km²) (Table 1-1). The headwaters of Goose Creek originate in the South Hills south of the town of Twin Falls, Idaho, and flow south into Nevada, east into Utah, and then north into Idaho. Several spring-fed headwater tributaries in all three states provide significant flows to Goose Creek before it reaches the Oakley Reservoir impoundment, about 4 miles () south of the town of Oakley, Idaho.

The Blackfoot watershed encompasses 702,274 acres (2,842 km²) (Table 1-1) and includes 984 km of streams. Diamond and Lanes creeks merge to form the Blackfoot River, which winds westward for 209 km before reaching the Snake River west of the city of Blackfoot. Major tributaries include the Little Blackfoot River and Wolverine, Brush, Corral, Meadow, Trail, Slug, Dry Valley, Angus, and Spring creeks. Blackfoot Reservoir, created in 1910, is the only major reservoir in this watershed; it is operated by the U.S. Bureau of Indian Affairs.

The Portneuf watershed drains 850,290 acres (3,441 km²) in southeastern Idaho (Table 1-1) and is bounded by Malad Summit to the south, the Bannock Range to the west, the Portneuf Range to the southeast, and the Chesterfield Range to the northeast. Marsh Creek is the only major tributary to the Portneuf River (Figure 1-5). Other creeks in this watershed include Mink, Rapid, Garden, Hawkins, Birch, Dempsey, Pebble, Twentyfourmile, and Toponce creeks. The total area of the Chesterfield Reservoir is estimated at 1,236 acres (5 km²).

The Willow watershed is located in the southwestern section of the Upper Snake subbasin in southeastern Idaho. The watershed contains a total area of 415,631 acres (1,682 km²) (Table 1-1) and is composed of the drainage and tributaries that originate near Grays Lake National Wildlife Refuge in the Caribou National Forest and eventually meander through the Willow Creek drainage to Ririe Reservoir. The 19 miles (31 km) of Willow Creek below Ririe Dam is controlled for irrigation and flood control. This segment of Willow Creek is annually dewatered to keep ice buildup from causing floods near Idaho Falls. Some trout from irrigation ditches that flow into Willow Creek via the South Fork Snake River provide a seasonal fishery. The 95 miles (153 km) of streams in the Willow Creek drainage above

Ririe Reservoir are mainly in narrow canyons and contain important wild cutthroat trout populations.

The Idaho Falls watershed is located in the southwestern section of the Upper Snake subbasin in southeastern Idaho (Figure 1-4). The watershed contains a total area of 735,139 acres (2,975 km²) (Table 1-1) and includes the mainstem Snake River below the confluence of the Henrys Fork and South Fork Snake River.

Adjacent to the Idaho Falls watershed is the American Falls watershed, which contains American Falls Reservoir. This is the second largest in the Upper Snake subbasin with a total area of 1,864,163 acres (7,544 km²). Surface hydrology in the American Falls watershed is reasonably simple, with a few tributaries flowing into the Snake River from the south, while the north is dominated by the characteristically dry and flat Snake River Plain.

Lake Walcott is the largest watershed in the subbasin with a total area of 2,293,870 acres (9,283 km²). The Snake River flows for roughly 100 km through this watershed. Similar to American Falls, the surface hydrology is dominated by a few tributaries to the Snake River flowing from the south, and a large, dry, flat area to the north.

The Upper Snake Rock watershed lies at the western most extent of the Upper Snake Province. It is relatively small, containing only 625,214 acres (2,530 km²). At its western extent, this watershed is bounded by Shoshone Falls, which forms a natural barrier to anadromous fish into the Upper Snake Province. Additionally of note is that the Upper Snake Rock watershed contains the Thousand Springs area, where ground water contained within Eastern Idaho's massive aquifer drains into the Snake River. Additionally, some surface tributaries

contribute to the Snake River from within this watershed, although conditions tend to be relatively dry and flat.

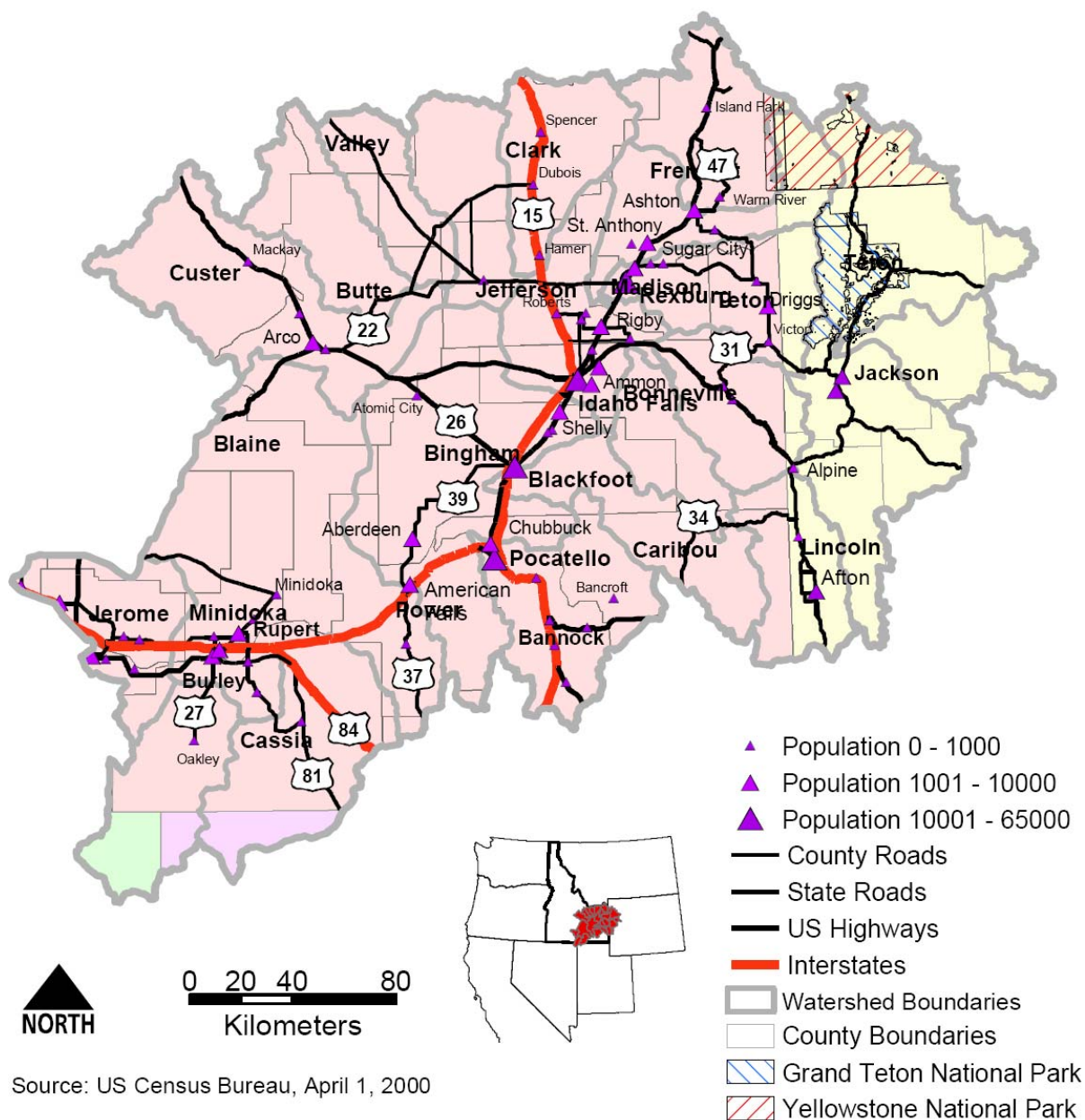


Figure 1-6. Population centers and major roadways in the Upper Snake province.

1.4.1.3 Closed Basin Subbasin

The Big Lost drainage is the largest of the Closed Basin drainages (Figure 1-4). Included in the Big Lost River watershed is Mackay

Reservoir (Figure 1-5). Major tributaries include Antelope, Summit, and Wildhorse creeks and the East, West, and North forks of the Big Lost River (IDFG 2001). The Big

Lost River originates near Mackay, Idaho, and drains more than 89,600 acres (3,626 km²) of mountainous area bounded by the Lost River Range and Pioneer Mountains to the east and west, respectively. Downstream from Arco, Idaho, water flow in the Big Lost River infiltrates to the Snake River Plain aquifer along the Big Lost River's channel and at sinks and playas at the river's terminus. Since 1965, excess runoff has been diverted to spreading areas to protect facilities at the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory, where much of the water rapidly infiltrates to the aquifer (Bennett 1990). Total drainage area is approximately 1,269,875 acres (5,139 km²) (Table 1-1).

The Bureau of Land Management administered portion of the upper Big Lost River watershed includes Thousand Springs, near Dickey, Idaho, and Chilly Slough, areas of unique hydrologic and ecosystem expression. In 1987, the Thousand Springs/Chilly Slough Area of Critical Environmental Concern (ACEC) was designated, and its management plan supports the protection and improvement of waterfowl and shorebird habitat. Species using these areas as breeding habitats include sandhill cranes, long-billed curlews, and numerous waterfowl. The Bureau of Land Management has joined with the Idaho Department of Fish and Game, as well as The Nature Conservancy and Ducks Unlimited, to develop a plan for the Chilly Slough Wetland Conservation Project (IDCDC 1999).

The Little Lost drainage is located in eastern Idaho (Table 1-1) on the northern margin of the Snake River Plain. This watershed covers 621,717 (2,516 km²) (Table 1-1). The river is flanked by the Lost River Range to the west and the Lemhi Range to the east. The headwaters of the Little Lost River are located in the far northern corner of the watershed in Sawmill Canyon. The river disappears into an

ephemeral playa, the Little Lost River Sinks, just south of Howe, Idaho, on the margin of the Snake River Plain. The river sometimes drains into the Big Lost River Sinks during times of extremely high runoff (Bartholomay 1990). Elevation in the Big Lost River watershed ranges from 4,777 feet (1,456 m) at the Little Lost River Sinks to 12,198 ft (3,718 m) at the summit of Diamond Peak in the Lemhi Range. The watershed has 17 lakes, 1 reservoir (Summit Creek Reservoir), 3 dysfunctional reservoirs, and several private ponds (Gamett 1990b). All of the lakes in the watershed are small (less than 6 ha or 0.6 km²) mountain lakes.

Like the Big Lost and Big Lost River watersheds, the Birch Creek watershed is a high, northwest- to southeast-trending mountain valley, approximately 460,604 acres (1,864 km²) in size (Table 1-1). The Birch Creek Valley is bordered by rugged mountains rising to nearly 11,155 ft (3,400 m) in the Beaverhead Mountains of the Bitterroot Range to the east and the Lemhi Range to the west. Willow Creek and Mud Creek are the major tributaries to Birch Creek, but much of the flow comes from springs high in the valley.

In the Medicine Lodge watershed, there are nearly 99 miles (160 km) of perennial streams, 57% of which are on lands administered by the U.S. Forest Service. Mud Lake/Terreton is the largest community in this drainage (Figure 1-6). At the lower end of the subbasin, Mud Lake actually receives its water from the Beaver-Camas watershed to the east and does not directly receive water from the Medicine Lodge watershed.

Beaver and Camas creeks of the Beaver-Camas watershed arise in the Centennial Mountains on the Idaho-Montana border and flow generally south and southwest, respectively. They converge just north of and provide the much of the water for the Camas

National Wildlife Refuge near Hamer, Idaho. After exiting the refuge, the combined streamflows westward into Mud Lake, a natural playa lake that was modified with a dam to form a year-round impoundment (Figure 1-5). The Beaver–Camas watershed encompasses 637,285 acres (2,576 km²) (Table 1-1).

1.4.2. Hydrology

The diversion dams (shown in Figure 1-7), reservoirs, and canals in the Upper Snake province are operated as a system divided into three water projects or districts. The projects begin with headwater reservoirs at Jackson Lake, Grassy Lake, and Henrys Lake and end with Milner dam and reservoir. Irrigated lands benefiting from these water projects extend downstream from Milner Dam to the town of Bliss, about 60 miles (96.6 km) below Milner Dam and 35 miles (56.3 km) below Shoshone Falls.

The Minidoka Project furnishes irrigation water from five reservoirs with a combined storage capacity of more than 3 million acre-feet. Project works include Minidoka Dam and Lake Walcott, as well as American Falls dam and reservoir. Above the Upper Snake subbasin, the project includes Jackson Lake dam and reservoir, Island Park dam and reservoir, and Grassy Lake dam and reservoir. Two diversion dams, canals, laterals, and drains deliver the water to about 1.1 million acres. American Falls Dam is used as a hydropower generation site by the Idaho Power Company. The Ririe Project is the smallest of the projects. Features of this project are the Ririe dam and reservoir. The project's principal purpose is flood control. Of the total reservoir capacity (100,500 acre-feet), 80,500 acre-feet serve both flood control and irrigation, 10,000 acre-feet are dead storage, and 10,000 acre-feet are reserved for flood control.

1.4.2.1 Snake Headwaters Subbasin

Much of the eastern and central portions of Grand Teton National Park (particularly areas covered by glacial outwash) have extensive groundwater resources (McGreevy and Gordon 1964, Cox 1974). Water tables vary from near the surface on floodplains to 30 to 60 feet (9.1-18.3 m) below the surface on outwash flats and deeper on most upland areas. Flow is toward the Snake River, and many springs emerge along the Snake River floodplain south of the Buffalo Fork confluence. Numerous springs also emerge from limestone areas in the northwest and southwest portions of Grand Teton National Park. Other springs along the park's east boundary include several thermal springs near the town of Kelly and East Gros Ventre Butte, Wyoming. Another series of thermal springs are on the west side of Jackson Lake and may be associated with the Teton fault.

Approximately 1.98 million acre-feet of water (average daily flow = 2,740 cfs) flow out of the National Park annually by way of the Snake River. Annual flow of the Gros Ventre River is about 345,000 acre-feet (average daily flow = 475 cfs). Streamflow is measured at three stations within the National Park: the Snake River below Jackson Lake Dam, Pacific Creek, and Buffalo Fork. The Pacific Creek and Buffalo Fork stations are under special use permit (U.S. Geological Survey). The Snake River station is on Bureau of Reclamation-withdrawn lands. Occasional streamflow measurements have been made for other streams in the National Park, but made systematically for only 15 years on the Gros Ventre River. Streamflow data are recorded in U.S. Geological Survey annual reports of water resources data.

Naturally occurring surface hydrologic features found on or influencing the National Elk Refuge include the Gros Ventre River, Flat Creek, Cache Creek, Nowlin Creek, and several other small creeks and springs. There

are two major streams flowing through the refuge. The Gros Ventre River forms much of the northern boundary, and Flat Creek, flowing east to west, nearly bisects the refuge. As Flat Creek approaches the western boundary of the refuge, it turns south and leaves the refuge in the southwest corner. The National Elk Refuge contains approximately 1,641 acres (6.6 km²) of wetlands consisting primarily of palustrine emergent and, to a lesser degree, scrub-shrub and aquatic bed wetlands. Refuge wetlands are some of the most diverse and important in the valley due to their multifunctional character, visual qualities, and importance to a wide variety of wildlife, especially resident and migratory birds. The majority of the wetlands on the refuge are located within the Nowlin Management Unit, which contains approximately 1,300 acres (5.3 km²) of the emergent wetlands. The remaining 300 acres (1.2 km²) can be found scattered throughout the refuge, often in the form of linear palustrine emergent or scrub-shrub wetlands along the banks of watercourses or in the form of unconsolidated bottom wetlands associated with seasonal watercourses.

The primary drainage for streams and groundwater in the Palisades watershed is the South Fork Snake River. The Bureau of Land Management and Targhee National Forest describe three general sections that characterize the stream corridor of the South Fork Snake River in this watershed (BLM and TNF 1991). From Palisades Dam downstream to Squaw Creek, the river follows a single channel through a narrow mountain valley cut into surrounding terraces, which rise steeply and abruptly transition to the uplands. Downstream from Squaw Creek, the river begins showing complex floodplain features, with side channels and islands, but the river bottom is narrow and flows through a rugged canyon. No road or foot traffic is possible along this stretch. The final stretch of the South Fork Snake River in this watershed

flows through a narrow canyon, but the river has several large river bars and numerous islands (BLM and TNF 1991).

Tributary flows are not regulated. The mountainous character of most of the Palisades watershed contributes to the natural stream discharge. The runoff pattern is dominated by snowmelt, which contributes to daily as well as seasonal variations in streamflow measurements. Flows are usually highest during spring runoff. Occasional summer thunderstorms sometimes increase tributary streamflow, but generally the lowest flows are in summer, fall, and winter (Drewes 1991).

Management of Palisades Reservoir currently regulates the water level and volume of the South Fork Snake River. The building of Palisades Dam was authorized primarily to store irrigation water, and the reservoir currently maintains an active storage capacity of 1,200,000 acre-feet. When the dam was completed in 1956, the upper portion of Swan Valley was inundated, and the flow rate of the river has been directed by irrigation needs since reservoir management began in 1957. Palisades Reservoir is also managed for flood control, power generation, recreation, and wildlife conservation. Water supply and demand are affected not only by weather, but also by storage holdover and water rights, and so analysis of average annual streamflow will not indicate natural hydrological trends for the South Fork Snake River (BLM and TNF 1991).

Composite hydrographs of mean daily discharge of the South Fork Snake River at the Heise gauging station were used to compare pre-Palisades Dam years to post-dam years to demonstrate altered flow patterns (Merigliano 1996). After the dam began controlling water discharge in 1957, three significant flow alteration trends appear on the comparative hydrographs. First, in post-

dam years, comparatively more water is released earlier in the spring, prior to snowmelt runoff, than was released in pre-dam years. Secondly, in post-dam years, throughout the late spring and summer months, larger peak flows that could lead to flooding are reduced. Finally, flows lower than those of pre-Palisades Dam conditions generally occur during fall and winter months while the reservoir is filling. Although the frequency of moderate flows has remained similar to that indicated in pre-dam data, the timing of these flows has changed. Moderate flows are the most efficient at transporting sediments over time, and the frequency of moderate flows has not changed significantly with operation of the dam.

Eighteen U.S. Geological Survey gages are located in the Palisades watershed. The two gages operating for the longest period of record and having the capability for reporting real time data are both below the dam on the South Fork Snake River near Irwin and Heise (Table 1-2). As shown in Table 1-2, the average annual discharge for the South Fork Snake River near Irwin is 6,578 cfs for the period 1935 to 1999, while the average annual discharge near Heise is 7,037 cfs for 1911 to 1999. Since Palisades Reservoir is managed primarily for irrigation needs (BLM and TNF 1990), the minor decrease in the lowest annual streamflows at the downstream Heise gage may be due to irrigation withdrawals.

Table 1-2. Flow statistics for data of record from U.S. Geological Survey gages near Heise and Irwin, Idaho (source: USGS 2004).

Station Name	Station	Data Years	Average Annual (cfs)	Highest Annual (cfs)	Lowest Annual (cfs)
Snake River near Irwin, ID	13032500	1935–1999	6,578	10,710	4,394
Snake River near Heise, ID	13037500	1911–1999	7,037	11,590	4,117

Drainage patterns are complex, but most of the major streams within the Palisades watershed exhibit dendritic, or branching, drainage patterns (USGS 1996), with some parallel drainage patterns in the Fall Creek region.

1.4.2.2 Upper Snake Subbasin

River systems and their drainage patterns in the Upper Snake subbasin are a result of water moving across areas of recent volcanic activity and uplifted mountains. The Lake Bonneville basin of western Utah, southern Idaho, and eastern Nevada had major influence on the subbasin's fisheries resources. The Lake Bonneville floods spilled over into the Portneuf River drainage and then

to the Snake River near Pocatello, Idaho, about 14,500 years ago. The event left its mark on the landscape of the Portneuf and Upper Snake–Rock watersheds (Malde 1968). In a few square miles of flat valley bottom near Soda Springs, Idaho, streams drain south to the Bear River and Lake Bonneville basin and north to the Blackfoot and Portneuf watersheds of the Upper Snake subbasin. Within the last million years, basaltic flows dammed and diverted the Bear River away from the Portneuf and Snake river drainages.

In general, streams or waterbodies within the Upper Snake subbasin may be divided into perennial and intermittent waterbodies. Each of these may be further subdivided into springs, streams, aqueducts, and

lakes/reservoirs or canals (Table 1-3)
Intermittent streams comprise 46.4% of the total stream kilometers; canals, 35.4%; and perennial streams, 15.2%.

American Falls Reservoir, a Bureau of Reclamation project with power generation by

Idaho Power Company, is the largest and lowest reservoir in the Upper Snake subbasin. Water discharges into the reservoir basin from springs between Blackfoot and the Fort Hall Bottoms, and flows of the Snake and Portneuf rivers reliably refill American Falls Reservoir (1.67 million acre-feet) each year.

Table 1-3. Perennial and intermittent water bodies of the Upper Snake subbasin (Buhidar 1999). Prepared by Idaho Department of Environmental Quality-Twin Falls Regional Office from U.S. Geological Survey GIS maps via ArcView 1996. (Note: a canal is a manmade conveyance structure used to carry irrigation water from a recognized point of diversion. Natural streams, which may at times convey irrigation water, are not considered canals under the current definition. Aqueducts are defined as conduits or artificial channels that convey water above the surface across a river or hollow.)

Waterbody	Kilometers	Percentage (%) of Total
Perennial Waterbodies		
Springs	10	0.20
Streams	797	15.18
Aqueducts	1	0.02
Lakes and reservoirs	143	2.73
Subtotal	952	18.13
Intermittent Waterbodies		
Springs	5	0.10
Streams	2,436	46.37
Aqueducts	1	0.03
Canals	1,858	35.37
Subtotal	4,301	81.87
Total	5,253	100.00

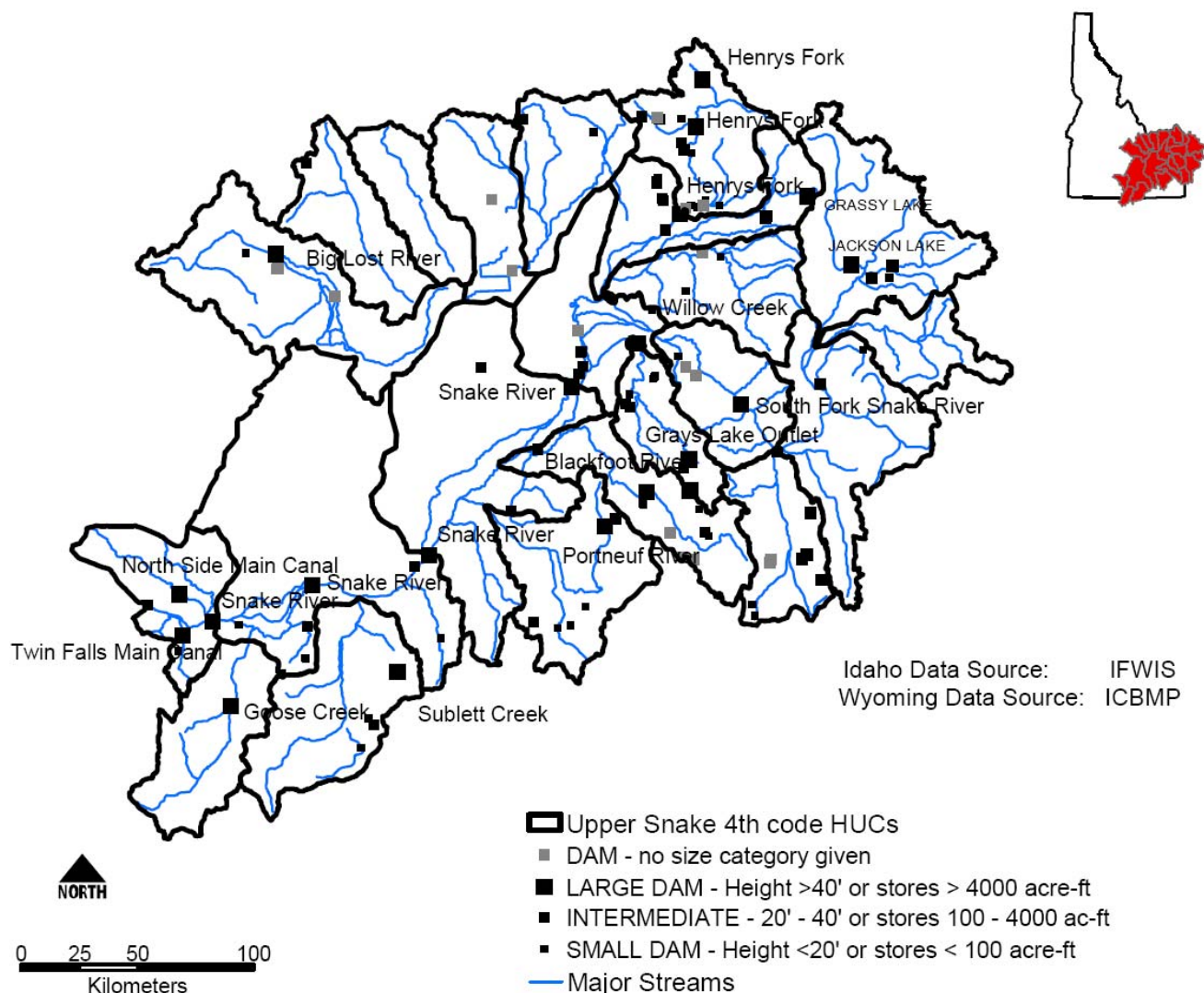


Figure 1-7. Locations of dams in the Upper Snake province.

Several hydroelectric power generation plants also operate in the Upper Snake subbasin. The Minidoka Power Plant (28.5 megawatts) serves the pumped irrigation requirements on and near the Minidoka Project. Power not needed for Bureau of Reclamation project purposes is marketed in the Federal Southern Idaho Power System administered by the Bonneville Power Administration. Idaho Power Company operates three hydroelectric power generation plants (IPC 2003). Plants at American Falls Dam generate

112,420 kilowatts, while Milner Dam generates 59,448 kilowatts and Shoshone Falls generates 12,500 kilowatts.

Much of the upper Henrys Fork hydrologic unit discharge (75% of base flow at Island Park and 45% of base flow at Ashton) originates as springs on the eastern edge of the Island Park Caldera (Whitehead 1978). These springs are ecologically important during winter, when they provide thermal refugia for fish and open water areas for waterfowl (Table 1-4). During summer, fish

also find thermal refugia in the springs, which remain cooler than adjacent streams affected by surface area. Springs located upstream of Island Park Dam, including Big Springs and

Lucky Dog Springs, provide a constant, dependable discharge used to fill Island Park Reservoir (Benjamin and Van Kirk 1999, Benjamin 2000).

Table 1-4. Temperatures and discharge rates of the Henrys Fork springs (data from Benjamin 2000).

Spring	Temperature (°C)	Discharge (m ³ /s)
Lucky Dog	12.6	0.8
Big Springs	12.5	5.4
Buffalo River	11.3	1.1
Chick Creek	11.0	0.4
Snow Creek	5.5	0.4
Warm River	12.0	5.6

1.4.2.3 Closed Basin Subbasin

Most of the watersheds within the Closed Basin subbasin have a somewhat similar hydrological regime. All have a large variety of streams, from streams with natural, steady, thermal springs to high-intensity runoff streams receiving snowmelt directly from high mountain ranges. Much of the land in each watershed is semiarid steppe, but there are also many miles of ephemeral and intermittent drainages. Many subdrainages never enter the waterways because of topographic barriers, irrigation withdrawals, and channel bed losses. There are seven U.S. Geological Survey streamflow gages in the Closed Basin subbasin. All are on the Big Lost River.

The average streamflow in the Big Lost River below Mackay Reservoir for the 83-year period of record (water years 1905, 1913–1914, and 1920–1999) was 225,500 acre-feet per year (Brennan *et al.* 2000). Streamflow in the Big Lost River below Mackay Reservoir was 274,900 acre-feet during the 1999 water year (Brennan *et al.* 2000). Annual peak streamflow measured below Mackay

Reservoir varies by as much as a factor of six. Recharge to the Snake River Plain aquifer can be substantial downstream from Arco; measured infiltration losses at various discharges ranged from 1 to 28 cfs/mile (Bennett 1990).

1.4.3 Geology

1.4.3.1 Snake Headwaters Subbasin

Anticlinal and synclinal structures of the Snake Headwaters subbasin in combination with fault thrust zones give rise to an intricate system of linear valleys and ridges (see Figure 1-8 for major geological formations within the province). The mountains are characterized by tight-to-open folded Paleozoic and Mesozoic sedimentary rocks (Ross and Savage 1967). The largest continual coverage of any one geological unit occurs in the Idaho Falls watershed where 72% of the land is Pleistocene to Pliocene basalts and associated tuffs and volcanic detritus. Peaks within the Snake Headwaters watershed exceed 14,436 ft (4,400 m) due to the faulting and tilting of the blocks that resulted in a very steep escarpment along the

east face of the Teton Range and a gentler slope on the west side. Deep, glacier-carved canyons cleave the mountains, and several canyons have large, morainal lakes at their mouths. Alpine lakes and tarns are numerous. The core of the Teton Range is metamorphic gneisses and schists and igneous rocks (granite and pegmatite).

The extent of mineral resources in Grand Teton National Park is poorly known. The two easternmost townships may have coal deposits of some value. Half of the park may have oil and/or gas deposits. Other possible minerals include phosphate, bentonite, asbestos, gold, lead, and silver (Austin *et al.* 1976). The federal Soil Conservation Service (now called the Natural Resources Conservation Service) has classified and mapped 44 soil series in Grand Teton National Park (Young 1982).

Within the boundaries of the National Elk Refuge, over 20 different soil types occur (Young 1982). Soils on the refuge at lower elevations are alluvial, generally sandy loam or loam, and are shallow and permeable. The soils at higher elevations are also loamy, but considerable areas of gravelly soils and cobblestone occur on the south slopes and ridges. The northern half of the refuge consists of steep rolling hills; the southern half is glacial outwash material, with one

resistant formation (Miller Butte) rising approximately 502 feet (153 m) above the valley floor.

Geological forces created a distinctive topographic trend along a northwest to southeast axis (USGS 1992), with mountain ranges to the southwest and northeast of the South Fork Snake River and valley flats between the ranges (Figure 1-8). An overthrust belt that was active during formation of the Rocky Mountains pushed from the southwest through layers of sedimentary bedrock to form the Caribou Range. High angle block-faulting events cut into this overthrust belt to create typical Basin and Range topography. These characteristics place the Palisades watershed in the Middle Rocky Mountains Hypsographic Province, with block-faulting influence from the Basin and Range Province to the south (Alt and Hyndman 1989). Igneous rocks of volcanic flows (where rhyolite and rhyolitic tuff are the dominant igneous rocks associated with extrusive flows and dissected shields); overthrust structures of sandstone, shale, limestone, and dolomite; glacial depositional/erosional cycles and deposits of alluvium at the base of block faults (Merigliano 1996); and hard Mesozoic sedimentary bedrock, mostly limestone, compose part of the geomorphology of the Palisades watershed.

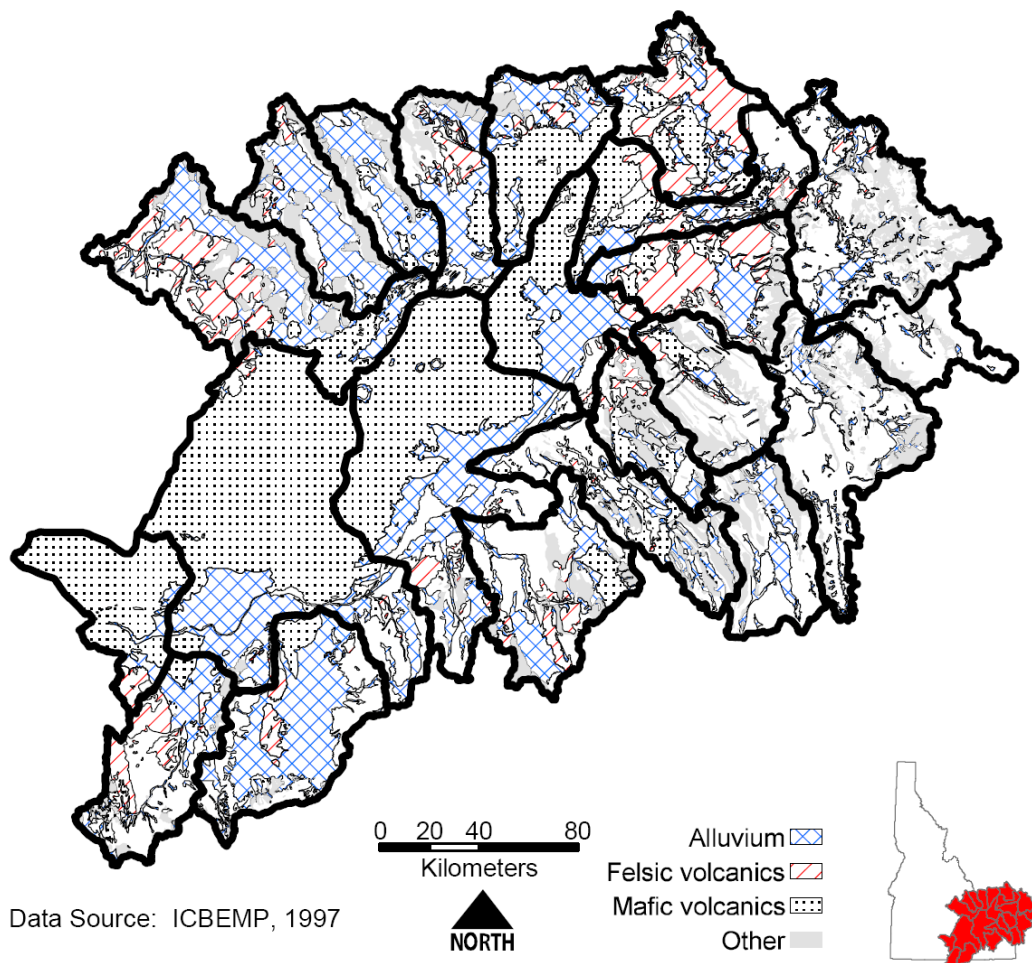


Figure 1-8. Major geological formations within the Upper Snake province.

1.4.3.2 Upper Snake Subbasin

In general, the Upper Snake subbasin has a land-surface form or topography that consists of tablelands with medium to high relief (Figure 1-8). The plains have hills or low mountains. The Snake River canyon is a steep-sided trench, cut into the relatively flat surrounding plain. Shoshone Falls is a 212-foot-tall (64.6 m) natural waterfall located about 2.7 miles (4.3 km) downstream of Twin Falls Dam. It is recognized as a natural barrier to upstream migration of native fish species (FERC 1997a).

The elevation within the Upper Snake subbasin also describes the varying topography of the subbasin. In the northwestern portion, the Clover Creek drainage begins at 6,400 feet (1,951 m) in the Bennett Hills. In the southeastern portion of the subbasin, the Rock Creek drainage begins at 7,700 feet (2,347 m) in the Sawtooth National Forest and drains northward to the Snake River at about 3,500 feet (1,067 m). Geology is characterized largely by basalt flows in the lowlands of the central and southern parts of the subbasin and by intrusive volcanic, sedimentary, and metamorphic rocks in the uplands and mountains to the north, south, and east.

In the Upper Snake subbasin, alkalization of the area lets the soil water bring salts and alkalis to the surface, where they then evaporate, leaving a whitish crust. This alkalization and evaporation process has produced salty desert soils (or Aridisols) in many areas of subbasin. In general, the subbasin is comprised of soils that are 87% Aridisols and 13% Mollisols. Aridisols are mineral soils that have developed in dry regions. They are light colored and low in organic matter and may have accumulations of soluble salts and lime. The lower the precipitation, the more likely these accumulations are to be near the surface. Of the Aridisols and Mollisols in the subbasin, about 35% are loess (or buff-colored calcareous silt transported as wind deposits), while the remaining 63% contain residuum (or residual soil that is developed from the weathering of rock directly beneath it), colluvium (loose and incoherent deposits at the base of slopes or cliffs brought there by gravity), and alluvium (deposits of silt or silty clay laid down during times of flooding).

The volcanic features present in the Upper Henrys Fork, Lower Henrys Fork, and Teton watersheds were created between about four million and 600,000 years ago as a “hot spot” of volcanism moved northeastward through the region (Hackett and Bonnicksen 1994). This hot spot now lies under Yellowstone National Park. The oldest volcanic formations in the watershed are those associated with the Snake River Plain: an 80- to 110-km-wide crescent of lava covering most of southern Idaho. The Island Park region lies at the transition between the basalts of the Snake River Plain and the more recent rhyolite flows of the Yellowstone Plateau (Christiansen 1982, Christiansen and Embree 1987). The Island Park Caldera consists of three smaller calderas formed by cycles of volcanism occurring between two million and 600,000 years ago. The Madison and Pitchstone plateaus on the northeastern edge of the

watersheds were formed by rhyolite flows that erupted from the Yellowstone hot spot about 600,000 years ago (Benjamin 2000).

1.4.3.3 Closed Basin Subbasin

The Closed Basin subbasin occurs within the Northern Rocky Mountain and Columbia Intermontane geomorphic provinces. The subbasin encompasses 16 major geological formations. Four geological features are predominant: Quaternary alluvial deposits, Pleistocene to Pliocene basalts and associated tuffs and volcanic detritus, Paleozoic and Mesozoic mixed sedimentary rocks, and Eocene mixed silicic and basaltic ejecta, flows, and reworked debris. The Beaver–Camas watershed is composed mainly of Pleistocene to Pliocene basalts and associated tuffs and volcanic detritus. Quaternary alluvial deposits are the dominant geological feature in the Big Lost, Birch, Little Lost, and Medicine Lodge watersheds.

Topographical relief of the subbasin is reflective of a terrain that once attained a mature erosional level (by the Middle Tertiary) and subsequently uplifted, thus reinitiating stream erosional processes (Ross and Savage 1967). Quaternary glaciation occurred primarily on isolated high-elevation peaks. Alpine glacier systems formed in the Pioneer Mountains, Lost River Range, Lemhi Range, and Centennial Mountains. Large-scale, glacially derived physiographic features (for example, broad U-shaped valleys) are not prominent. Rather, stream erosion has played the predominant role in shaping the physiography of the mountainous regions of the subbasin. Stream erosion since the Middle Tertiary has given rise to topography characterized by relatively narrow, V-shaped valleys; steep valley side slopes; and relatively broad, gentle ridge systems. Lower portions of the Big Lost, Little Lost, and Birch Creek watersheds and much of the Medicine Lodge and Beaver–Camas

watersheds encompass the lava-filled structural and topographical basin of the upper Snake River Plain. The young lava plateau of converging low shield volcanoes is punctuated by cinder cones and low lava ridges and mantled by a thin layer of wind-blown soil (Ross and Savage 1967).

1.4.4 Climate

The climate in the Upper Snake province is influenced by interactions between prevailing southwesterly winds and the typically north-south orientation of mountain ranges. Pacific maritime-influenced climatic conditions prevail in the high-elevation regions of the province; continental climatic conditions prevail in the low-elevation broad valleys and plains. Precipitation is relatively evenly divided between cold winters and warm summers but is usually characterized by a large early-winter peak in higher elevations. Average annual precipitation exceeds 25 inches (63.5 cm) along the Continental Divide and is approximately 8 to 10 inches (20-25 cm) at the lower elevations. The vast majority of discharge in the province's streams is derived from snowfall at elevations higher than 6,234 ft (1,900 m). July, August, and September are normally the driest months. Topography is a primary influence on climate in areas along the Continental Divide and in mountain ranges including the Lemhi Range, Lost River Range, and Pioneer Mountains.

Some of the lowest temperatures in the United States have been recorded in this region. A temperature of -63 °F (-52.8 °C) was recorded on February 9, 1933, in Jackson Hole, Wyoming. The lowest temperatures ever recorded for the months of February, March, July, September, October, and December were also recorded in the Snake Headwaters subbasin. Average annual temperatures during July, the warmest month, are typically near 70 °F (21 °C). Summer

temperatures in excess of 100 °F (38 °C) are common.

1.4.4.1 Snake Headwaters Subbasin

The climate of the Snake Headwaters subbasin is influenced by interactions between prevailing southwesterly winds and the typically north-south orientation of mountain ranges (McNab and Avers 1994). Pacific maritime-influenced climatic conditions prevail in high-elevation regions of the subbasin. In these regions, precipitation occurs primarily as snow during winter. Summers are relatively short, cool, and dry. In contrast, on low-elevation broad valleys and plains of the subbasin, continental climatic conditions are prevalent. Precipitation is relatively evenly distributed between the cold winters and warm summers. Continental climatic conditions are particularly pronounced within the Palisades and Salt watersheds.

The climate of the Upper Snake province above Palisades Dam is very much dependent upon topography. For the most part, the region is mountainous, except for the valley of the Salt River, called Star Valley, and Jackson Hole. The entire basin is above 6,000 feet (1,829 m), except for a small part of the lower Star Valley and the area immediately around Palisades Reservoir. Because of this scheme, the Palisades watershed experiences long, cold winters and pleasantly mild summers. Freezing temperatures have occurred in all months of the year, and most areas have a freeze-free season of fewer than 30 days.

Precipitation varies widely depending on elevation. From Palisades Dam upstream to both Afton and the Star Valley and Jackson in Jackson Hole, annual amounts are between 15 and 20 inches (38-51 cm). Most precipitation in valleys occurs as snow from November through March, with some snowfalls

occurring as early as August or as late as June. In the high country, annual precipitation varies from about 20 inches (51 cm) on lower slopes to over 70 inches (179 cm) on the Pitchstone Plateau in Yellowstone National Park and other mountain areas over 9,000 feet (2,743 m). Snow can occur anytime throughout the year, although the period of significant snow accumulation extends from late October through April. Annual snowfall can vary from about 55 inches (140 cm) in the vicinity of Palisades Dam, to 80 inches (203 cm) at Afton and Jackson, to about 120 inches (305 cm) at Moran. Above Jackson Lake, snowfall increases significantly with increasing elevation, especially in the northern part of the basin. More than 500 inches (1,270 cm) of snow falls annually over the Pitchstone Plateau in Yellowstone National Park and in mountains north and east of Jackson Lake. Lower-elevation mountains can receive between 200 and 400 inches (508-1,016 cm) a year. The greatest flood potential occurs when heavy spring rains fall during the snowmelt season from late May through July. Precipitation during the warm season falls mostly from showers and thunderstorms. Thunderstorms are frequent from June through August, occurring, on average, on about half the afternoons. Precipitation amounts from individual storms are relatively small. The greatest daily precipitation recorded during summer at any of the stations in the subbasin was 2.56 inches (6.5 cm) at the Snake River Range Station on July 24, 1913.

1.4.4.2 Upper Snake Subbasin

The climate of the Upper Snake subbasin is semiarid with low annual rainfall, moderately hot and dry summers, moderate to cold winters, and relatively windy springs. Average annual precipitation is 11 inches (27 cm) and may vary from 50 to 150% of the mean. In general, precipitation is fairly consistent throughout the year, except in July

through September, when the total for the three months may be less than 1 inch (< 3 cm). More recently, from 1991 to 1996, annual precipitation of 9.6 inches (28.4 cm) was higher than the historical normal of 10.5 inches (26.7 cm) due to above normal snows and rains in winter and spring (AgriMet 1994).

Average annual air temperature ranges from 40 to 51 °F (100 °C). January and July are typically the coldest and warmest months, with average temperatures of 29.4 °F and 72.7 °F, respectively. During summer, temperatures in excess of 100 °F are common (AgriMet 1994).

The climate of the Upper Henrys Fork subbasin is primarily arid to semiarid and characterized by subfreezing winters and cool summers. Mean annual temperature ranges from about 41.53 °F (5.3 °C) at the lowest elevations to less than 343 °F (<1 °C) at the highest elevations. Mean annual precipitation ranges from 12 inches (30 cm) at low elevations to greater than 40 inches (100 cm) at higher elevations (Van Kirk and Benjamin 2000). Precipitation is nearly uniformly distributed throughout the year at the lowest elevations but exhibits a large early-winter peak at the higher elevations. May and June are the wettest months at lower elevations, whereas November, December, and January are the wettest months in the mountains. The vast majority of discharge in the subbasin's streams is derived from snowfall at elevations higher than 6,234 ft (1,900 m) (Van Kirk and Benjamin 2000).

1.4.4.3 Closed Basin Subbasin

Due to the large range in elevation, from the Continental Divide down to the Lost River Sinks on the Snake River Plain, temperatures and precipitation vary significantly throughout the subbasin. The average annual precipitation exceeds 64 cm on the

Continental Divide and high mountains but is 25 cm at Mud Lake. Thirty years of precipitation monitoring at the U.S. Department of Agriculture's Dubois Experimental Station, representative of a mid-elevation band within the Medicine Lodge watershed, shows the average annual precipitation at 33 cm, with an average monthly peak of 5 cm in June and an average monthly low at 2 cm in February. Weather records for the Idaho National Engineering and Environmental Laboratory, located at the lowest elevation in the subbasin, show a 40-year annual average precipitation (Clawson *et al.* 1989) of 22 cm at the southern (highest) end and 20 cm at northern end near the Lost River Sinks. The climate and landscape of this area are semiarid steppe. Day winds on the Snake River Plain and the Medicine Lodge and Beaver–Camas watersheds are primarily from the southwest, while night winds, generally reversed, are from the northeast (Clawson *et al.* 1989). Winds in the Big Lost, Little Lost, and Birch Creek valleys usually parallel and blow up valley in the daytime and down valley at night. As in other high-elevation, interior continent environments, there are significant daily and annual temperature fluctuations. Recorded high and low temperatures on the Idaho National Engineering and Environmental Laboratory are 102 °F (39 °C) and -47 °F (-43.9 °C), respectively.

1.5 Biological Description

1.5.1 Aquatic Species

The Snake River ecosystem has undergone significant transformation from a primarily free-flowing, coldwater system to a slower-moving, warmer system. Consequently, this change has impacted many of the native aquatic species. Species present in the Snake River system are vulnerable to continued adverse habitat modification and deteriorating water quality from one or more of the

following: hydroelectric development, load-following (the practice of artificially raising and lowering river levels to meet short-term electrical needs by local run-of-river hydroelectric projects) effects of hydroelectric project operations, water withdrawal and diversions, water pollution, inadequate regulatory mechanisms, and possible adverse effects of introduced exotic species.

1.5.1.1 Invertebrate Species

Over 40 native mollusc species reside in the mainstem Snake River and adjacent springs (Bowler and Frest 1992). Five snails are listed under the Endangered Species Act (ESA), and three others are classified as species of concern (Table 1-5). The listed snails are primarily limited to the Snake River basin below American Falls Dam and are generally intolerant of pollution, though they have divergent habitat preferences. The California floater (*Anodonta californiensis*) and three of the snails listed under the ESA are known to occur in the Upper Snake province: the Utah valvata snail (*Valvata utahensis*), Bliss Rapids snail (*Taylorconcha serpenticola*), and Snake River physa snail (*Physa natricina*).

The numerous springs that arise within the Snake River canyon provide a unique habitat that has been geologically isolated for several thousand years. This isolation has caused populations of molluscs to evolve as separate species that are found only within this reach of the Snake River and some of the adjacent springs. These native, coldwater snails appear to have decreased in numbers, while more pollution-tolerant, introduced species such as the New Zealand mudsnail (*Potamopyrgus antipodarum*) have increased in numbers. The New Zealand mudsnail is a relatively new invasive snail that has rapidly expanded its range and tends to dominate the invertebrate community in many locations of the Snake River (Bowler 1991, Royer *et al.* 1995).

Table 1-5. Threatened (T), endangered (E), and sensitive mollusc species found in the Snake River. (Note: W = watch species, species of concern to the U.S. Fish and Wildlife Service (USFWS) but without formal federal status.)

Species Common Name	Species Scientific Name	ESA Listing or USFWS Concern Status
Bliss Rapids snail	(<i>Taylorconcha serpenticola</i>)	T
Idaho springsnail	(<i>Pyrgulopsis idahoensis</i>)	E
Utah valvata snail	(<i>Valvata utahensis</i>)	E
Snake River physa snail	(<i>Physa natricina</i>)	E
Banbury Springs limpet	(<i>Lanx</i> sp.)	E
Giant Columbia River limpet	(<i>Fisherola nuttalli</i>)	W
California floater	(<i>Anodonta californiensis</i>)	W
Columbia pebblesnail	(<i>Fluminicola fuscus</i>)	W

1.5.1.2 Fish Species

A relatively small number of coldwater fish species, primarily Catostomidae (suckers), Cottidae (sculpins), and *Rhinichthys* (dace), are native to the Upper Snake River above Shoshone Falls (Table 1-6). Other native nonanadromous species include Yellowstone cutthroat trout (*Oncorhynchus clarki*

bouvieri), finespotted cutthroat trout (*O. clarki* spp.), mountain whitefish (*Prosopium williamsoni*), Utah chub (*Gila atraria*), and leatherside chub (*G. copei*). White sturgeon (*Acipenser transmontanus*) and rainbow trout (*O. mykiss*) do not migrate above Shoshone Falls but have been introduced to various waterways in the province.

Table 1-6. Fish species present in the Snake River above Shoshone Falls (Buhidar *et al.* 1999). (Note: N = native origin; I = introduced origin.)

Family Taxonomy		Species Taxonomy		Origin
Common Name	Scientific Name	Common Name	Scientific Name	
Sturgeon	<i>Acipenseridae</i>	White sturgeon	<i>Acipenser transmontanus</i>	I
Trout	<i>Salmonidae</i>	Mountain whitefish	<i>Prosopium williamsoni</i>	N
		Yellowstone cutthroat trout	<i>Oncorhynchus clarki bouvieri</i>	N
		Finespotted cutthroat trout	<i>Oncorhynchus clarki</i> ssp.	N
		Rainbow trout	<i>Oncorhynchus mykiss</i>	I
		Utah chub	<i>Gila atraria</i>	N
		Leatherside chub	<i>Gila copei</i>	N
		Longnose dace	<i>Rhinichthys cataractae</i>	N
		Speckled dace	<i>Rhinichthys osculus</i>	N

Family Taxonomy		Species Taxonomy		Origin
Common Name	Scientific Name	Common Name	Scientific Name	
		Redside shiner	<i>Richardsonius balteatus</i>	N
Sucker	<i>Catostomidae</i>	Utah sucker	<i>Catostomus ardens</i>	N
		Mountain sucker	<i>Catostomus platyrhynchus</i>	N
Sculpin	<i>Cottidae</i>	Mottled sculpin	<i>Cottus bairdi</i>	N
Trout	<i>Salmonidae</i>	Coho salmon	<i>Oncorhynchus kisutch</i>	I
		Golden trout	<i>Oncorhynchus aguabonita</i>	I
		Brown trout	<i>Salmo trutta</i>	I
		Brook trout	<i>Salvelinus fontinalis</i>	I
		Lake trout	<i>Salvelinus namaycush</i>	I
		Arctic grayling	<i>Thymallus arcticus</i>	I
		Carp	<i>Cyprinus carpio</i>	I
		Grass carp	<i>Ctenopharyngodon idella</i>	I
		Spottail shiner	<i>Notropis hudsonius</i>	I
		Fathead minnow	<i>Pimephales promelas</i>	I
		Brown bullhead	<i>Ameiurus nebulosus</i>	I
		Blue catfish	<i>Ictalurus furcatus</i>	I
		Channel catfish	<i>Ictalurus punctatus</i>	I
Livebearer	<i>Poeciliidae</i>	Mosquitofish	<i>Gambusia affinis</i>	I
Sunfish	<i>Centrarchidae</i>	Pumpkinseed	<i>Lepomis gibbosus</i>	I
		Bluegill	<i>Lepomis macrochirus</i>	I
		Smallmouth bass	<i>Micropterus dolomieu</i>	I
		Largemouth bass	<i>Micropterus salmoides</i>	I
		Black crappie	<i>Pomoxis nigromaculatus</i>	I
Perch	<i>Percidae</i>	Yellow perch	<i>Perca flavescens</i>	I
		Walleye	<i>Stizostedion vitreum</i>	I

A native nongame species, the leatherside chub, is also listed by the Idaho Department of Fish and Game as a species of special concern¹. This fish has a limited distribution in the Upper Snake subbasin and may never have been abundant. Populations of leatherside chub occur in the Goose Creek

and Raft River drainages, near the lower end of the Upper Snake subbasin. In 2000, Caribou National Forest biologists found leatherside chub in the upper Blackfoot River tributary of Angus Creek.

The Snake River from American Falls Dam to the mouth of Raft River has long been considered a quality trout fishery and recently produced a quality smallmouth bass population. From Eagle Rock to the mouth of Raft River, the river is actually the backwater of Lake Walcott behind Minidoka Dam. This

¹ In March 2004, the Idaho Department of Fish and Game Commission voted to eliminate the conservation category, Species of Special Concern. This change is expected to take place July 1, 2004.

area is a quality trout and bass fishery especially when fish are washed into the river from American Falls Dam and upriver water quality is poor and/or water quantity is low. A portion of the river between Raft River and Cold Creek is within the Minidoka National Wildlife Refuge, and boaters are prohibited from entering this area.

In addition to trout, this river reach contains a sturgeon fishery that was newly developed during the 1990s. Bass fishing is most common in the lower portion of this reach, and sturgeon fishing is best in the first deep pool downriver from American Falls Dam.

There is no surface water connection between waters within the Closed Basin subbasin and the Snake River. However, a number of nonnative species, all salmonids, were introduced into the Closed Basin subbasin, and most of those species are still present. Most of the fisheries within the Closed Basin subbasin are artificially sustained. Few sustaining populations of native, resident fish remain. Rainbow trout (*Oncorhynchus mykiss*) of generally small size are the predominant fish throughout the Closed Basin drainages, except for some headwaters and a few minor tributaries where brook trout are dominant. Native bull trout (*Salvelinus confluentus*) and Yellowstone cutthroat trout are maintaining fishable populations in some limited areas. Mountain whitefish are found only in the Big Lost River watershed.

1.5.2 Wildlife

Many areas within the Upper Snake province support a variety of wildlife species (up to 401 species) including big game, upland game, waterfowl, and nongame species (Appendix 1-1). Wildlife populations in the province tend to fluctuate in response to natural and anthropogenic environmental conditions and habitat changes. Direct wildlife population management (that is, hunting, trapping, etc.) also affects wildlife populations. Wildlife species present in the province include actively managed big game species, native and nonnative game birds, waterfowl, and a larger number of nongame mammals, birds, amphibians, and reptiles (Appendix 1-1). Gray wolves (*Canis lupus*) inhabit a portion of the province. Watersheds in the Snake Headwaters and Upper Snake subbasins provide important nesting areas for bald eagles (*Haliaeetus leucocephalus*) and peregrine falcons (*Falco peregrinus*) and wintering habitat for trumpeter swans (*Cygnus buccinator*). The Closed Basin subbasin supports relatively healthy populations of native wildlife (Figure 1-9), primarily because of relatively limited anthropogenic effects. Within the Closed Basin subbasin, areas of high vertebrate richness are in the Little Lost and Birch Creek watersheds.

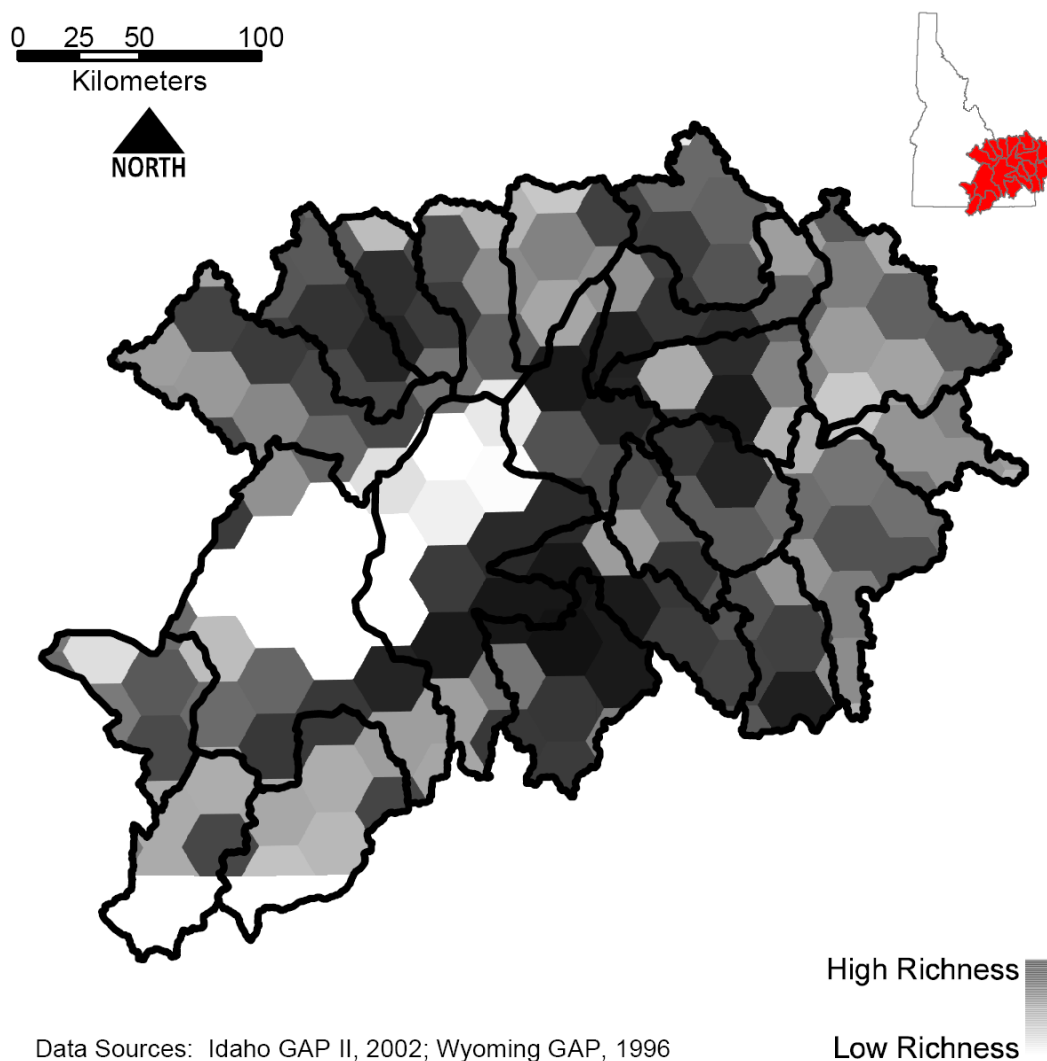


Figure 1-9. Vertebrate species richness, where richness was calculated as the number of species predicted to occur within each hexagon.

The wildlife species occurring in the Upper Snake province that are listed as threatened or endangered under the Endangered Species Act (ESA) are the bald eagle, grizzly bear (*Ursus arctos horribilis*), and Canada lynx (*Lynx canadensis*). Also present in the province are two experimental populations of endangered species: the gray wolf and whooping crane (*Grus americana*) (Figure 1-10).

The wolverine (*Gulo gulo*), present in some of the northern watersheds of the Upper

Snake province, was petitioned for proposal for listing under the ESA; on October 21, 2003, the U.S. Fish and Wildlife Service determined that there was insufficient data for listing the wolverine. The greater sage-grouse and pygmy rabbit (*Brachylagus idahoensis*) were also petitioned for listing under the ESA, and determinations have not yet been made. The yellow-billed cuckoo (*Coccyzus americanus*), also found in the province, is currently a candidate species under the ESA.

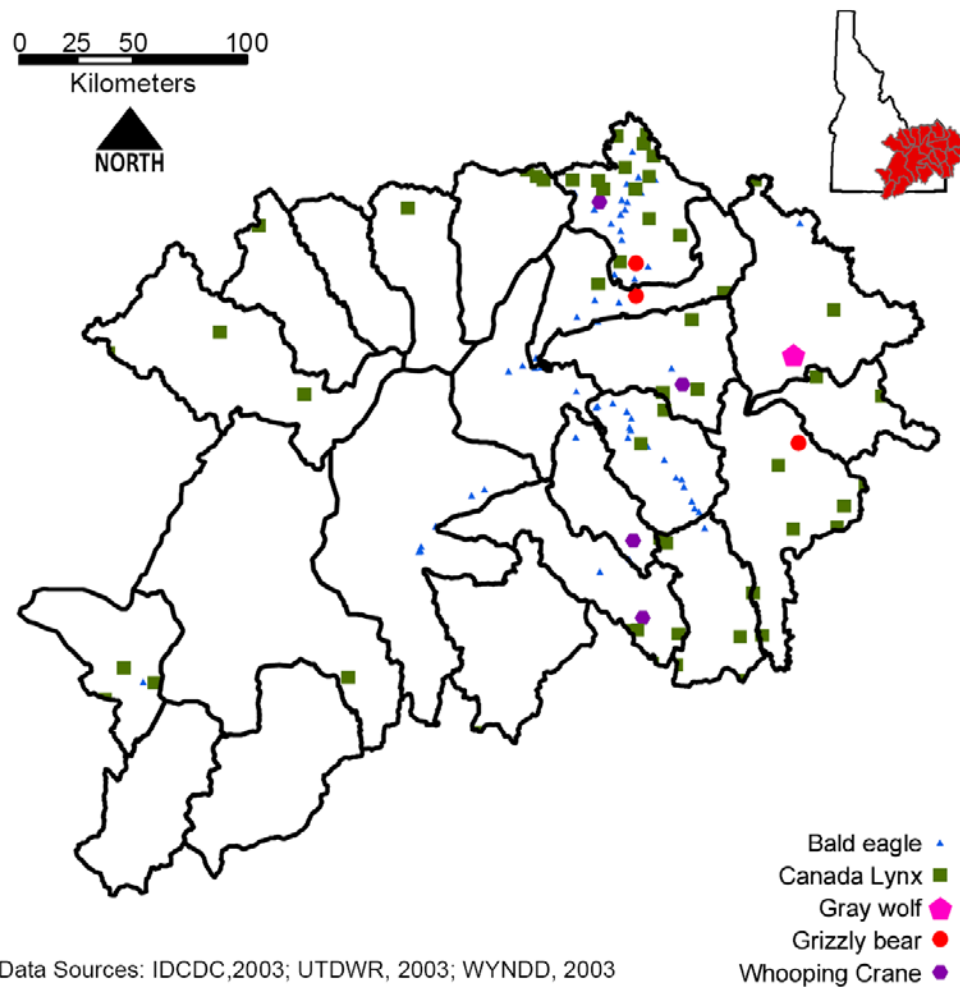


Figure 1-10. Documented occurrences of threatened and endangered species in the Upper Snake subbasin.

1.5.2.1 Mammals

Ninety-seven mammalian species are present in the Upper Snake province, including the grizzly bear, mountain lion (*Puma concolor*), and gray wolf (Appendix 1-1). Twenty-two of these species have close associations with riparian/herbaceous wetlands (Appendix 1-1). Unique to the Upper Snake province of all other Columbia River basin provinces is that the Snake Headwaters subbasin and watersheds (Lower Henrys Fork, Upper Henrys Fork, and Teton) in the Upper Snake

subbasin support grizzly bears. Mountain lions are distributed throughout much of the Upper Snake subbasin. Nearly all of the Upper Snake province was thought to have supported gray wolves, and because of reintroduction in 1995 and 1996, wolves can now be found in the Snake Headwaters, Upper Snake, and Closed Basin subbasins.

The Upper Snake province supports a number of nationally important and seasonally migratory ungulate species that have been affected by anthropogenic effects on habitat.

Pronghorn (*Antilocapra americana*), which occur in the Closed Basin subbasin, are forced onto the Snake River Plain during severe winters, but their access to traditional winter ranges has been impeded by Interstate-15. Under current conditions, the population of this herd increases during light to moderate winters but is decimated during hard winters. The Closed Basin subbasin also historically supported Rocky Mountain bighorn sheep (*Ovis canadensis*) populations. However, vegetative changes due to livestock use of winter ranges, livestock-related diseases, and indiscriminate harvest by settlers and miners caused bighorn sheep populations to decline. In the Snake Headwaters subbasin, the internationally renowned Jackson elk herd summers on U.S. Forest Service lands but is completely dependent on confinement and feeding during winter due to development and loss of winter range in the Jackson Hole area.

1.5.2.2 Birds

Up to 274 bird species are known to reside or migrate through the Upper Snake province (Appendix 1-1). Of this number, 27 are birds of prey, including 12 owls, 9 hawks, 2 eagles, and 4 falcons. Bald eagle populations are increasing along the Snake River in Wyoming (Harmata and Oakleaf 1992). The South Fork Snake River provides habitat for nesting bald eagle pairs and up to 100 wintering eagles. The peregrine falcon (*Falco peregrinus*) is found as an occasional visitor and a winter migrant in the American Falls area and upstream to the confluence with the Henrys Fork. Although nesting has not been documented in the American Falls area, suitable habitat and food are present and adequate to support a nesting site (USFWS 1984). The Snake River, up to its confluence with the Henrys Fork, is known to support three peregrine falcon nesting territories. Surveys have documented that more than 28 young have been produced from these sites since 1990. Two of the sites, both located on

the Snake River, have each produced a total of four young since 1990. The third site, located on Palisades Reservoir just north of Alpine, Wyoming, has produced over 20 young.

An Idaho population of whooping cranes was reestablished through introduction at Gray's Lake National Wildlife Refuge. The population was designated as experimental and nonessential on July 21, 1997. One of the purposes of the experimental reintroduction was to investigate the possibility that sandhill cranes could raise whooping cranes. Whooping crane eggs were translocated into sandhill crane nests, and sandhill cranes successfully raised whooping crane young and taught them seasonal migration routes. However, the whooping cranes wrongly imprinted and never mated, and the experiment was discontinued. Only a few whooping cranes remain in this population.

There are five grouse species in the Upper Snake province (Appendix 1-1). In the late 1990s, sharp-tailed grouse (*Tympanuchus phasianellus*) were discovered wintering in the Camas Creek drainage. They are the only known sharp-tailed grouse to occur in the Closed Basin subbasin. Few, if any, sharp-tailed grouse are known to reside north and west of the Snake River, mostly due to a lack of wintering habitat. Healthy populations are found south of the Snake River, in the Rock and Bannock creek drainages, but they appear to be highly dependent on the Conservation Reserve Program (CRP). In 1995, intensive searches for sharp-tailed grouse leks located 64 leks. A survey of 59,052 hectares in Bonneville and Bingham counties in 2002 identified 56 sharp-tailed grouse leks and provided a qualitative habitat suitability assessment. The dominant land use in areas where grouse were observed was land enrolled in the Conservation Reserve Program (Stanley *et al.* 2002).

The majority of greater sage grouse and their habitats are found north of the Snake River (Figure 1-11). Sage-grouse are highly dependent on sagebrush habitats, including open areas adjacent to sagebrush for use as leks, breeding habitats with a sagebrush canopy of 15 to 25% and sagebrush height of 40 to 80 cm, brood-rearing habitats of 10 to 25% sagebrush canopy and height of 40 to 80 cm, and winter habitats of 10 to 30% sagebrush canopy and height of 25 to 35 cm (Connelly *et al.* 2000). The Upper Snake province has the best long-term data set on sage-grouse in the region; data on lek routes and production go back to the 1960s. Sage-grouse and sagebrush habitat trends in the Upper Snake province are typical of those across the West. Numbers of sage-grouse and acres of sage-grouse and shrub-steppe habitats have declined, and population trends according to bird surveys are downward.

Eighteen species of ducks, four geese, two swans, and two cranes occur in the Upper Snake subbasin during migration and nesting season (IDFG 1990) (Appendix 1-1). Duck and goose nesting and loafing are primarily on rivers, streams, canals, reservoirs, and small ponds. Historically, ducks and geese utilized these waterways for nesting and resting and foraged in adjacent grain fields. As agricultural practices evolved, many wetlands and forage crops were eliminated, which reduced nesting and feeding areas for ducks. In contrast, the Canada goose (*Branta canadensis*) has made substantial gains in population levels. With the advent of artificial nest platforms and development of security sanctuaries for Canada geese along the Snake River, goose populations have risen to all time highs.

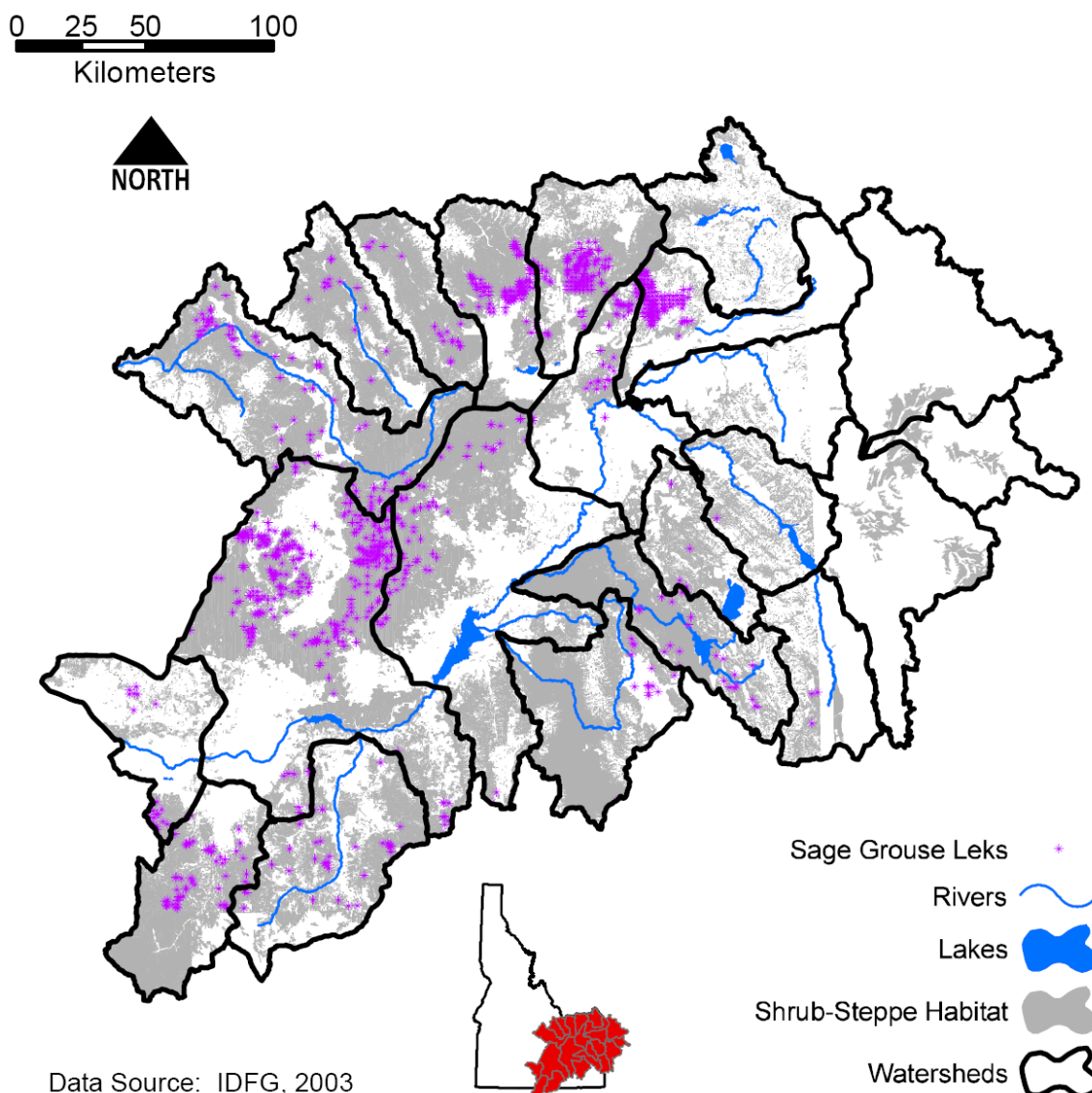


Figure 1-11. Predicted shrub-steppe habitats and sage-grouse lek locations in the Upper Snake province.

The Snake River below American Falls Dam supports one of the largest wintering concentrations of Barrow's goldeneye (*Bucephala islandica*) in the West. American Falls Reservoir and the Fort Hall Bottoms harbor wintering and migrating trumpeter and tundra swans (*Cygnus columbianus*), as well as snow geese (*Chen caerulescens*). Riverine, palustrine, emergent, and open water wetland

habitat types are important for waterfowl in the Upper Snake subbasin.

Many species of waterfowl also use the Birch Creek watershed in the Closed Basin subbasin, which is part of the Pacific Flyway, both for nesting/rearing and overwintering. Species common in the watershed in the winter include the mallard (*Anas platyrhynchos*), blue-winged teal (*Anas*

discors), green-winged teal (*Anas crecca*), common merganser (*Mergus merganser*), double-crested cormorant (*Phalacrocorax auritus*), American widgeon (*Anas americana*), lesser scaup (*Aythya affinis*), Greater scaup (*Anas marila*) and Canada goose.

1.5.2.3 Reptiles and Amphibians

The Upper Snake province supports 10 amphibian and 20 reptile species. All amphibian species in the Upper Snake province are closely associated with riparian habitats and all, except for the inland tailed frog (*Ascaphus montanus*), are closely associated with herbaceous wetlands (Appendix 1-1). The common garter snake (*Thamnophis sirtalis*) is the only reptile species considered to be closely associated with riparian/herbaceous wetland habitats (Appendix 1-1). Amphibians known or suspected to inhabit the Big Lost River watershed include the inland tailed frog, northern leopard frog (*Rana pipiens*), western toad (*Bufo boreas*), Pacific chorus frog (*Pseudacris regilla*), Columbia spotted frog (*Rana luteiventris*), and long-toed salamander (*Ambystoma macrodactylum*). Inland tailed frogs are present and abundant in many streams within the study area (LLRITAT 1998). In good water years, the spadefoot toad (*Spea intermountana*) occurs in great numbers at the Big Lost River watershed (Reynolds *et al.* 1986).

1.5.3 Vegetation and Floristic Diversity

Existing vegetation is the plant cover, or floristic composition and vegetation structure, occurring at a given location at the current time (Brohman and Bryant 2003). Potential natural vegetation (sometimes called PNV) is the vegetation that would become established if all successional sequences were completed under the present climatic and edaphic

conditions without interference by people (Brohman and Bryant 2003). Therefore, potential natural vegetation classifications are based on existing vegetation, successional relationships, and environmental factors (for example, climate, geology, soil, etc.) considered together. Potential natural vegetation classification uses information on structure and composition similar to that needed for existing vegetation classification, but with greater emphasis on composition and successional relationships (Brohman and Bryant 2003). Existing vegetation classifications and maps provide much of the information needed to do the following:

- Describe the diversity of vegetation communities occupying an area.
- Characterize the effect of disturbances or management on species, including threatened and endangered species (sometimes called TES), and community distributions.
- Identify realistic objectives and related management opportunities.
- Document successional relationships and communities within potential natural vegetation or ecological types.
- Streamline monitoring design and facilitate extrapolation of monitoring interpretations.
- Assess resource conditions, determine capability and suitability, and evaluate forest and rangeland health.
- Assess risks for invasive species, fire, insects, and disease.
- Conduct project planning and watershed analysis and predict activity outcomes at the project or land and resource management planning scales.

- More effectively communicate with our partners, stakeholders, and neighbors.

The current plant community reflects the history of a site. That history often includes geologic events, geomorphic processes, climatic changes, migrations of plants and animals in and out of the area, natural disturbances, chance weather extremes, and numerous human activities. Because of these factors, existing vegetation seldom represents the potential under current environmental conditions (Brohman and Bryant 2003).

Existing vegetation information by itself cannot answer questions about successional relationships, changes over time, historical range of variation, productivity, habitat characteristics, and responses to management actions. These questions can only be addressed by combining information about potential natural vegetation, existing vegetation, and stand history (Brohman and Bryant 2003).

Appendix 1-2 includes percentages of representation of both potential and current natural vegetation, by major watershed, for the Upper Snake province.

1.5.3.1 Snake Headwaters Subbasin

The Snake Headwaters subbasin is predominated by forest cover types. The primary historic vegetative types within the Snake Headwaters subbasin include aspen, Douglas-fir, and spruce-fir (with aspen, without aspen, and mixed). Comparing current with historic estimates of these predominant potential natural forest vegetations shows that Douglas-fir, aspen, and subalpine fir are 40%, 59%, and 61% of predicted historic cover, respectively. Alternatively, although sagebrush-related cover types are not common in the Snake Headwaters subbasin, they show an increase of 3,800% over historic estimates. This

increase, although it may not be precise, probably accurately represents the trend in conversion of forest types to drier shrub types.

1.5.3.2 Upper Snake Subbasin

The primary historic vegetative types within the Upper Snake subbasin include aspen, big sagebrush, and spruce-fir types. Aspen cover has decreased to an estimated 47% of historic levels. Big sagebrush types, the predominant vegetative types in this subbasin, have decreased to 42% of their historic levels. Spruce-fir types are estimated to be at 12% of historic representation, while lodgepole pine types have increased to more than 1100% of historic cover estimates. Agricultural lands comprise an estimated 23% of the current Upper Snake subbasin cover and represent a conversion of this proportion of historic vegetative cover and habitat, which was probably mostly shrub-steppe vegetation types.

1.5.3.3 Closed Basin Subbasin

The Closed Basin subbasin was historically dominated by sagebrush types, which comprised more than 50% of the historic representation of the vegetation in the subbasin. Current vegetation representation shows that this proportion has not changed. Agricultural types currently comprise approximately 5% of the current vegetation representation. Forested types, historically comprising more than 20% of the vegetative cover in the subbasin, now are estimated to represent approximately 15% of current vegetative cover. Aspen is now estimated to cover less than 1% of the subbasin, just less than 0.5% less than historic cover estimates.

1.5.4 Rare and Endemic Plants

A total of 118 species of threatened, endangered, sensitive, or rare plants occur in

the Upper Snake province (see Appendix 1-3 for a list of the 76 threatened, endangered, sensitive, or rare species in the Idaho portion of the subbasin). Generally, presence and abundance of these plant species correlate with areas of the lowest anthropogenic effects

(Figure 1-12). However, data and surveys on these plant species are limited, and therefore understanding of their abundance and distribution throughout the province is limited.

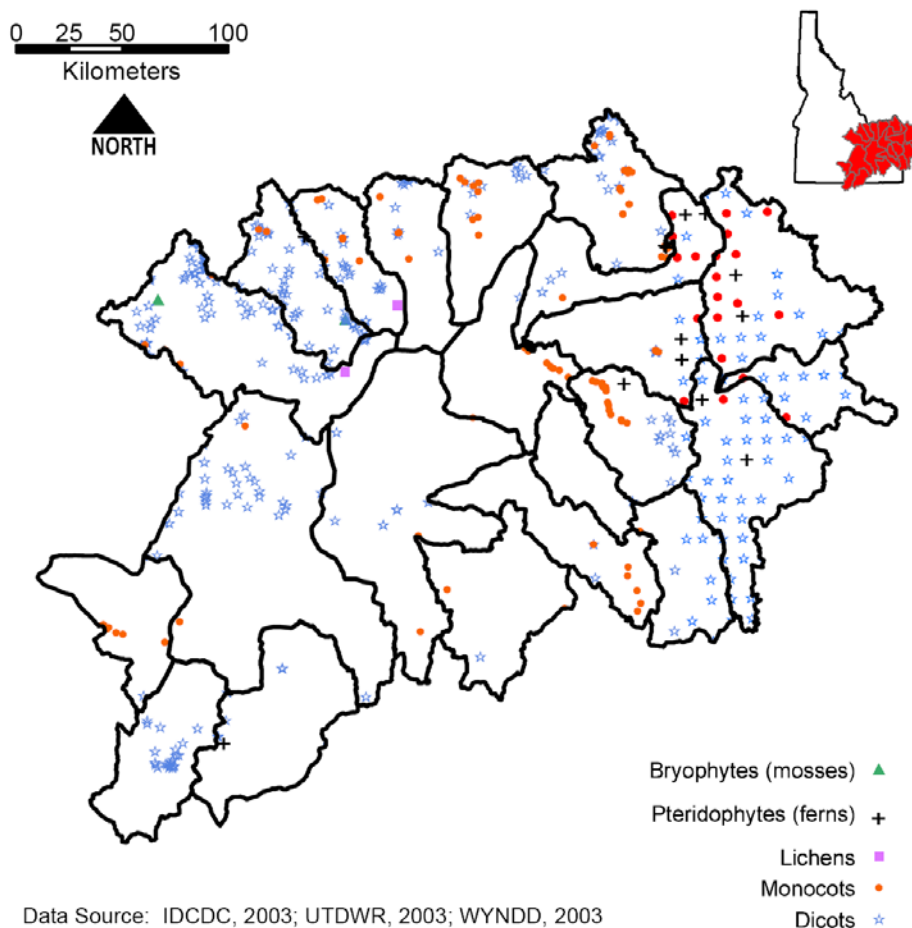


Figure 1-12. Distribution of rare plants in the Upper Snake province.

1.6 Social Description

1.6.1 Demographics

The Upper Snake province was originally the realm of the Shoshoni, Bannock, and Northern Paiute Native American tribes. Although raid and rivalry between the Nez Perce and Shoshoni bands was continuous,

the area was relatively peaceful. Starting in the early 1800s, white explorers began encroaching from the east. John Jacob Astor's Astorians, under Wilson Price Hunt, entered what would become the Idaho Territory as early as 1811 but did not reach southeast Idaho until 1813 when developing a route to the mouth of the Columbia River. They recognized the bountiful fur resources of the

area, and this resource attracted the mountain men and Indian traders.

Starting about 1841, and continuing to 1870, emigrants on the Oregon Trail passed through Montpelier, Georgetown Summit, and Soda Springs on their way to the Oregon Territory. This “trail” became a highway for a major episode of human migration. In 1843, John C. Fremont arrived in southeast Idaho and further solidified the route of the Oregon Trail. Fort Hall became a supply and rest point on the trail. When gold was discovered in 1861 near Pierce, in north-central Idaho, there was a large increase in traffic on the Oregon Trail as would-be miners traveled to the new discoveries.

However, not all of the people who migrated along the Oregon Trail were gold seekers; some stayed in this corner of Idaho. These settlers were primarily Mormons moving north from Utah into the fertile valleys of Bear Lake County and Old Bannock County (later divided into Bannock and Caribou counties) (Figure 1-13). Small communities, such as Franklin, Montpelier, and Bennington lent a note of social stability to the region, more so than did the mining regions in north-central Idaho. These towns turned into centers of ranching and farming.

Although sparsely populated when compared with other areas in the Upper Snake province, the Closed Basin subbasin also has a history of use by humans. Shoshone-Bannock peoples traditionally occupied and used these lands until these people were moved to the Fort Hall Indian Reservation in 1907. The Shoshone-Bannock tribes and the Northwest Band of the Shoshone Nation retain treaty rights that allow access to traditional cultural properties and resources in this subbasin. The Nez Perce tribes also retain certain rights and interest related to their seasonal travels through portions of the subbasin and their

association with the Nez Perce (Nee Me Poo) National Historic Trail.

The Fort Hall Indian Reservation was created by an Act of Congress on July 3, 1868, ratified on February 16, 1869, and formally proclaimed on February 24, 1869. The Shoshone and Bannock tribes were moved onto the reservation from several areas throughout southern Idaho.

Twenty-seven counties lay either wholly or partially within the Upper Snake province (Table 1-7). Four are within Wyoming, one is in Nevada, and one is in Utah. The fastest-growing counties in the province, Teton County in Idaho and Teton County in Wyoming, are within the Headwaters subbasin. Only one county within the province, Butte County, exhibited negative population growth during the past 10 years. State and local government employment in the Upper Snake province has been largely stable in the past 10 years.

The largest industries within the province include agriculture, services, retail trade, manufacturing, and government. Agriculture, largely dependent on surface water irrigation, predominates in the Upper Snake subbasin where potato and seed crops are grown. Livestock ranching and irrigated forage crops also make significant contributions to the agricultural economy in the Upper Snake and Closed Basin subbasins.

Services associated with tourism and outdoor recreation have been growth industries in the Upper Snake province during the last 10 years. In the Snake Headwaters subbasin, visitors to Yellowstone and Teton National Parks and Jackson Hole, as well as outdoor recreationists, make tourism-related services a growth industry. In association with these increases, the industries of finance, insurance, and real estate are increasing in this subbasin.

Manufacturing of nondurable goods and mining in the Upper Snake province is largely centered on fertilizer production in the cities of Pocatello and Soda Springs in the Upper Snake subbasin. However, this industry has been in slow decline in the last 10 years.

Unique to the Upper Snake province is the Idaho National Engineering and

Environmental Laboratory. Not only does this national laboratory protect a large area of high shrub-steppe desert from development, its employment of research, management, and administration staff make a significant contribution to the economy of the Upper Snake subbasin and its surrounding communities.

Table 1-7. Demographic information for the Upper Snake province. (Note: population counts taken in 2001; ppsm = persons per square mile; trend calculated between 1990 and 2000. Source: U.S. Census Bureau 2003).

County	State	Land Area (sq mi)	Population Estimate	Population Density (ppsm)	Population Trend (% change)
Bonneville	Idaho	1,868	83,807	44.2	+14.3
Jefferson	Idaho	1,095	19,578	17.5	+15.8
Madison	Idaho	470	27,327	58.3	+16.0
Fremont	Idaho	1,867	11,822	6.3	+8.1
Teton	Idaho	450	6,419	13.3	+74.4
Bingham	Idaho	2,095	42,335	19.9	+11.0
Caribou	Idaho	1,766	7,397	4.1	+4.9
Bannock	Idaho	1,113	75,323	67.9	+14.4
Power	Idaho	1,406	7,468	5.4	+6.4
Oneida	Idaho	1,200	4,210	3.4	+18.1
Cassia	Idaho	2,566	21,577	8.3	+9.6
Blaine	Idaho	2,645	19,798	7.2	+40.1
Minidoka	Idaho	760	19,677	26.6	+4.2
Jerome	Idaho	600	18,449	30.6	+21.2
Lincoln	Idaho	1,206	4,132	3.4	+22.2
Gooding	Idaho	731	14,207	19.4	+21.7
Twin Falls	Idaho	1,925	64,731	33.4	+20.0
Butte	Idaho	2,233	2,856	1.3	-0.7
Clark	Idaho	1,765	971	0.6	+34.1
Valley	Idaho	3,678	7,716	2.1	+25.2
Custer	Idaho	4,925	4,292	0.9	+5.2
Lincoln	Wyoming	4,069	14,793	3.6	+15.4
Fremont	Wyoming	9,182	35,967	3.9	+6.4
Sublette	Wyoming	4,883	6018	1.2	+22.2
Teton	Wyoming	4,008	18,437	4.6	+63.3
Elko	Nevada	17,179	45,275	2.6	+35.3
Box Elder	Utah	5,723	43,397	7.5	+17.2

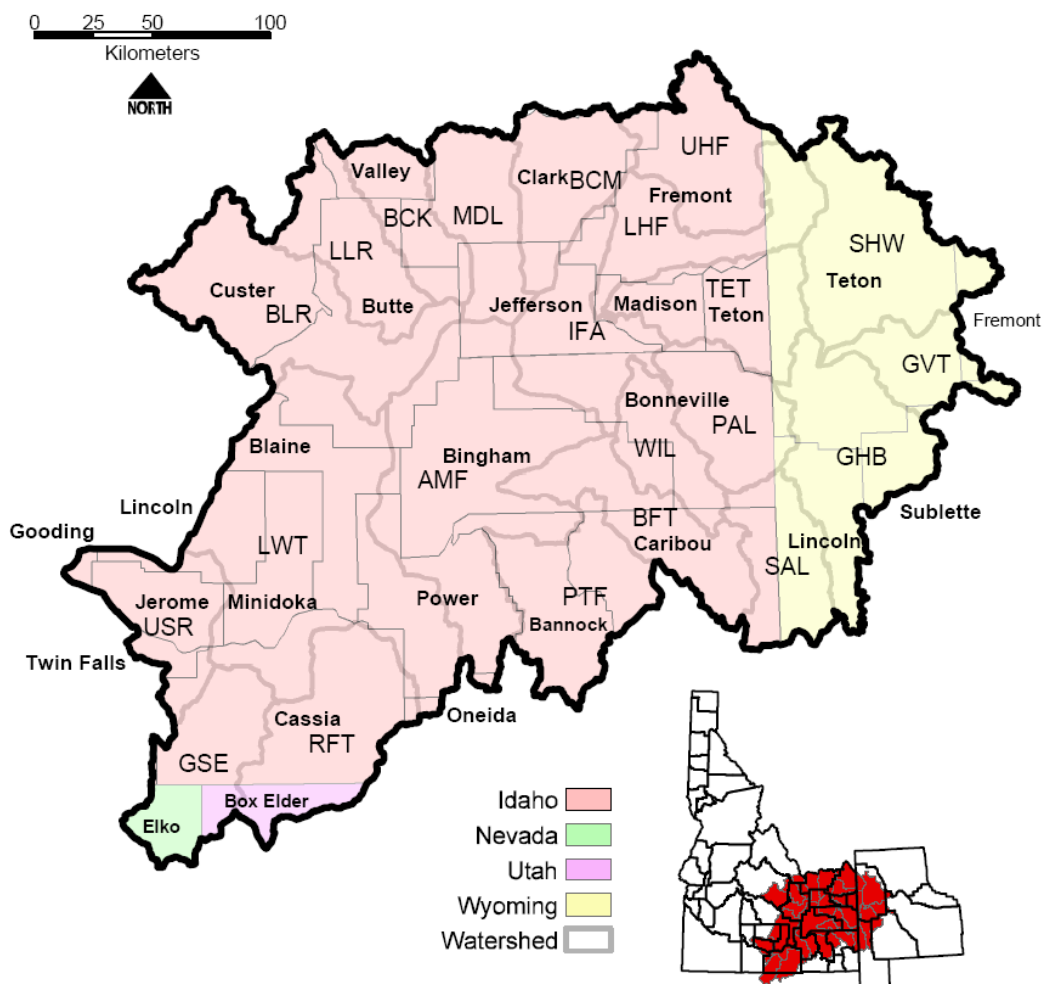


Figure 1-13. Twenty-seven counties comprise the Upper Snake province. Several counties are comprised of two or more watersheds. Twenty-one counties occur in Idaho, four in Wyoming, and two in Utah.

1.6.2 Ownership and Land-use Patterns

Land-use and ownership within the Upper Snake province is largely reflective of coarse patterns of geography and physiography and the distribution of arable soils. Federal ownership by the Bureau of Land Management, U.S. Forest Service, U.S. Department of Energy, and National Park Service predominates throughout the province

and especially in the upper watersheds where lack of arable soils and more varied topography limit human use (Figure 1-14). The Bureau of Land Management and U.S. Forest Service are the predominate federal land managers in the province (Table 1-8 to Table 1-10). In none of the three subbasins does private landownership exceed more than half the area. The Snake Headwaters subbasin is only 12.3% privately owned. In the Upper Snake province, private landownership is

predominant in the valley bottoms of the Snake Headwaters subbasin, valley bottoms and broader flat areas of the Closed Basin subbasin, and areas south of the Snake River and High Desert in the Upper Snake subbasin. These areas are characterized by agricultural development; canal, water, and road development; and small rural communities.

Within the province, the Greys–Hoback, Gros Ventre, and Snake Headwaters watersheds are

in the most pristine and least modified conditions. Watersheds with the most private ownership—including the Upper Snake–Rock, Raft, American Falls, Portneuf, Blackfoot, Willow, Idaho Falls, Teton, Lower Henrys Fork, and Beaver–Camas watersheds—have been the most impacted by human development and natural resource use, primarily farming and ranching.

Table 1-8. Percentage of land area in the Snake Headwaters subbasin for various ownership/management entities, by watersheds and a 50-m stream buffer.

Landowner/Manager	Percentage of ownership by Watershed / 50m buffer of streams ^a					% Entire Subbasin
	GHB	GVT	PAL	SAL	SHW	
Bureau of Land Management	2 / 3	0 / 0	<1 / <1	1 / <1	0 / 0	1
Bureau of Reclamation	0 / 0	0 / 0	2 / 3	0 / 0	0 / 0	1
Department of Defense	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0
U.S. Department of Energy	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0
National Park Service	2 / 2	<1 / 0	0 / 0	0 / 0	43 / 40	13
Private/Water	7 / 10	5 / 6	20 / 23	30 / 38	8 / 4	12
State of Idaho	<1 / <1	0 / 0	<1 / 0	1 / 1	<1 / 0	1
Tribal	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0
U.S. Forest Service	89 / 85	95 / 94	78 / 74	68 / 60	49 / 60	72
U.S. Fish and Wildlife Service	<1 / <1	<1 / <1	0 / 0	0 / 0	0 / 0	1
Total Area (km ²) ^b	4,035	1,642	2,395	2,295	4,371	100

^a Percentages may not sum to 100 because of rounding.

^b Total area for watersheds may differ from drainage areas given in Table 1-1 because of rounding.

Table 1-9. Percentage of land area in the Upper Snake subbasin for various ownership/management entities, by watersheds and a 50-m stream buffer.

Landowner/Manager	Percentage of ownership by Watershed / 50m buffer of streams ^a												% Entire Sub-basin
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL	
Bureau of Land Management	27 / 7	4 / 5	44 / 37	24 / 1	11 / 2	10 / 6	32 / 24	1 / <1	3 / 3	39 / 19	58 / 14	2 / 4	27
Bureau of Reclamation	<1 / <1	0 / 0	0 / 0	0 / 0	0 / 0	0 / <1	0 / 0	0 / 0	1 / <1	1 / 0	<1 / 1	0 / 0	<1
Department of Defense	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	<1 / <1	<1
U.S. Department of Energy	13 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	2
National Park Service	0 / 0	0 / 0	0 / 0	0 / 0	24 / 25	0 / 0	0 / 0	<1 / <1	6 / 5	0 / 0	2 / <1	0 / 0	3

Landowner/ Manager	Percentage of ownership by Watershed / 50m buffer of streams ^a												% Entire Sub- basin
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL	
Private/Water	40 / 51	41 / 47	27 / 24	71 / 96	43 / 45	60 / 64	46 / 50	58 / 59	15 / 23	55 / 66	34 / 71	71 / 67	44
State of Idaho	3 / <1	18 / 15	2 / 2	4 / 2	6 / <1	4 / 3	2 / 1	2 / <1	4 / 3	6 / <1	7 / 3	15 / 17	3
Tribal	17 / 39	16 / 13	0 / 0	0 / 0	0 / 0	7 / 5	0 / 0	0 / 0	0 / 0	0 / 0	0 / <1	0 / 0	5
U.S. Forest Service	<1 / 2	18 / 19	26 / 37	<1 / <1	16 / 28	19 / 21	20 / 25	40 / 39	72 / 67	4 / 15	2 / 9	9 / 8	15
U.S. Fish and Wildlife Service	0 / 0	0 / 0	0 / 0	0 / 0	<1 / 0	0 / 0	0 / <1	0 / 0	0 / 0	0 / 0	<1 / 1	3 / 2	<1
Total Area (km ²) ^b	7,534	2,833	2,887	2,975	2,665	3,420	3,893	2,857	2,850	2,530	9,274	1,682	100.0

^a Percentages may not sum to 100 because of rounding.

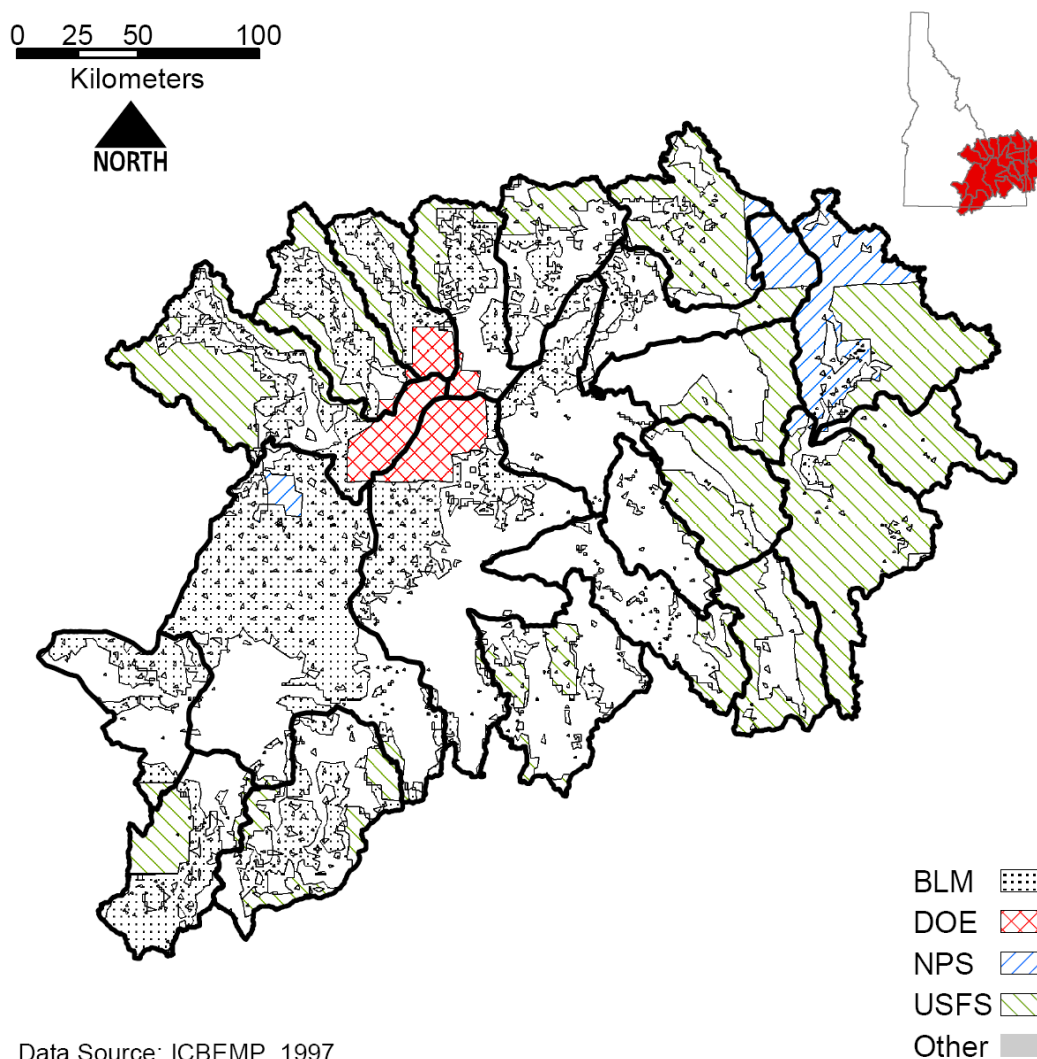
^b Total area for watersheds may differ from drainage areas given in Table 1-1 because of rounding.

Table 1-10. Percentage of land area in the Closed Basin subbasin for various ownership/management entities, by watersheds and a 50-m stream buffer.

Landowner/Manager	Percentage of ownership by Watershed / 50m buffer of streams ^a					% Entire Subbasin
	BCM	BCK	BLR	LLR	MDL	
Bureau of Land Management	23 / 7	41 / 44	27 / 20	44 / 39	35 / 31	33
Bureau of Reclamation	0 / <1	0 / 0	0 / 0	0 / 0 / 0	0 / 0	0
Department of Defense	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0
U.S. Department of Energy	0 / 0	19 / 7	15 / 4	3 / 0	7 / 0	10
National Park Service	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0
Private/Water	42 / 51	4 / 7	14 / 26	8 / 11	32 / 24	10
State of Idaho	10 / <1	1 / 2	1 / <1	2 / 1	3 / 2	3
Tribal	0 / 39	0 / 0	0 / 0	0 / 0	0 / 0	0
U.S. Forest Service	24 / 2	34 / 41	42 / 49	43 / 49	24 / 43	35
U.S. Fish and Wildlife Service	2 / 0	0 / 0	0 / 0	0 / 0	0 / 0	<1
Total Area (km ²) ^b	2,566	1,861	5,139	2,516	2,423	100.0

^a Percentages may not sum to 100 because of rounding.

^b Total area for watersheds may differ from drainage areas given in Table 1-1 because of rounding.



Data Source: ICBEMP, 1997

Figure 1-14. Land ownership/management patterns within the Upper Snake province.

1.6.3 Water Diversion and Management

The state's largest water district, District 1, covers the entire Upper Snake subbasin above Milner Dam and includes numerous streams and tributaries and thousands of individual water users. The water district operates reservoirs, canals, and diversion dams in three water projects as a system. The projects begin with headwater reservoirs at Jackson Lake (Upper Snake subbasin) and Grassy and Henrys lakes (Upper Henrys Fork watershed) and end with Milner dam and reservoir.

The policy of Water District 1 is to store water in reservoirs that are highest in the system and use water in the lowest reservoirs (R. Carlson, Idaho Department of Water Resources, Public Informational Workshop, Pocatello, Idaho. November 21, 2000). American Falls Reservoir is the largest reservoir and the lowest meaningful reservoir. Water discharges into the reservoir basin from springs between Blackfoot and the Fort Hall Bottoms, and flows of the Snake and Portneuf rivers reliably refill American Falls Reservoir (1.67 million acre-feet) each year.

Consequently, this reservoir is the workhorse for irrigation supply in the Minidoka Project.

The Minidoka Project furnishes irrigation water from five reservoirs having a combined storage capacity of more than 3 million acre-feet. Within the Upper Snake subbasin, the project works include Minidoka dam and power plant and Lake Walcott, as well as American Falls dam and reservoir. Above the Upper Snake subbasin, the project includes Jackson Lake dam and reservoir, Island Park dam and reservoir, and Grassy Lake dam and reservoir. Two diversion dams, canals, laterals, and drains deliver the water to about 1.1 million acres. American Falls Dam is used by Idaho Power Company to generate hydropower.

The Palisades Project of Idaho and Wyoming is the second largest water project in Water District 1. The principal features of the project are Palisades dam, reservoir, and power plant located in the Palisades watershed, Snake Headwaters subbasin. The Palisades Project is instrumental in providing water to meet the Minidoka Project water requirements. The Bureau of Reclamation operates and maintains the project.

About 650,000 acres of irrigated land in the Minidoka and Michaud Flats projects in the Upper Snake subbasin are provided supplemental water from the Palisades Project. Palisades Reservoir stores 1,401,000 acre-feet (1,200,000 active) of water. The State of Wyoming has 33,000 acre-feet of “joint use” space in Palisades Reservoir, an amount that can be used to either retain water in Jackson Lake, Wyoming, or increase winter flows in the Snake River between Jackson Lake and Palisades Reservoir to benefit cutthroat trout.

The Ririe Project is the smallest of the three Water District 1 water projects. Features of the project are Ririe dam and reservoir.

Ririe’s principal purpose is flood control. Out of its total reservoir capacity (100,500 acre-feet), 80,500 acre-feet serve both flood control and irrigation, 10,000 acre-feet is dead storage, and 10,000 acre-feet are reserved for flood control.

Several hydroelectric power generation plants operate as part of the Water District 1 projects within the Upper Snake subbasin. The Minidoka Power Plant (28.5 megawatts) serves the requirements for pumped irrigation on and near the Minidoka Project in southern Idaho. Power not needed for Bureau of Reclamation project purposes is marketed in the Federal Southern Idaho Power System administered by the Bonneville Power Administration. Palisades Power Plant (176,600 kilowatts) also serves large power requirements for irrigation pumping on and near the Minidoka Project.

The Idaho Power Company operates three hydroelectric power generation plants. Plants at American Falls Dam generate 92,340 kilowatts; downstream at Milner Dam, 59,448 kilowatts; and farthest downstream at Shoshone Falls, 12,500 kilowatts. Idaho Power Company has an open access transmission policy. The company, Bonneville Power Administration, and seven other major transmission owners are moving forward collectively on developing a Regional Transmission Organization (RTO).

The Bureau of Reclamation actively pursues and provides water for Snake River/Columbia River flow augmentation for threatened and endangered salmon and steelhead. The Idaho Legislature authorized short-term rental of up to 427,000 acre-feet of water from the water supply bank each year. Both Bureau of Reclamation space and water rental from reservoir space holders are provided. Approximately 22,000 acre-feet of Bureau of Reclamation space and 38,000 acre-feet of American Falls Reservoir water leased long-

term from the Shoshone-Bannock Tribes were provided in addition to another 148,400 acre-feet rented from the District 1 Water Bank in 1999.

The State of Idaho has statutory authority in administering water rights within its boundaries. Under the prior appropriation doctrine, natural flow rights in Idaho are satisfied in order of priority based on date (first in time is first in right). When the water supply is limited, a water right holder with an earlier natural flow right (a senior water right) may receive a full supply, whereas a water right holder with a later or more recent date (a junior water right) may not receive a full supply. Diversion rights for irrigation are appurtenant to the land, whereas diversion

rights for other purposes such as power, municipal, and industrial water supply are not.

Storage reservoirs such as American Falls Reservoir, Jackson Lake, and Palisades Reservoir are constructed and operated to change the flow regime for irrigation purposes to provide for the water rights. Spaceholder contracts (through November 1995) in the American Falls, Jackson Lake, and Palisades storage facilities for the specific canal companies in the Upper Snake subbasin are shown in Table 1-11. The two primary canal companies in the subbasin have their water rights based primarily on natural flow with supplemental storage rights.

Table 1-11. Spaceholder contracts in the Upper Snake subbasin as of November 1995 (Buhidar 1999).

Spaceholder ^a	American Falls	Jackson Lake	Palisades	Total
American Falls Reservoir District	274,338 (NSCC) 148,747 (TFCC)	0 0	0 0	423,085
MID	44,951	0	44,500	89,451
NSCC	116,471	312,007	116,600	545,078
TFCC	0	97,183	0	97,183
TOTAL (%)	584,507 (50.6%)	409,190 (35.4%)	161,100 (14.0%)	1,154,797 (100%)

^a NSCC = North Side Canal Company; TFCC = Twin Falls Canal Company; MID = Milner Irrigation District. A spaceholder contract is defined as a type of repayment contract in which storage space is purchased in contrast to a specific amount of water being purchased. The amount of water that accumulates in that storage space belongs to the purchaser. Storage season is normally defined as beginning October 1 and extending to the date when no more water is available for storage. The irrigation season is defined in spaceholder contracts as April 1 to October 31, although the actual water may not be used until April 15 to October 15. A water year (or WY) begins on October 1 and extends to September 30 of the following year.

The Twin Falls Canal Company and North Side Canal Company irrigate tracts on the south and north sides of the Snake River. The Twin Falls area (or Twin Falls tract) is predominantly irrigated by the Twin Falls Canal Company, the largest irrigation company in Idaho. This canal company diverts an average of 1.1 million acre-feet per year from the Snake River. The irrigation

water is delivered to the area by gravity feed via the High Line and Low Line canals. Approximately 202,000 acres are serviced by the Twin Falls Canal Company. An estimated 85 to 90% of irrigation in the Twin Falls tract is surface irrigated, with sprinkler irrigation making up the balance (Barry 1996, Cosgrove *et al.* 1997).

The Hazelton-Jerome-Wendell-Gooding area (or Northside Tract) is predominantly irrigated by the North Side Canal Company, which diverts an average of 1.2 million acre-feet per year from the Snake River. The irrigation water is delivered to the area by gravity feed via the Main Canal. Approximately 160,000 acres are serviced by the North Side Canal Company. An estimated 80% of irrigation is primarily sprinkler irrigation (Barry 1996).

Approximately 6,000 farms within the Twin Falls and Northside Tracts discharge into one or more points in a return flow channel. At Milner Dam, there are 10 different discharges: 1) Middle Snake River, 2) Milner Hydro Plant, 3) North Side Canal Company, 4) Twin Falls Canal Company, 5) Milner-Gooding Canal, 6) Cross-cut canal, 7) A-Lateral, 8) PA-Lateral, 9) Milner Irrigation Pumping Plant, and 10) A & B Irrigation Pumping Plant. The largest withdrawals within this reach of the river are at Minidoka Dam and Milner Dam. During low water years, essentially all of the flows from the Snake River are diverted from the river channel at Milner Dam, leaving the Snake River completely dry until it picks up spring flows several miles downstream.

The 124 dams and impoundments in the province are for hydroelectric generation, water storage for irrigation and other agricultural uses, wildlife habitat, and recreation (Appendix 1-4). Seventy percent of these dams, most of them privately owned, are within the Upper Snake subbasin. Of the 124 dams within the province, 22 are federally owned. Twenty of those are within the Snake Headwaters subbasin, and the remaining 2 are in the Upper Snake subbasin. Of the 22 federal projects, only Palisades and Minidoka are currently within the NPCC's Columbia River Basin Fish and Wildlife Program and have had construction and inundation loss assessments prepared and accepted by the NPCC (NPPC 2000).

1.6.4 Protected Areas

The majority of the province and its subbasin have been affected by human development. The areas with the highest road densities (Figure 1-15) represent areas of agricultural and community developments. Every major watershed within the province has been accessed and impacted by roads. The existing level of road development and associated use by people negatively impact fish and wildlife populations, habitats, and habitat linkage and connectivity.

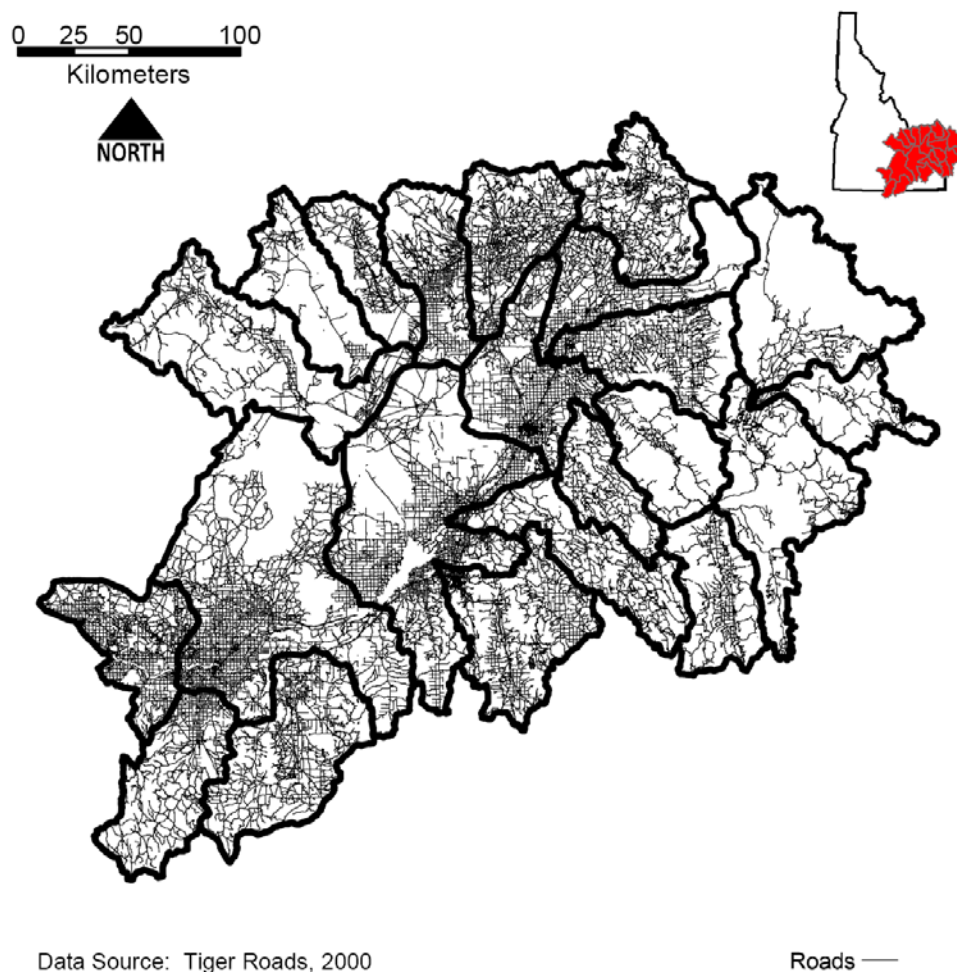


Figure 1-15. Road densities within the Upper Snake province.

Although development has impacted most of the province, a diverse range of protected areas occurs (Figure 1-16). These specially designated areas include Wilderness and Wilderness Study Areas, National Parks, roadless areas, protected streams and rivers including those in the Wild and Scenic Rivers System, National Recreation Areas, fishing and hunting access areas, and natural areas. Natural areas, as defined here, are areas managed by various landowners in a natural state and managed to retain or restore naturalness for research, monitoring, inventory, habitat protection, education, or social needs. Mapped wetland areas have also been identified and mapped according to U.S.

Fish and Wildlife Service guidelines (Figure 1-17).

Relatively small, protected ecological reference areas are also present within the Upper Snake province, including U.S. Forest Service Research Natural Areas and Special Interest Areas, Bureau of Land Management Research Natural Areas and Areas of Critical Environmental Concern, and Nature Conservancy preserves. Research Natural Areas provide pristine, high quality, representative examples of the important ecosystems within the province and opportunities for research regarding physical and biological ecosystem processes.

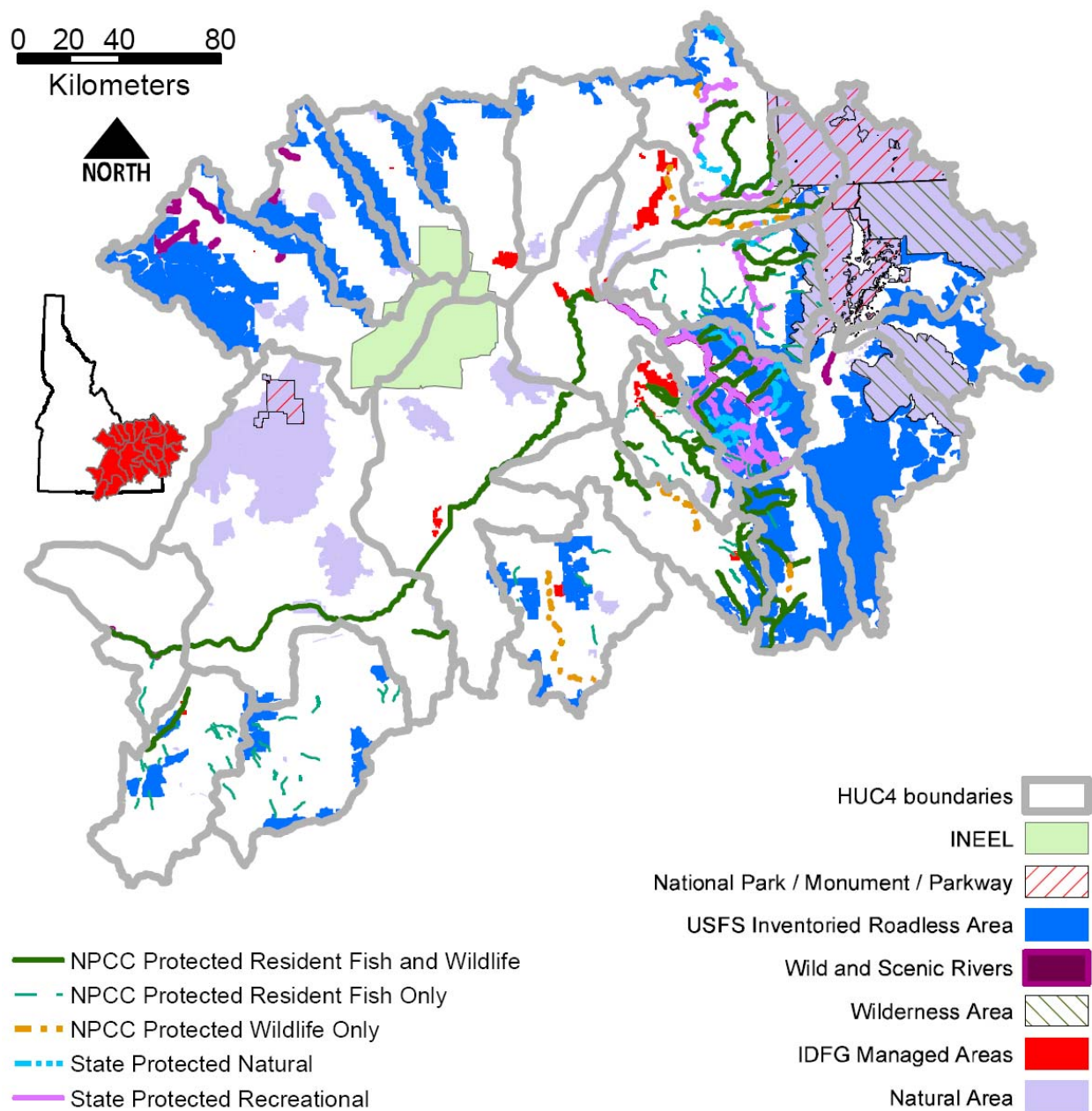


Figure 1-16. Protected areas within the Upper Snake province. Data are not complete or consistent across the basin. Boundaries are not verified, and resolution and accuracy of the source data vary widely. Original scales on sources varied from 1:24,000 to 1:500,000. Additional areas of Wild and Scenic River System were created by buffering 1:24,000-scale river reaches to fill gaps in original data. A buffer of 0.25 mile was used on each side of a river.

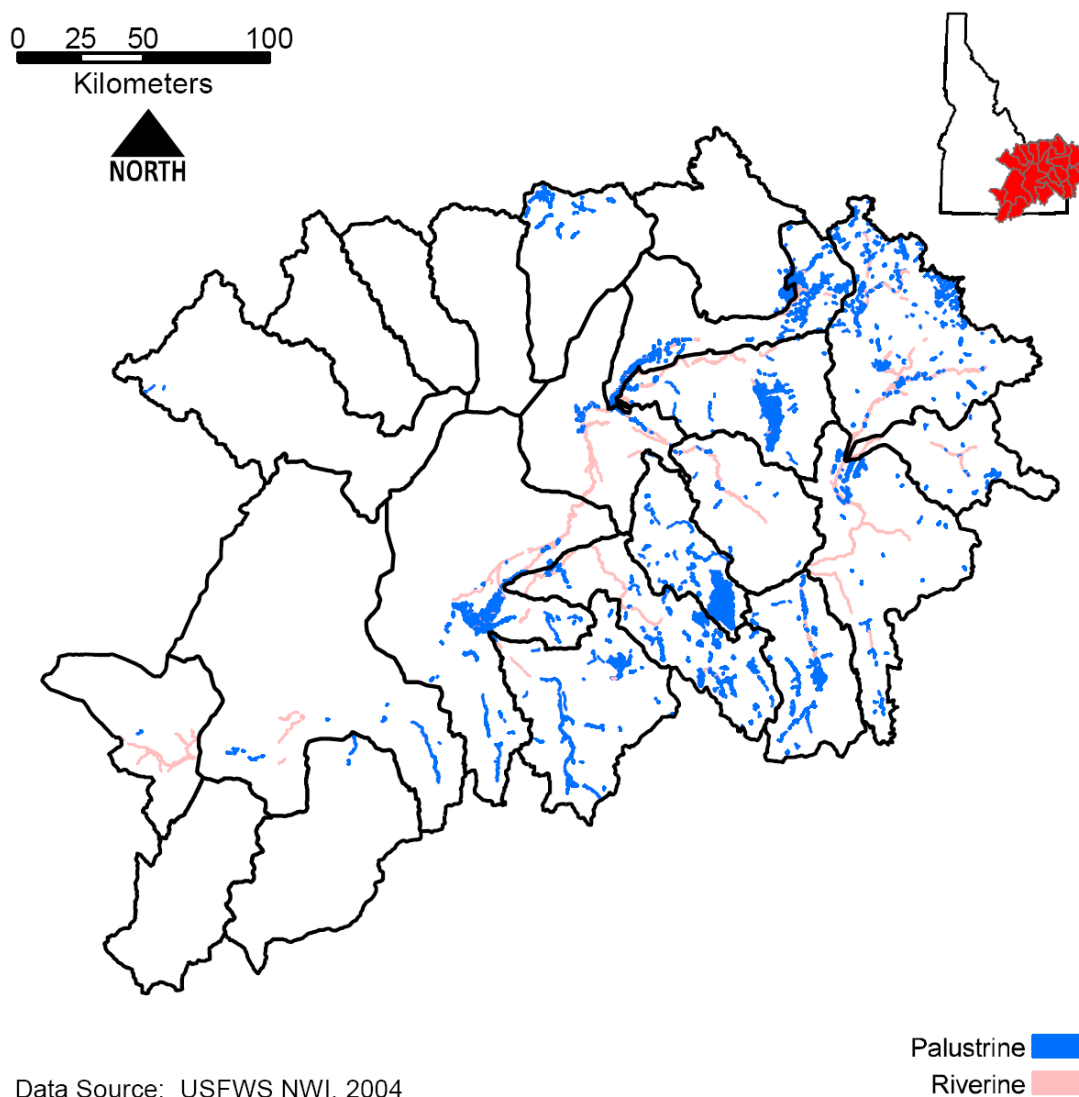


Figure 1-17. Mapped wetlands within the Upper Snake province as delineated by the U.S. Fish and Wildlife Service National Wetland Inventory.

The Snake Headwaters subbasin encompasses portions of the Gros Ventre and Teton Wilderness areas and Yellowstone and Grand Teton National Parks. Forty-three U.S. Forest Service roadless areas are identified in this subbasin. They occur on the ridge crests and peaks of the Caribou, Wyoming, and Gros Ventre ranges. Three Bureau of Land Management Wilderness Study Areas are present within the Idaho Falls and Palisades watersheds. We estimate that 1,219,941 acres,

or 33%, of the Snake Headwaters subbasin is defined as protected.

Within the Upper Snake subbasin, the entire 569,600-acre (2,305 km²) Idaho National Engineering and Environmental Laboratory (INEEL) is designated as a National Environmental Research Park. Because these lands have been withdrawn from the public domain for over 50 years, this national laboratory arguably retains the largest and best representation of the shrub-steppe

ecosystem in the western United States (Anderson 1999). In addition, over 60,000 acres (243 km²) of the Idaho National Engineering and Environmental Laboratory at the mouth of the Birch Creek Valley were recently set aside as the Shrub-steppe Ecosystem Reserve, under joint management of the U.S. Department of Energy, Bureau of Land Management, and U.S. Fish and Wildlife Service. The 714,727-acre (2,892 km²) Craters of the Moon National Park consists of remote and largely undeveloped lava fields and shrub-steppe areas. Traditional livestock grazing continues within the grass/shrublands administered by the Bureau of Land Management. We estimate that 1,219,941 acres (4,937 km²) or about 10%, of the Upper Snake subbasin is defined as protected area, mostly within the boundaries of the Idaho National Engineering and Environmental Laboratory and Craters of the Moon National Park.

Protected areas within the Closed Basin subbasin are primarily roadless areas managed by the U.S. Forest Service.

1.7 Environmental and Biological Situation

1.7.1 Water Quality

A total of 99 waterbodies totaling 1,822 miles (2,933 km) of stream in the Upper Snake province are classified as impaired under the guidelines of section 303(d) of the Clean Water Act (USEPA and IDEQ 1998) (Figure 1-18). The primary limiting factors on water

quality limited waters in the Upper Snake province are sediments (cases), nutrients (cases), flow alteration, and irregular temperatures.

The Upper Snake subbasin has 71 water quality limited streams totaling 1,307 miles (2,104 km) of stream miles (or approximately 20% of all streams in the basin – see Appendix 1-5). The Snake Headwaters subbasin has 5 water quality limited streams totaling 46 miles (74 km) of stream miles, or approximately 2% of streams in the subbasin (see Appendix 1-5). Finally, the Closed Basin subbasin has a total of 23 water quality limited streams totaling 469 miles (755 km) of stream, or approximately 14% of streams in the subbasin – see Appendix 1-5 for more information.

As illustrated in Figure 1-18, some watersheds have notably greater distribution of water quality impaired streams than do others. To assess and mitigate these water quality issues, total maximum daily load (TMDL) standards are being addressed. TMDL standards were approved for the Little Lost River, Lake Walcott, and Upper Snake Rock watersheds. Standards have been developed and are in review for the Big Lost River, Goose Creek, and Raft River watersheds. Finally, standards are yet to be developed for the Camas Creek and Birch creek watersheds. Further, implementation plans are complete for the Upper Snake Rock watershed, and are in process for the other watersheds (IDEQ 2004).

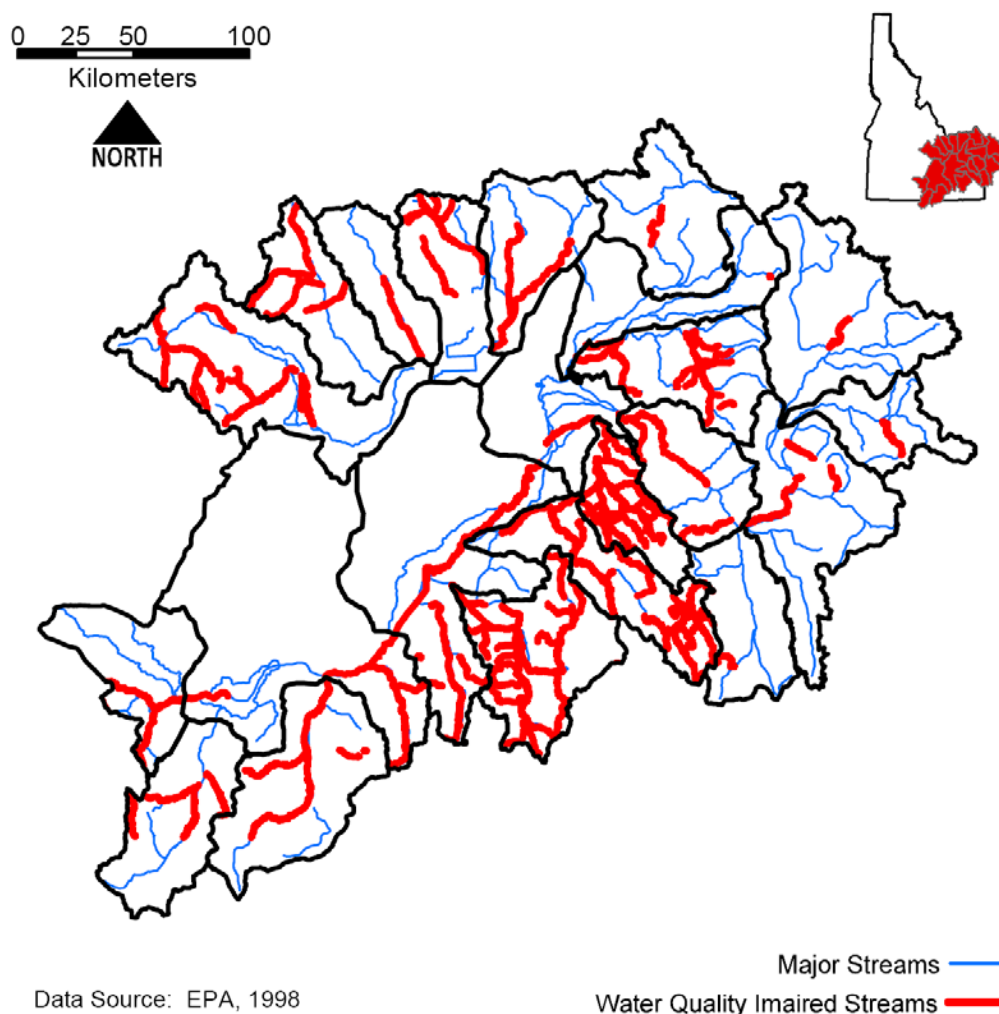


Figure 1-18. Water quality limited (section 303(d)) streams in the Upper Snake province.

1.7.2 Species and Habitat Status and Constraints

The Upper Snake province has been affected by a relatively high level of anthropogenic effects. At a provincial level, fish and wildlife species status and constraints can be divided into four primary associations: terrestrial species largely dependent on intact forested habitats, including the grizzly bear, wolverine, and lynx; terrestrial species largely dependent on shrub-steppe habitats, including the greater sage grouse, Brewer's sparrow, antelope, and other shrub-steppe obligates; and terrestrial and aquatic species dependent

on aquatic and riparian habitats, including the Yellowstone cutthroat trout, bald eagle, whooping crane, trumpeter swan, and invertebrates such as the California floater, Utah valvata snail, Bliss Rapids snail, and Snake River physa snail. Wide-ranging predators such as wolves and peregrine falcons are dependent on prey availability and environmental factors, respectively; they are less habitat dependent than the above species are and more dependent on prey availability than the above species are.

The Snake Headwaters and Closed Basin subbasins provide the most forested habitats

and accordingly can support more and healthier populations of forest-associated species. Habitat fragmentation, conversion, fire frequency, disturbance, and increased mortality of forested species through increased human access and recreation are the primary constraints to sustaining forest-dependent species in the Snake Headwaters and Closed Basin subbasins. The associated human activities contributing to these constraints include road construction, development, timber harvest, tourism, increasing and unrestricted human access, and fire suppression.

The Upper Snake and Closed Basin subbasins provide the majority of shrub-steppe habitat and species dependent on shrub-steppe habitat in the Upper Snake province. Noxious weeds, habitat fragmentation, fire frequency, habitat conversion, and disturbance are the primary constraints to sustaining species dependent on shrub-steppe in the Upper Snake and Closed Basin subbasins. The associated human activities contributing to these constraints include livestock grazing, conversion of shrub-steppe habitats, and fire management.

The Snake Headwaters, Closed Basin, and Upper Snake subbasins all provide important aquatic and aquatic-associated habitats. The primary constraints to aquatic-dependent

species include water quantity and quality. The associated human activities enabling these constraints include water diversion, irrigated agriculture, and livestock grazing. In an analysis of geomorphic integrity and water quality integrity, the majority of watersheds analyzed show moderate soil and water integrity (< 20% degraded stream miles) (Figure 1-19), while several watershed show low integrity (> 20% degraded stream miles). Likewise, a majority of watersheds show fair water quality integrity, while several show poor water (Figure 1-20). Watersheds ranked as having high integrity for either geomorphic or water quality characteristics are discontinuous and rare throughout the province (Figure 1-19 and Figure 1-20).

New Zealand mudsnails also threaten aquatic habitats and species. These small brown snails measure less than 0.125 inch. These mudsnails easily reach densities that cause significant habitat degradation. Snail numbers as high as 750,000 per square yard have been recorded in some areas. At high densities, the snails consume most available food, leaving little for native snails and aquatic insects to feed on. This situation leads to a reduction or elimination of these species, as well as to indirect but significant impacts on fish and on riparian-dependent wildlife populations.

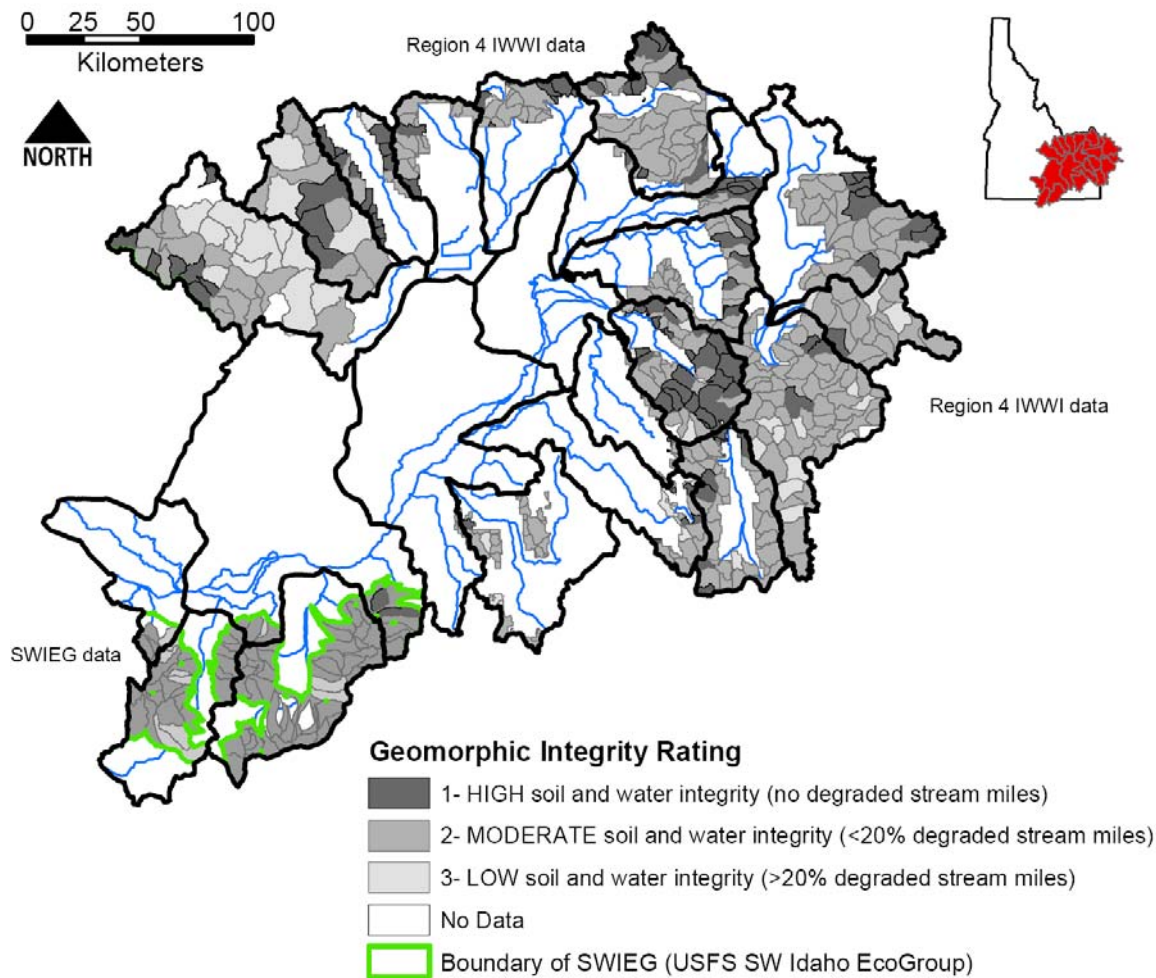


Figure 1-19. Watershed geomorphic integrity within the Upper Snake province (IWWI = Inland West Watershed Initiative and SWIEG = Southwest Idaho Ecogroup). Sources: USDA 2003 and USFS 2003.

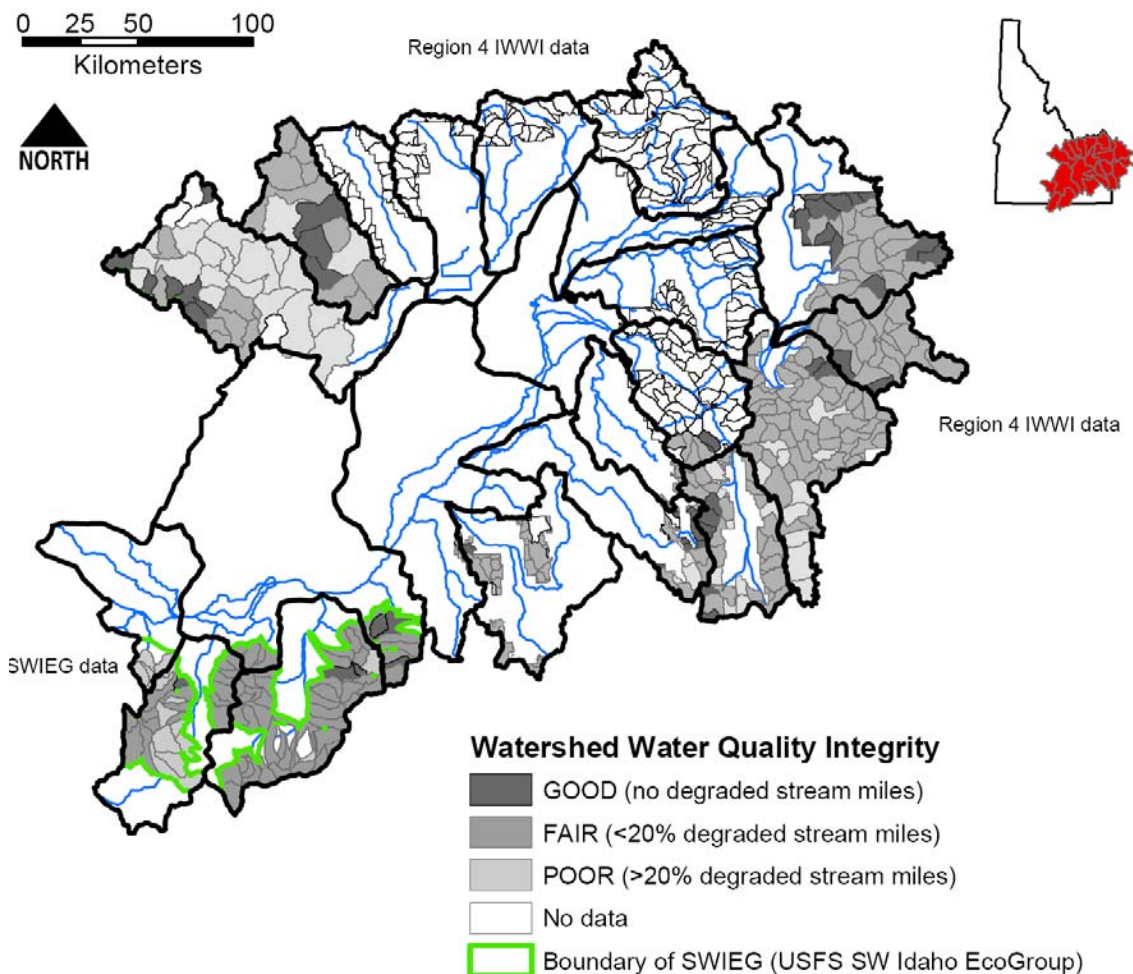


Figure 1-20. Water quality integrity within the Upper Snake province (IWVI = Inland West Watershed Initiative and SWIEG = Southwest Idaho Ecogroup). Sources: USDA 2003 and USFS 2003.

1.7.3 Disturbance

We classified disturbance in the Upper Snake province in relation to fire (areas burned within the last 25 years), areas currently under cultivation and irrigation, and areas currently undergoing livestock grazing.

The largest areas that have been disturbed by fire in the last 25 years are represented by large blocks of forested habitats in the Upper Snake subbasin consisting of primarily U.S. Forest Service and National

Park Service lands (Figure 1-21). These forested areas that have been disturbed by fire total 1,950 acres (8 km²), 50 acres (0.2 km²), and 3,700 acres (15 km²) in the Snake Headwaters, Closed Basin, and Upper Snake subbasins, respectively². Bureau of Land Management areas that have been disturbed

² These areas are additive. If an area is burned twice, it is counted 2 times. Also, area locations are assigned based on the point location. Source: Federal Fire History, BLM, Denver, CO.

by fire within the last 25 years occur primarily within the Upper Snake subbasin, where predominately shrub-steppe habitats have been disturbed. These areas total 5,700 acres (23 km²) in the Upper Snake province.

This amount represents more than 45% of the total ownership of the Bureau of Land Management and 30% of the total shrub-steppe habitat in this province.

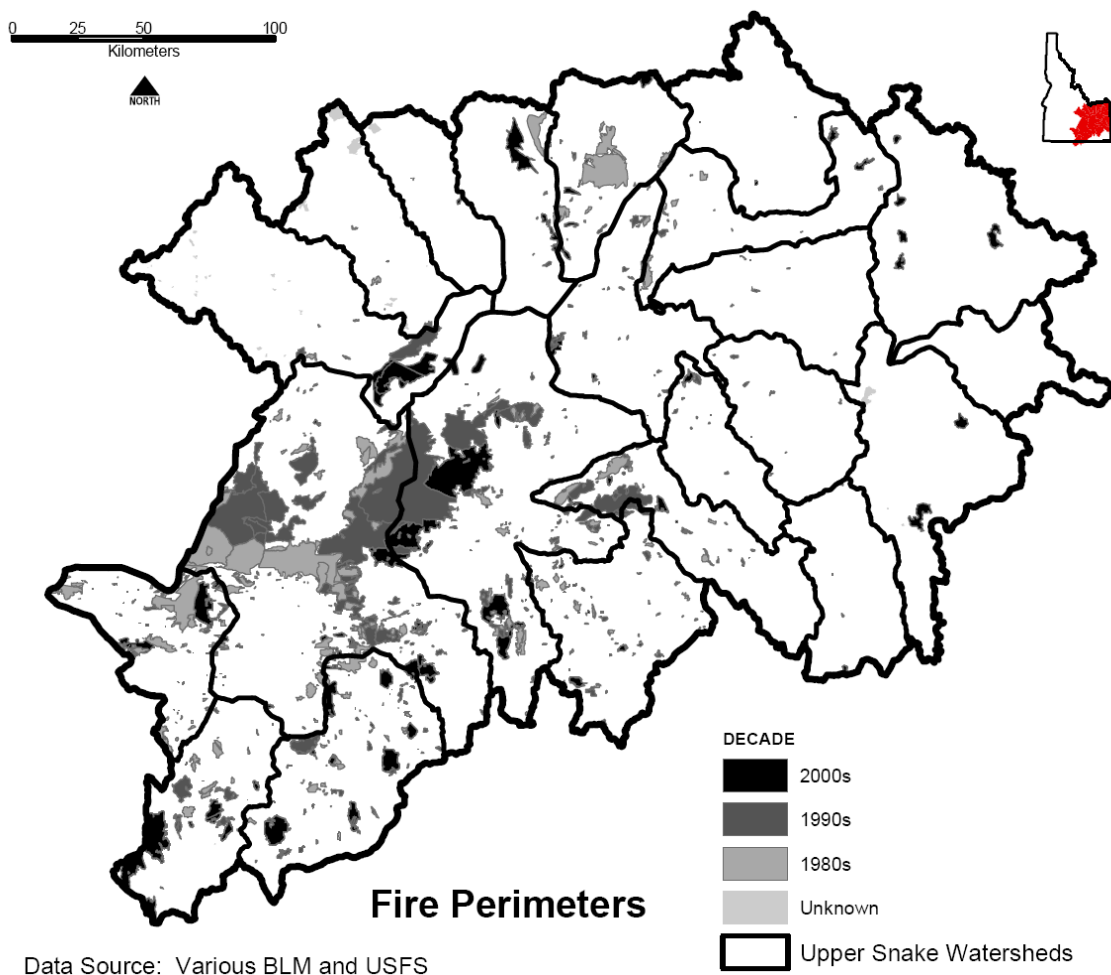


Figure 1-21. Distribution of fires in the Upper Snake province over the last 25 years.

Areas continuously disturbed by agricultural activity include more than 2,774,672 acres, or 15%, of the entire province. These disturbed lands consist primarily of irrigated crops and hayfields on private lands. Agriculturally disturbed lands constitute less than 5% of the Snake Headwaters subbasin. In the Closed Basin subbasin, agricultural lands comprise approximately 6% of the

land area. In the Upper Snake subbasin, more than 22% of the land area is in agricultural production, with the highest agricultural development occurring in the Teton, Idaho Falls, and Upper Snake–Rock watersheds, which have 48, 58, and 48%, respectively, of their land area in agriculture.

Areas of known livestock grazing disturbance were estimated primarily through information on grazing allotments on federal and state lands (Figure 1-22). These figures indicate more than 81% of the federal lands in the province are disturbed by grazing. Of that percentage, 84% of the Upper Snake subbasin is grazed, 65% of the Snake Headwaters subbasin are grazed, and 95% of the Closed Basin subbasin is under grazing allotments. Lands with high to

moderate probability of uncharacteristic effects from grazing include 4,906, 38,052, and 12,231 km² in the Snake Headwaters, Upper Snake, and Closed Basin subbasins, respectively (ICBEMP 1997). These amounts indicate that 33, 83, and 84% of the Snake Headwaters, Upper Snake, and Closed Basin subbasins, respectively, have been impacted by livestock grazing. Less than 1% of each of the three subbasins has or had little or no grazing.

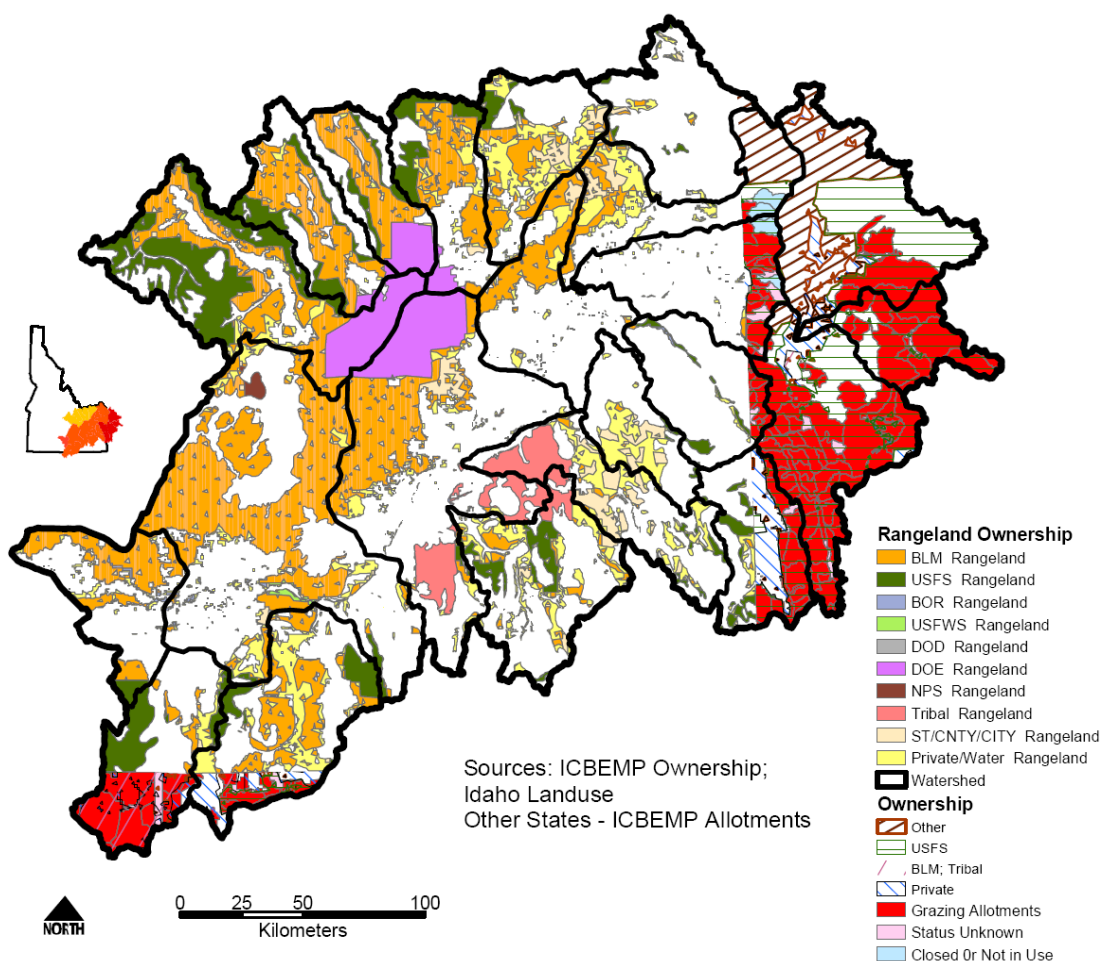


Figure 1-22. Showing the ownership of rangeland in Idaho and ownership of grazing allotments in Utah, Nevada and Wyoming.

1.7.4 Noxious Weeds

Twenty-three noxious weed species are known to occur within the Upper Snake province in Idaho. In Wyoming, an estimated 46 species of noxious weeds are within the Snake Headwaters subbasin. The Gros Ventre, Greys–Hoback, and Snake Headwaters watersheds have the greatest number of noxious weed species. Current location data on species occurrences within the subbasin are limited and only enable identification to county (Figure 1-23). This mapped information and data should be considered gross estimates. However, the information indicates that noxious weeds have invaded every county and watershed within the Upper Snake province (see Appendix 1-6 for weeds occurring in Teton County, Idaho, and Teton County, Wyoming). The noxious weeds most widespread within the province include black henbane (*Hyoscyamus niger*), Canada and musk thistle (*Cirsium arvense* and *Carduus nutans*), field bindweed (*Convolvulus arvensis*), leafy spurge (*Euphorbia esula*), spotted knapweed (*Centaurea biebersteinii*), hoary cress (also

known as whitetop, *Cardaria draba*), and poison hemlock (*Conium maculatum*). Noxious weed species of emerging concern include meadow knapweed (*Centaurea debeauxii*), Syrian beancaper (*Zygophyllum fabago*), yellow starthistle (*Centaurea solstitialis*), buffalobur nightshade (*Solanum rostratum*), purple loosestrife (*Lythrum salicaria*), silverleaf nightshade (*Solanum elaeagnifolium*), spring millet grass (*Milium vernale*), Johnsongrass (*Sorghum halepense*), and perennial pepperweed (*Lepidium latifolium*).

This noxious weed assessment does not include estimates or interpretations of the occurrence and coverage for cheatgrass (*Bromus tectorum*), a purposely introduced species intended to increase livestock forage on shrub-steppe range. Its introduction and spread has negatively impacted native shrub-steppe range through increased fire frequency and reduction in native forb production (Connelly *et al.* 2000). Cheatgrass abundance and distribution, although not mapped, is assumed to be pervasive throughout the province.

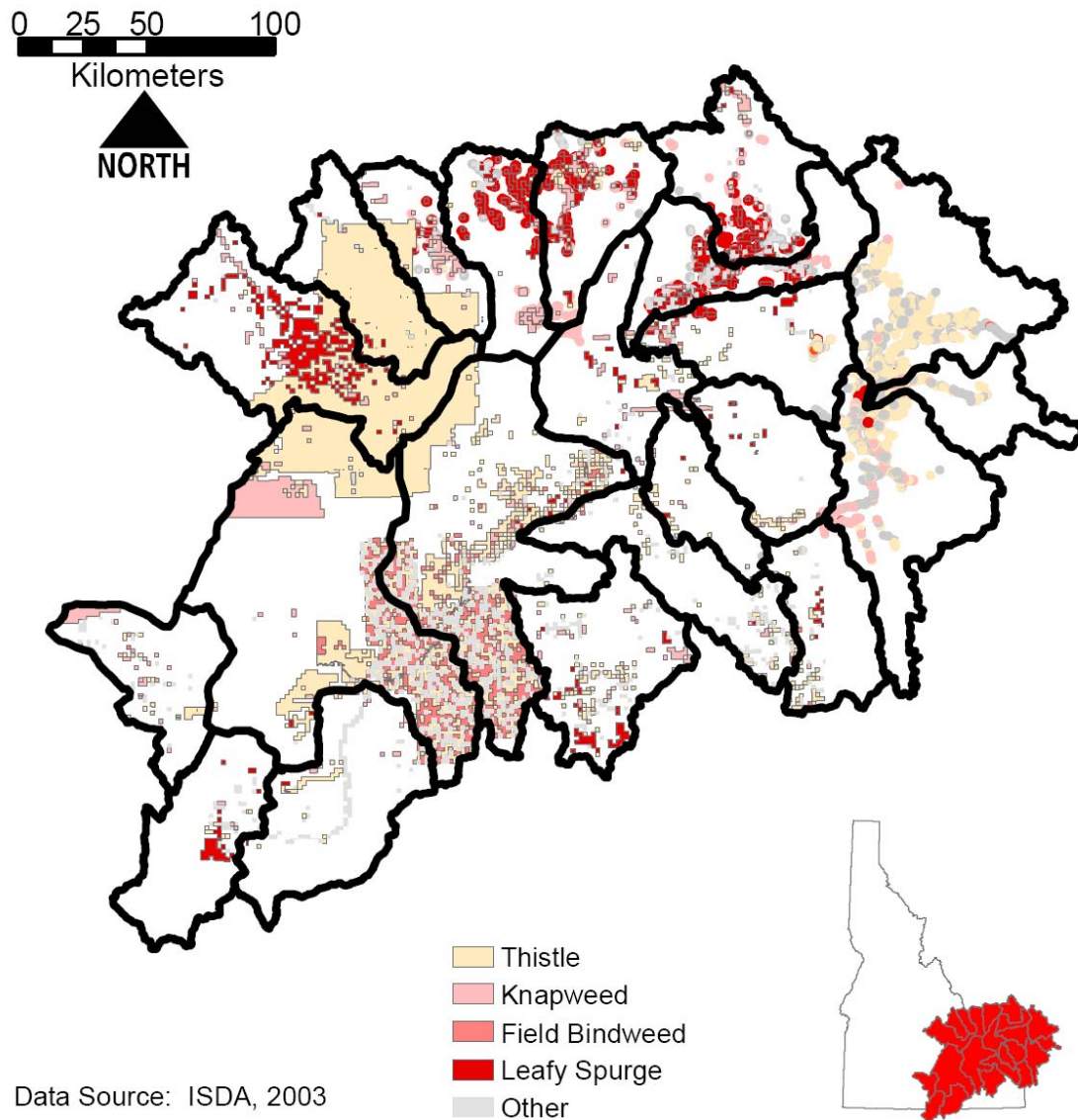


Figure 1-23. Known Distribution of noxious weeds in the Upper Snake province.

2 Subbasin Biological Resources

This section of the assessment describes the environmental conditions and fish and wildlife populations in the Upper Snake province. A key element is information on the current and potential conditions within each of the 22 watersheds.

This assessment reflects the complex of environmental linkages and does not focus on a single species. The challenge is to consider the numerous roles of each species in the environment and the consequences of the elimination of or decrease in one habitat and/or species on other habitats and species. This assessment adopts an approach developed by the Interactive Biodiversity Information System (IBIS 2003) for evaluating the ecological functions of species.

This assessment focuses on nine habitats and their associated focal species (Figure 2-1 and Table 2-1). Although the discussions are separate, we recognize the hierarchical relationships between focal habitats, focal vegetation species, and focal wildlife species that depend, either directly or indirectly, on the focal vegetation species.

Both the aquatic and terrestrial resources sections describe the physical and biological features of a focal habitat. Focal habitats describe a combination of unique vegetative characteristics, dominant plant species, or successional stages with important ecological ties to fish and wildlife (e.g., old growth). Focal habitats may also be composed of specific environmental elements integral to the viability of fish and wildlife populations (e.g., snags, caves). The technical teams used one or more of the following criteria to identify and select focal habitats and species in this assessment:

- Comparatively high fish and/or wildlife density
- Comparatively high fish and/or wildlife species diversity
- Important fish and/or wildlife breeding habitat
- Important fish and/or wildlife seasonal ranges
- Important fish and/or wildlife population or habitat linkage areas
- Rareness
- High vulnerability to habitat alteration
- Unique or dependent species

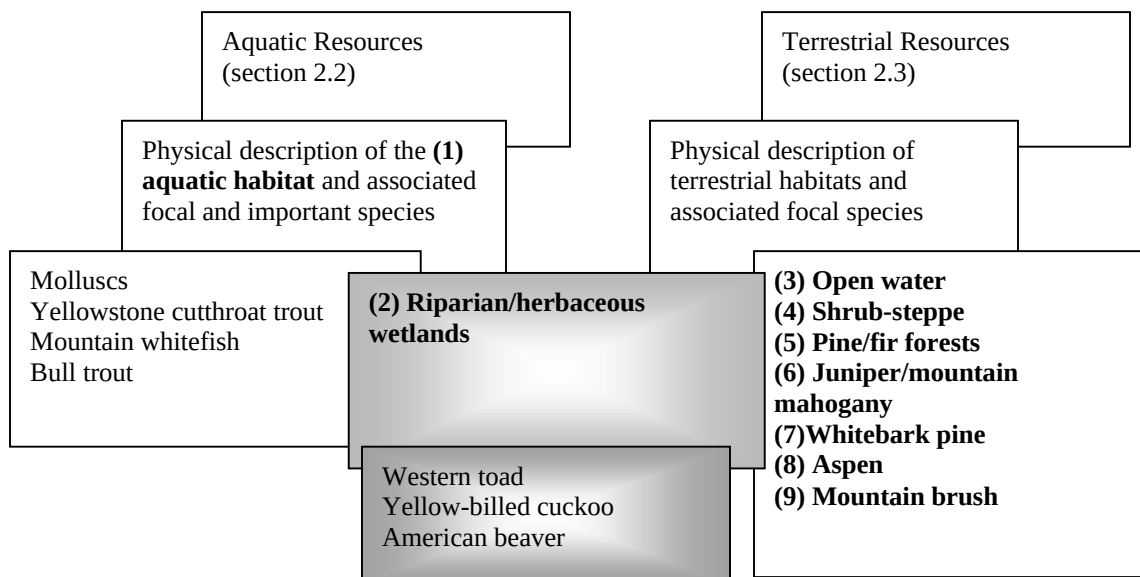


Figure 2-1. Organization of the nine focal habitats for the Upper Snake province. Note that the riparian/herbaceous wetlands habitat is the link between the aquatic and terrestrial resources. The American beaver is especially important to aquatic and riparian/herbaceous wetland habitats because it creates and maintains waterways and affects hydrography.

The selection of the terrestrial focal habitats acknowledged the complexity and high variety of habitats found within the Upper Snake province. For example, classifications of wildlife habitats and land cover are closely related. Land cover is the physical observation of the surface of the ground relating to soils, rock, waterbodies, vegetation and various forms of human development. These same features form the basis for the description of wildlife habitats, though often habitats have more specific definitions relating to key biological functions or species. Typically, land cover classifications are devised for rapid assessment of large areas

using remote sensing techniques, whereas habitat classifications rely on more detailed field observations and tend to have a more restricted geographical scope. For terrestrial habitats, vegetation types are crucial, and in general, the condition of habitats is described by reference to the component vegetation types and botanical composition of the vegetation plots (although it was noted that elevation can sometimes confuse the issue). Therefore, we considered land and vegetation classification systems of cover types and structural stages when identifying focal habitats.

Table 2-1. Focal habitats and species associated with the focal habitats in the Upper Snake province.

Focal Habitat	Focal Species	Species' Key Roles in Maintaining Ecological Conditions
Aquatic	Molluscs	Detritivore; grazes along the mud surfaces, ingesting diatoms or small plant debris. May act as first alert regarding pollutants long before the pollutants are seen in other organisms.
	Yellowstone cutthroat trout (<i>Oncorhynchus clarkii bouvieri</i>)	Insectivorous and piscivorous at larger sizes. Provides food base for piscivorous birds and mammals.
	Mountain whitefish (<i>Prosopium williamsoni</i>)	Insectivorous. Provides food base for piscivorous birds and mammals.
	Bull trout (<i>Salvelinus confluentus</i>)	Top aquatic predator. Spawns in very cold headwater areas.
Riparian/herbaceous wetlands	Western toad (<i>Bufo boreas boreas</i>)	Feeds in water on decomposing benthic substrate and aids in physical transfer of substances for nutrient cycling (C, N, P). Uses burrows dug by other species (secondary burrow user). Physically affects (improves) soil structure and aeration (typically by digging).
	Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	Prey for secondary or tertiary consumer (primary or secondary predator). Interspecies nest parasite. Controls or depresses insect population peaks.
	American beaver (<i>Castor canadensis</i>) (the only species that actively creates waterways)	Prey for primary or secondary predator. Primary burrow excavator (fossorial or underground burrows). Creates trails (possibly used by other species). Aids in physical transfer of substances for nutrient cycling (carbon, nitrogen, phosphorus, etc.). Physically affects (improves) soil structure and aeration (typically by digging). Impounds water by creating diversions or dams; creates ponds or wetlands by building physical barriers. Creates standing dead trees (snags).
Open water (lakes)	Trumpeter swan (<i>Cygnus buccinator</i>)	Prey for secondary or tertiary consumer (primary or secondary predator). Primary creation of ground structures (possibly used by other organisms).
	Western grebe (<i>Aechmophorus occidentalis</i>)	Disperses vascular plants, insects, and other invertebrates. Primary creation of aquatic structures (possibly used by other organisms).
	American white pelican (<i>Pelecanus erythrorhynchos</i>)	Piscivorous (fish eater). Primary creation of aerial structures (possibly used by other organisms).
	American avocet	Prey for secondary or tertiary consumer (primary or secondary predator). Disperses insects and other invertebrates.
	Common loon (<i>Gavia immer</i>)	Piscivorous (fish eater). Disperses vascular plants, insects, and other invertebrates.

Focal Habitat	Focal Species	Species' Key Roles in Maintaining Ecological Conditions
Shrub-steppe	Sagebrush (<i>Artemisia</i> spp.)	Provides food, cover, and nesting substrate, especially for sage-steppe obligates. Sometimes protects other native forbs and grasses from overgrazing (when in the interface). Determines which other kinds of vegetation will occur. Stabilizes soil; tolerates drought.
	Northern sagebrush lizard (<i>Sceloporus graciosus graciosus</i>)	Prey for secondary or tertiary consumer (primary or secondary predator). Physically affects (improves) soil structure and aeration (typically by digging).
	Greater sage grouse (<i>Centrocercus urophasianus</i>)	Prey for secondary or tertiary consumer (primary or secondary predator). Disperses seeds.
	Sage sparrow (<i>Amphispiza belli</i>)	Prey for secondary or tertiary consumer (primary or secondary predator). Common interspecific nest host. Disperses seeds/fruits (through ingestion or caching).
Pine/fir forest (dry, mature)	Great gray owl (<i>Strix nebulosa</i>)	Uses aerial structures created by other species. Controls terrestrial vertebrate populations (through predation).
	Black-backed woodpecker (<i>Picoides arcticus</i>)	Primary cavity excavator in snags or live trees. Controls or depresses insect population peaks. Physically fragments downed, standing wood.
	Boreal owl (<i>Aegolius funereus</i>)	Vertebrate eater (consumer or predator of herbivorous vertebrates). Secondary cavity user.
	Northern goshawk (<i>Accipiter gentilis</i>)	Controls terrestrial vertebrate populations (through predation or displacement). Primary creation of aerial structures (possibly used by other organisms).
Juniper/mountain mahogany	Mountain mahogany (<i>Cercocarpus ledifolius</i>)	Big game cover and forage, especially during winter. Very palatable to bighorn sheep. Some stabilization properties; helps to stabilize soil in disturbed areas such as roadcuts and mine spoils. Tolerant of heat and drought.
Whitebark pine	Whitebark pine (<i>Pinus albicaulis</i>)	Provides forage for bears and other species. Survives where tree growth is limited. Provides hiding and thermal cover for wildlife.
	Clark's nutcracker (<i>Nucifraga columbiana</i>) (keystone species in whitebark pine regeneration)	Prey for secondary or tertiary consumer (primary or secondary predator). Disperses seeds/fruits (through ingestion or caching).
Aspen	Quaking aspen (<i>Populus tremuloides</i>)	Provides important breeding/nesting, foraging, cover, and resting habitat for a variety of birds and mammals. Has a high food value. Important for certain cavity nesters. Important mid-seral species.
Mountain brush	Antelope bitterbrush (<i>Purshia tridentata</i>)	An important browse for wildlife and livestock. Supports several insect populations. Provides cover for birds and rodents.

Focal Habitat	Focal Species	Species' Key Roles in Maintaining Ecological Conditions
	Green-tailed towhee (<i>Pipilo chlorurus</i>)	Prey for secondary or tertiary consumer (primary or secondary predator).
	Mule deer (<i>Odocoileus hemionus</i>) (migrates to juniper/mountain mahogany habitat in winter)	Herbivory on trees, shrubs, grasses, and forbs that may alter vegetation structure and composition. Major prey species for carnivores. Creates trails (possibly used by other species); uses trails created by other species.
	Rocky Mountain elk (<i>Cervus elaphus nelsoni</i>) (migrates to juniper/mountain mahogany habitat in winter)	Prey for secondary or tertiary consumer (primary or secondary predator). Herbivory on trees or shrubs that may alter vegetation structure and composition. Transportation of viable seeds, spores, plants, or animals. Disperses fungi. Physically fragments down wood. Creates trails (possibly used by other species); uses trails created by other species.

Focal species either have special ecological, cultural, or legal status, or can be used to evaluate the health of the ecosystem and effectiveness of management actions. The following selection criteria were used in the focal species identification:

- Federal/state classification
- Cultural/economic significance
- Critical ecological function
- Indicator of environmental health
- Locally significant or rare
- Guild representative
- Habitat obligate
- Managed species
- Relationship to salmon
- Data availability

One aquatic species, bull trout (*Salvelinus confluentus*), and four terrestrial species in the Upper Snake province are listed as threatened under the Endangered Species Act of 1973 (ESA)¹ (Table 2-2). Two snail species, the

Utah valvata snail (*Valvata utahensis*) and the Snake River physa snail (*Physa natricina*), are listed as endangered. Species listed under the ESA, but not included as focal species for the priority habitats, are included in the assessment (see section 2.3.9) as they affect future management actions or projects.

¹ The term “threatened species” means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The term “endangered species” means any species

that is in danger of extinction throughout all or a significant portion of its range.

Table 2-2. Species listed under the Endangered Species Act in the Upper Snake province.

Species	Status	Date	Protective Regulations
Aquatic			
Utah valvata snail (<i>Valvata utahensis</i>)	endangered	December 14, 1992	57 FR 59244
Snake River physa snail (<i>Physa natricina</i>)	endangered	December 14, 1992	57 FR 59244
Bull trout (<i>Salvelinus confluentus</i>)	threatened	November 1, 1999	64 FR 58910
Terrestrial Species			
Bald eagle (<i>Haliaeetus leucocephalus</i>)	endangered threatened	March 11, 1967 July 12, 1995	32 FR 4001 60 FR 35999
Wolf (<i>Canis lupus</i>)	threatened (experimental population) ²	March 11, 1967 November 18, 1994 November 22, 1994	32 FR 4001 59 FR 60252 59 FR 60266
Canada lynx (<i>Lynx canadensis</i>) (see section 2.3.9.3)	threatened	March 24, 2000	65 FR 16051
Grizzly bear (<i>Ursus arctos horribilis</i>)	endangered threatened	March 11, 1967 July 28, 1975	32 FR 4001 40 FR 31734

² The Endangered Species Act Amendments of 1982, Pub. L. 97-304, made significant changes to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), including the creation of section 10(j), which provides for the designation of specific animals as “experimental.” Under section 10(j), a listed species reintroduced outside of its current range, but within its historic range, may be designated, at the discretion of the Secretary of the Interior (Secretary), as “experimental.” This designation increases the U.S. Fish and Wildlife Service’s flexibility and discretion in managing reintroduced endangered species because such experimental animals may be treated as threatened species. The act requires that animals used to form an experimental population be separated geographically from nonexperimental populations of the same species.

Two primary information sources used in this assessment include the Interior Columbia Basin Ecosystem Management Project (ICBEMP)³ data set, and the Geographic Approach to Planning (GAP)⁴ data set. The ICBEMP data set supplied information on the potential (i.e., historic) vegetation coverage, while the GAP II data set supplied information on current coverage. With any remotely derived information, such as that of the GAP data set, there is a certain degree of uncertainty. In GAP, spatial and spectral resolutions, temporal constraints, cloud cover, and geometric correction accentuated uncertainty. For this assessment, the most important habitats are the aquatic, riparian, and herbaceous wetlands. However, GAP II did not assess riparian areas (see Appendix 2-1). Since riparian habitats are a focal habitat, as well as the critical overlap of terrestrial and aquatic environments, obtaining reliable information on the quantity and quality of the riparian and herbaceous wetlands in the Upper Snake province is of foremost importance.

³ More than 300 different geographic information system (GIS) data layers or themes were compiled or created in support of the ICBEMP assessment. In addition, numerous databases were created. The U.S. Forest Service's Pacific Northwest Research Station serves as custodian of the project data. These data are available for download from the ICBEMP web site, which is maintained by the Interior Columbia Basin Ecosystem Management Project of the U.S. Department of Agriculture, Forest Service and U.S. Department of the Interior, Bureau of Land Management.

⁴ GAP analysis is a rapid conservation evaluation method for assessing the current status of biodiversity at large spatial scales. It uses geographic information systems (GIS) to identify habitats. By identifying their habitats, GAP analysis gives land managers, planners, scientists, and policy makers the information they need to make better-informed decisions when identifying priority areas for conservation.

2.1 Key Ecological Functions of Fish and Wildlife Species

2.1.1 Overview

2.1.1.1 *Key Ecological Functions and Environmental Correlates*

Understanding ecological roles of fish, wildlife, and plant species is important in understanding the consequences of changes and management on ecosystems. As suggested by Figure 2-1, many species perform several functions in their environments. Further, a specific function in the environment might be occupied by several species. This concept, called functional redundancy, is defined as the total number of wildlife species performing a specific ecologic function. Functional redundancy is just one of many community patterns used to describe ecological systems. Other ecological functions, or community patterns, in wildlife communities include total functional diversity, functional richness, functional webs, functional profiles, and functional homologies (Marcot and Vander Heyden 2001).

In this assessment, key ecological functions (KEFs) and key environmental correlates (KECs) (IBIS 2003) were used to describe and compare wildlife species and their associations with each other and their environment (Appendix 2-2). The KEFs of species refer to the major ecological roles that species play in their ecosystem and the resulting influences on diversity, productivity, and eventually sustainability of resource use and production (Marcot and Vander Heyden 2001). KEFs are defined for each species using a standardized classification system (see Appendix 2-2). One limitation to using this system is that the relative impacts or importance of different functions are excluded. Another major limitation to this process is that there has been little research

done to quantify the rates of KEFs (i.e., tonnage of soil worked by burrowing and digging animals per acre per year).

Key environmental correlates (KECs) refer to environmental influences on the distribution and abundance of organisms. KECs are also denoted for each species using a standard classification system that includes categories for vegetation habitat elements, nonvegetation, terrestrial elements, aquatic bodies and substrates, and anthropogenic structures. As with KEFs, one major limitation of KEC information is that it is represented as simple categorical relations with species rather than as quantified correlations (i.e., specific amounts, levels or rates of each KEC and corresponding population densities or trends of each species).

2.1.1.2 Functional Specialists and Generalists

In the Upper Snake province, the frequency of species by number of KEF categories is

roughly characterized by a distribution right skewed frequency (Figure 2-2). The species with many KEF categories tend to be functional generalists: they perform many functions. Species with fewer KEF categories are functional specialists, performing only a few functions within their ecosystems. We identified 60 functional specialist species in the Upper Snake province (Appendix 2-2). The only focal species identified as functional specialist was the boreal owl (*Aegolius funereus*). Nine species were identified that performed only one KEF in the Upper Snake province (Figure 2-2): the black swift (*Cypseloides niger*), common nighthawk (*Chordeiles minor*), common poorwill (*Phalaenoptilus nuttallii*), harlequin duck (*Histrionicus histrionicus*), merlin (*Falco columbarius*), rough-legged hawk (*Buteo lagopus*), turkey vulture (*Cathartes aura*), and ringneck snake (*Diadophis punctatus*) (Appendix 2-2). Only one species performs 14 ecological functions: the black bear (*Ursus americanus*). The majority of the species in the Upper Snake province perform between two and seven KEFs (Figure 2-2).

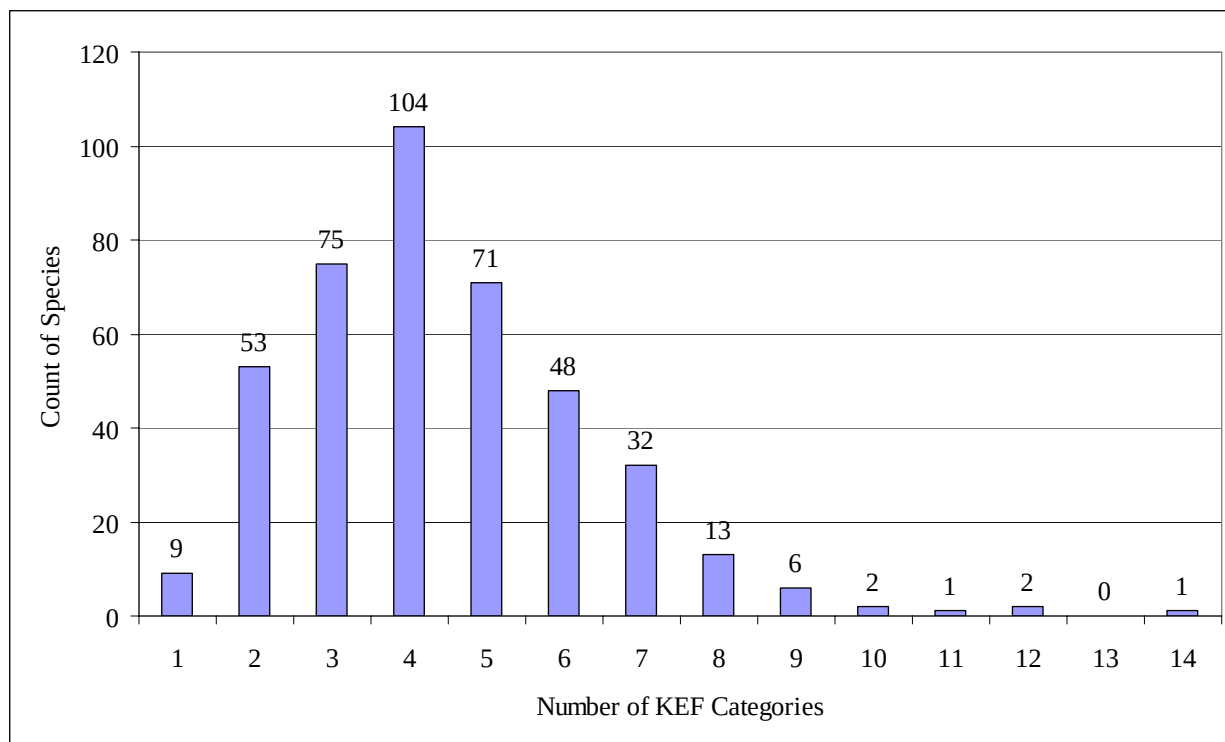


Figure 2-2. Frequency histogram showing the number of vertebrate wildlife species by number of categories of key ecological functions (KEFs) that they perform in the Upper Snake province (IBIS 2003).

2.1.1.3 Functional Richness

We also determined the functional richness in the Upper Snake province by taking the total number of KEF categories in a community (IBIS 2003). The wildlife habitats in the Upper Snake province appear more or less equally functionally rich, with between 37 and 46 species per wildlife habitat (Appendix 2-2). The most functionally rich communities are the riparian and herbaceous wetland areas. Forested habitats are also slightly greater in the functional richness than shrub-steppe or grassland habitats.

2.1.1.4 Trophic Levels

Evaluation of KEFs can also be used to depict general trophic structures of communities and

identify species that aid in the physical transfer of substances for nutrient cycling. In the Upper Snake province, 222 wildlife species (55%) are categorized as primary consumers, 370 (92%) as secondary consumers (primary predators), and 7 (<1%) species as tertiary consumers (secondary predators) (Figure 2-3). Bird species appear to play a proportionally greater role across the trophic levels. Other minor trophic categories include carrion feeders (<1%, mostly birds and mammals), cannibalistic feeders (<1%, amphibians and mammals), and coprophagous feeders (feces eaters) (<1%, all mammals).

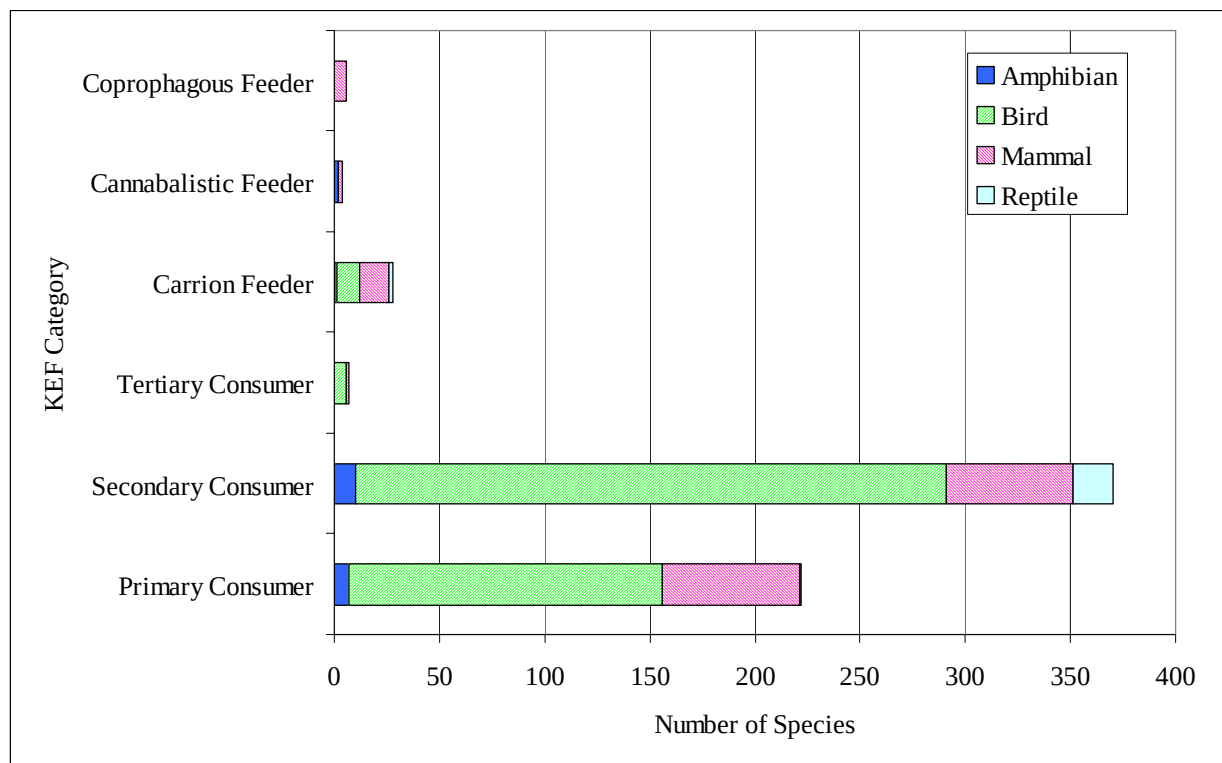


Figure 2-3. Trophic level functions of wildlife in the Upper Snake province (IBIS 2003).

We also evaluated 27 categories of organismal relationships within wildlife communities (Appendix 2-2). Five species of birds serve as pollination vectors for plants (Figure 2-4). Among terrestrial vertebrates, mammals are the sole dispersers of fungi and lichens, and both birds and mammals disperse seeds and fruits. Fourteen bird species and

one mammalian species act as primary cavity excavators, serving 31 bird and 7 mammalian secondary cavity-using species. Birds and mammals create roosting, denning, and nesting structures in aerial, ground, and aquatic environments that other amphibian, reptile, bird, and mammal species also use (Figure 2-4).

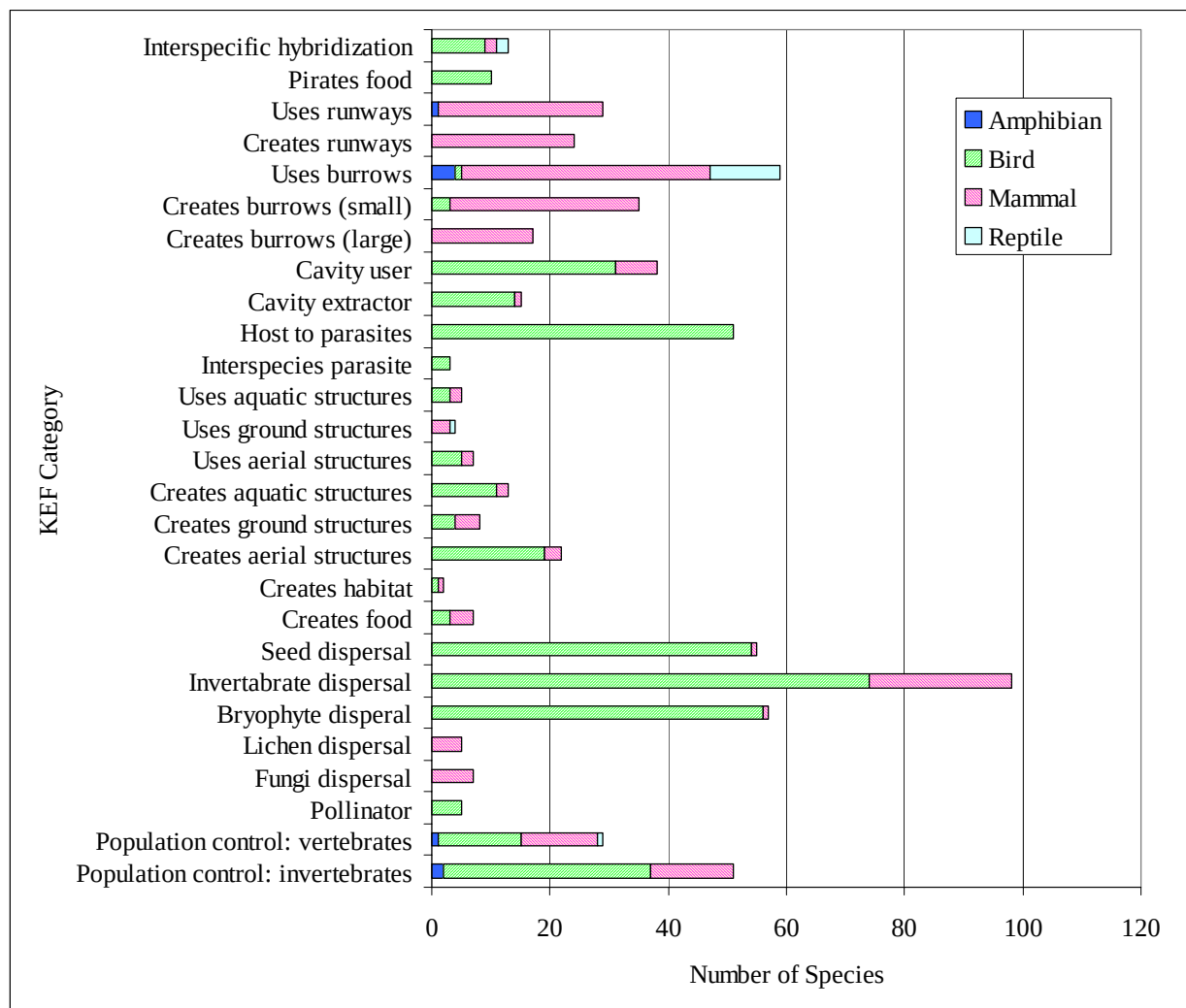


Figure 2-4. Organismal functional relations of wildlife in the Upper Snake province (see appendix (IBIS 2003)).

2.1.1.5 Total Functional Diversity

Total functional diversity is functional richness weighted by functional redundancy (Brown 1995). The change in total functional diversity (TFD) in the Upper Snake province from the historic to current conditions (circa 1850 to 2000) suggests that large scale decreases have occurred and significant decreases in total functional diversity have occurred in the Lower Henrys, Teton, Idaho Falls, Willow, Palisades, American Falls, Portneuf, Blackfoot, Raft, LakeWalcott,

Upper Snake–Rock, and Goose watersheds (Figure 2-5). However, some areas within these same watersheds and others have significantly increased in total functional diversity (Figure 2-5). Increases in total functional diversity might be explained changes in habitats due to either natural or anthropogenic causes. The analysis of functional richness for different habitats demonstrated that riparian or forested habitats had greater functional richness than other habitats like grasslands or shrub-steppe. Areas in the Upper Snake province with increased

total functional diversity may originate from areas that were once grasslands or shrub-steppe that have now converted to forested or open water types. In addition, increases in total functional diversity might be explained by animals leaving areas of high anthropogenic disturbance to find refuge in protected or wilderness areas and relatively

intact watersheds. To escape human or natural disturbances occurring in preferred environments, species might occupy habitats that they do not normally prefer. Finally, we must consider the potential for unknown shortcomings in the IBIS model in our analysis.

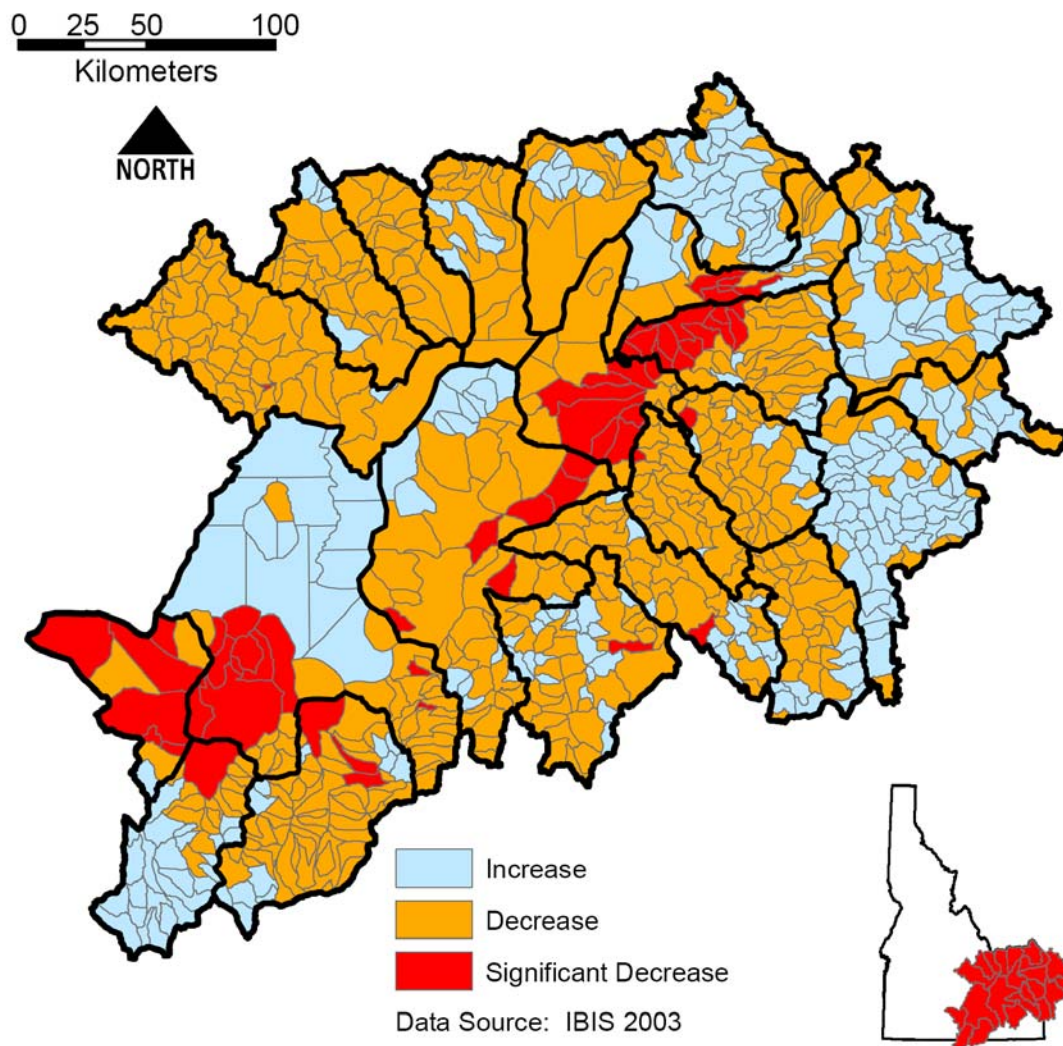


Figure 2-5. Change in total functional diversity from historic to current (circa 1850 to 2000) conditions in the Upper Snake province (IBIS 2003).

2.1.1.6 Functional Profiles

Marcot and Vander Heyden (2001) hypothesize that functional redundancy imparts resilience because increases in functional redundancy are often correlated to increases in the functional resilience (or resistance for that function). Functional profiles also show the degree of functional redundancy across communities. For instance, an analysis of the functional profile identifies the level of redundancy of a particular KEF. Communities that are functionally homologous have similar functional profiles and patterns of functional redundancy, even if the species performing the functions differ. Functionally homologous communities can be expected to operate in similar ecological ways. Currently, there is not enough information to determine which communities

are functionally homologous in the Upper Snake province. Information on species and habitats need to be collected over time to make these types of determinations.

To illustrate the functional profiles in the Upper Snake province, we compared the number of KEF categories among the focal habitats (Figure 2-6 and Figure 2-7). Overall, riparian/herbaceous wetland habitats appear to have the greatest number of species performing the greatest number of ecological functions. There are a few exceptions: there are more tertiary consumers in the pine/fir forests (Figure 2-6), more mammals dispersing fungi and lichens in the pine/fir forests, and more species making and using burrows and ground structures in the shrub-steppe habitat than there are in riparian/herbaceous wetlands (Figure 2-7).

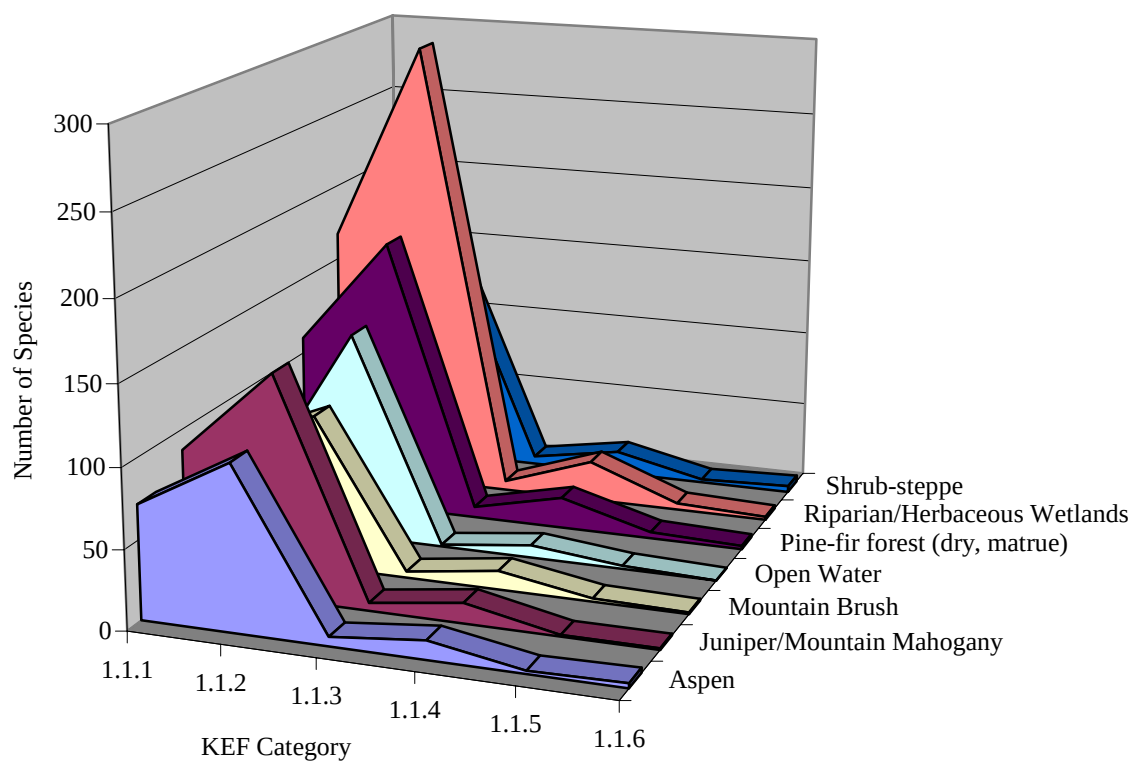


Figure 2-6. Degree of functional redundancy in trophic levels for seven focal habitats in the Upper Snake province (IBIS 2003) (see Appendix 2-2 for KEF category definitions).

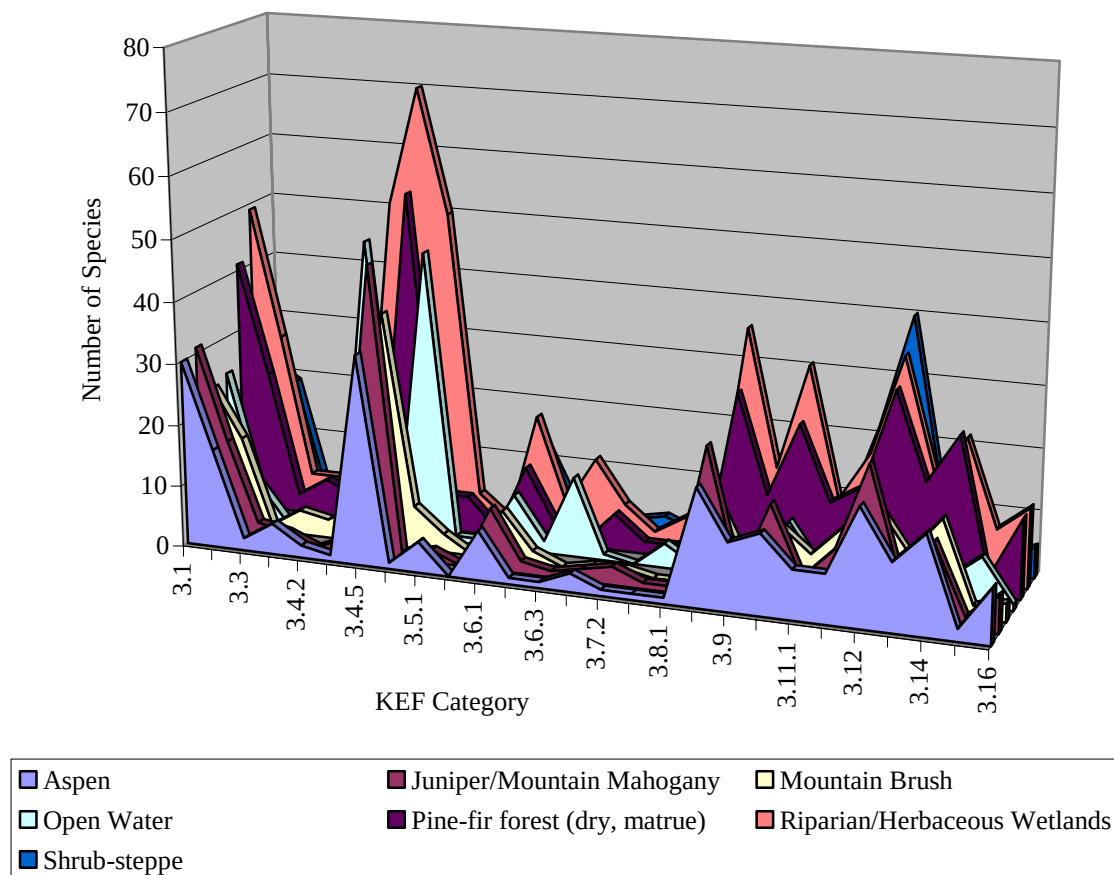


Figure 2-7. Degree of functional redundancy in organismal relationships for seven focal habitats in the Upper Snake province (IBIS 2003) (see Appendix 2-2 for KEF category definitions).

The findings from comparing functional profiles for focal habitats suggest riparian and herbaceous wetlands are a functionally resilient habitat, while aspen and juniper/mountain mahogany habitats are less functionally resilient. The functional profiles also show which ecological functions or roles are performed by many species or only a few species for each focal habitat. For instance, many species disperse seeds and fruits in all focal habitats (KEF category 3.4.5) (Figure 2-7), implying a redundancy for this ecological function. In contrast, for some habitats, very few species act as pollinators (KEF category 3.3) or disperse lichens (KEF category 3.4.2) (Figure 2-7).

2.1.1.7 Critical Functional Link Species

An ecological function that is represented by very few species; by species that are scarce or declining; or by species that, if extirpated, would mean loss of the function to the system are termed “imperiled functions.” Loss of imperiled functions serves to degrade ecosystem integrity, even seldom performed but critical ecological functions that maintain ecosystems. Reductions or extirpations of species that perform critical functional links may have ripple effects in the ecosystem, causing unexpected or undue changes in

biodiversity, biotic processes, and the functional web of a community.

By definition, if the species is the only one that performs a particular ecological function within a community, then it is a critical functional link species. For instance, the black-chinned (*Archilochus alexandri*) and rufous (*Selasphorus rufus*) hummingbirds are two species that act as pollination vectors for a variety of habitats. These species are critical functional link species for shrub-steppe and grasslands habitats (Appendix 2-2).

Focal species that perform critical functional roles in certain habitats are the American beaver (*Castor canadensis*) and Rocky Mountain elk (*Cervus elaphus nelsoni*) (Appendix 2-2). The beaver is also a critical functional link species for several habitats because it is the only species that functions to impound water by creating diversions or dams. The elk is the only species to create small ponds or increase herbaceous wetlands through wallowing in shrublands and shrub-steppe.

2.1.2 Focal Species

We summarized KEFs and KECs for each of the wildlife species identified as a focal species in the Upper Snake province (Figure 2-8 and Figure 2-9, respectively). Wildlife species that have high KEF counts are considered to be generalists in their environment, while species that have low KEF counts are considered specialists (Figure 2-8). Species that have high KEC counts are

considered to be robust because they can more easily adapt to changes in their environment than species with low KEC counts can (Figure 2-9). Of the focal species for the Upper Snake province, the Rocky Mountain elk, beaver, and mule deer appear to be the more resilient to changes in their environment because they have high KEF and KEC counts. The focal species most susceptible to changes in their environment are the boreal owl, sagebrush lizard, and black-backed woodpecker (*Picoides arcticus*). For instance, the black-backed woodpecker is dependent on fire landscapes and other large-scale forest disturbances and so fire suppression and post-fire salvage logging are detrimental to the species and have reduced its habitat.

Other species with relatively low KEF counts are the great gray owl (*Strix nebulosa*) and American white pelican (*Pelecanus erythrorhynchos*), but these species also have relatively high KEC counts (Figure 2-8 and Figure 2-9). Such counts mean that these species are functional specialists but that they are also capable of adapting to changes in their environment. Both the great gray owl and American white pelican are capable of migrating to different areas to find preferred forage. So, although they may be functional specialists, they move from one area to another to find forage. The American avocet is also a functional specialist because it eats primarily invertebrates. But the avocet utilizes both the aquatic and terrestrial environments, increasing its ability to find adequate forage.

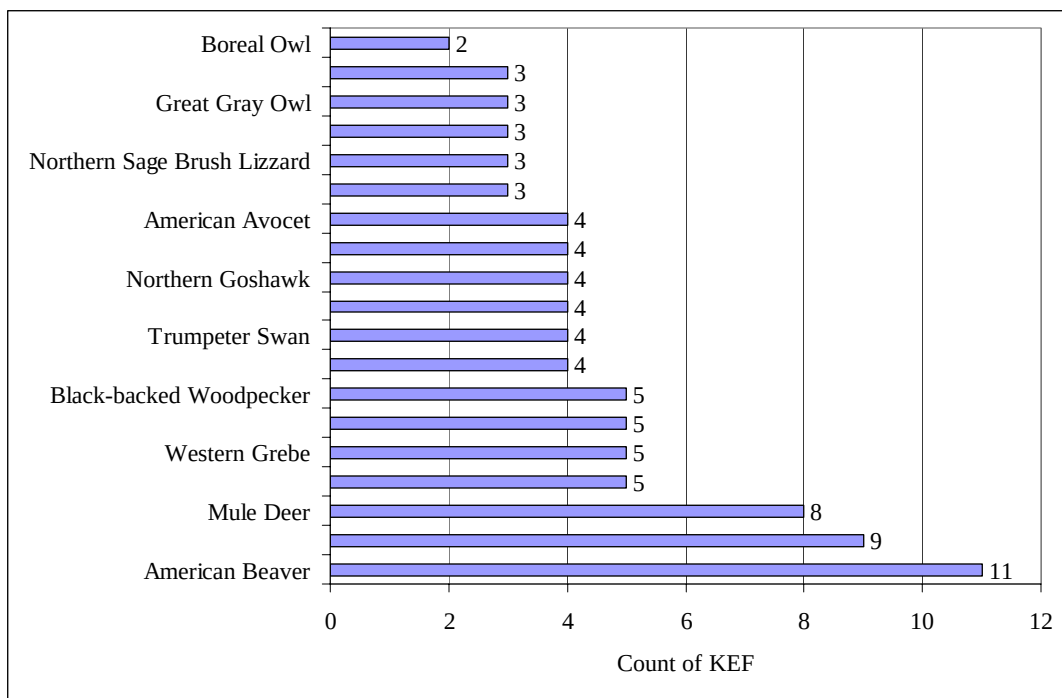


Figure 2-8. Counts of key ecological functions (KEFs) for focal wildlife species in the Upper Snake province (IBIS 2003).

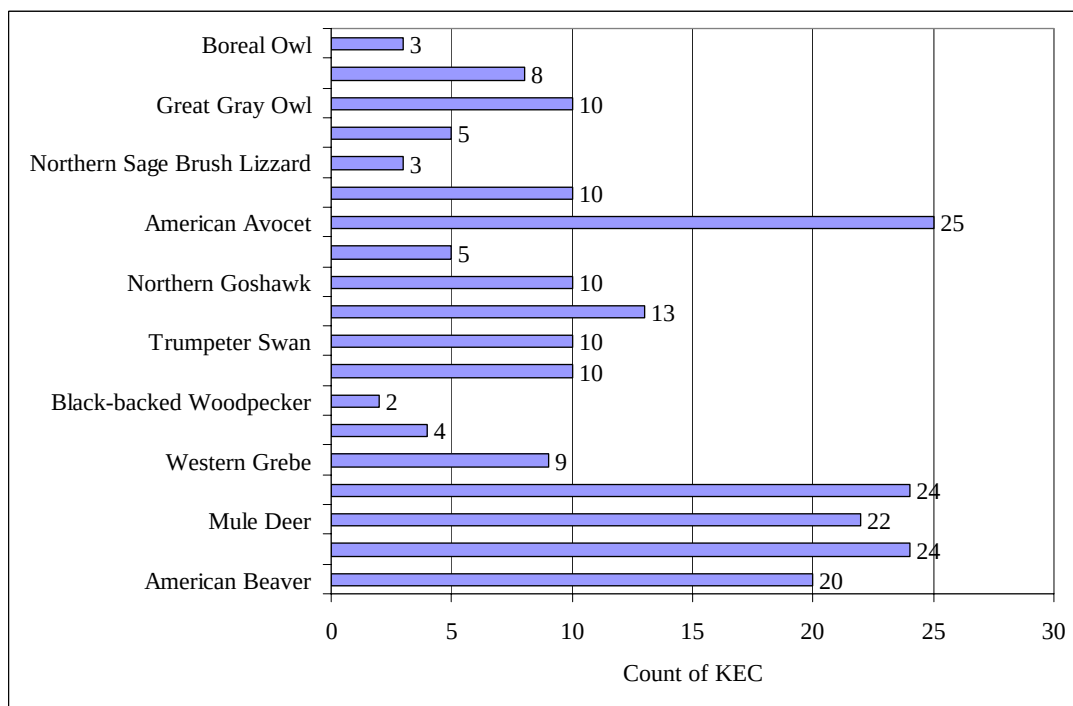


Figure 2-9. Counts of key environmental correlates (KECs) for focal wildlife species in the Upper Snake province (IBIS 2003).

To evaluate how the ecological functions and roles of wildlife and fish species might overlap, we assessed the wildlife focal species for direct associations with aquatic environments (Figure 2-10). Two hundred sixteen species in the Upper Snake province have direct associations with the aquatic environment (Appendix 2-2). Of the focal species, 8 birds, 3 mammals, and the western toad (*Bufo boreas boreas*) were found to have direct associations with the aquatic environment. KEC counts for these species reveal that the American avocet,

American beaver, elk, mule deer, and western toad would be better adapted to changes in their environment, while the trumpeter swan (*Cygnus buccinator*), common loon (*Gavia immer*), and western grebe (*Aechmophorus occidentalis*) would be less adaptable to changes in their aquatic environments. Overall, the avocet and beaver seem able to use both aquatic and terrestrial habitats equally, whereas the trumpeter swan relies more on the aquatic environment than the terrestrial (Figure 2-10).

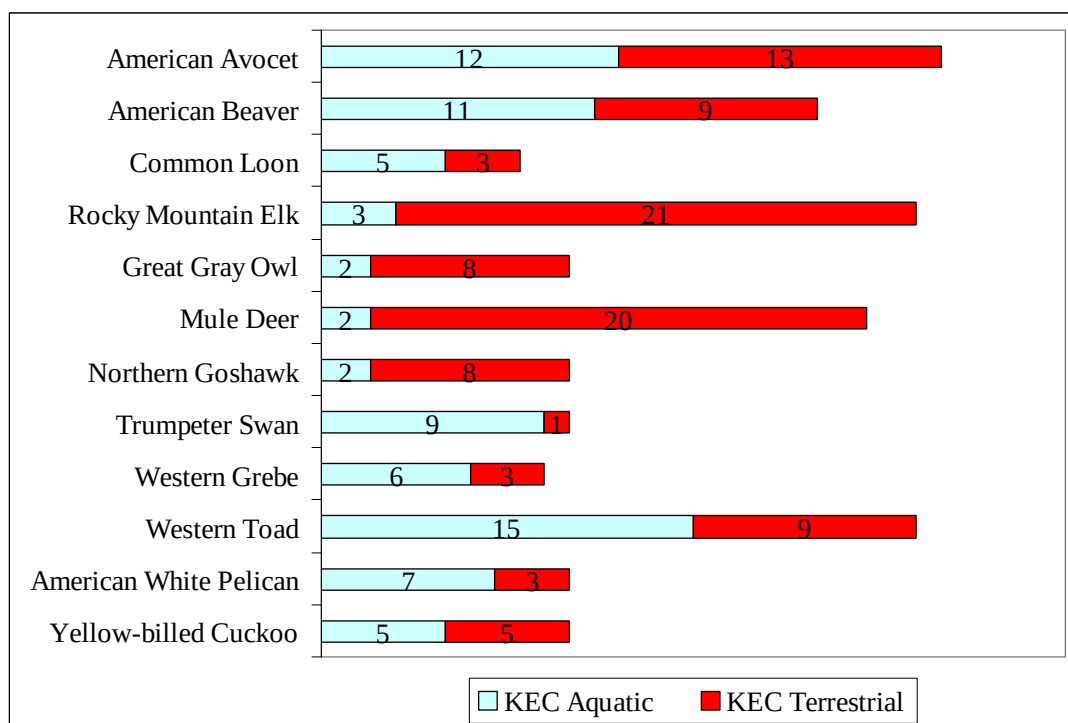


Figure 2-10. Terrestrial focal species associated with aquatic environments in the Upper Snake province and their respective key environmental correlate (KEC) counts (IBIS 2003).

Using the IBIS data set and known species distribution in the Upper Snake province, we determined the percentage change in total functional diversity for each of the focal species in their respective focal habitats

(Figure 2-11). Even though species are capable of occupying the entire area of a particular focal habitat, they often occupy only a certain percentage of it. So, over the total area for a focal habitat, some areas

show increases in the total functional diversity, while other areas show decreases. The same approach can be applied to understanding the changes in total functional diversity for each of the focal habitats in the Upper Snake province (Figure 2-12).

Decreases in total functional diversity in both focal species and focal habitats suggest an overall decline in habitat quality and quantity (Figure 2-11 and Figure 2-12). Focal habitats appearing to be in critical need of mitigative action to increase their total functional diversity in the Upper Snake province include the juniper/mountain

mahogany, whitebark pine, and open water habitats. Each of these habitats has declined in total functional diversity by at least 81%. Open water habitats and riparian/herbaceous wetlands in the Upper Snake province have declined significantly in total functional diversity by 23 and 9%, respectively (Figure 2-12). Consequently, there are declines in the total functional diversity for all the open water and riparian/herbaceous wetland focal species, except for the common loon. One possible explanation for this finding may be that the differences between manmade and natural reservoirs benefit the common loon.

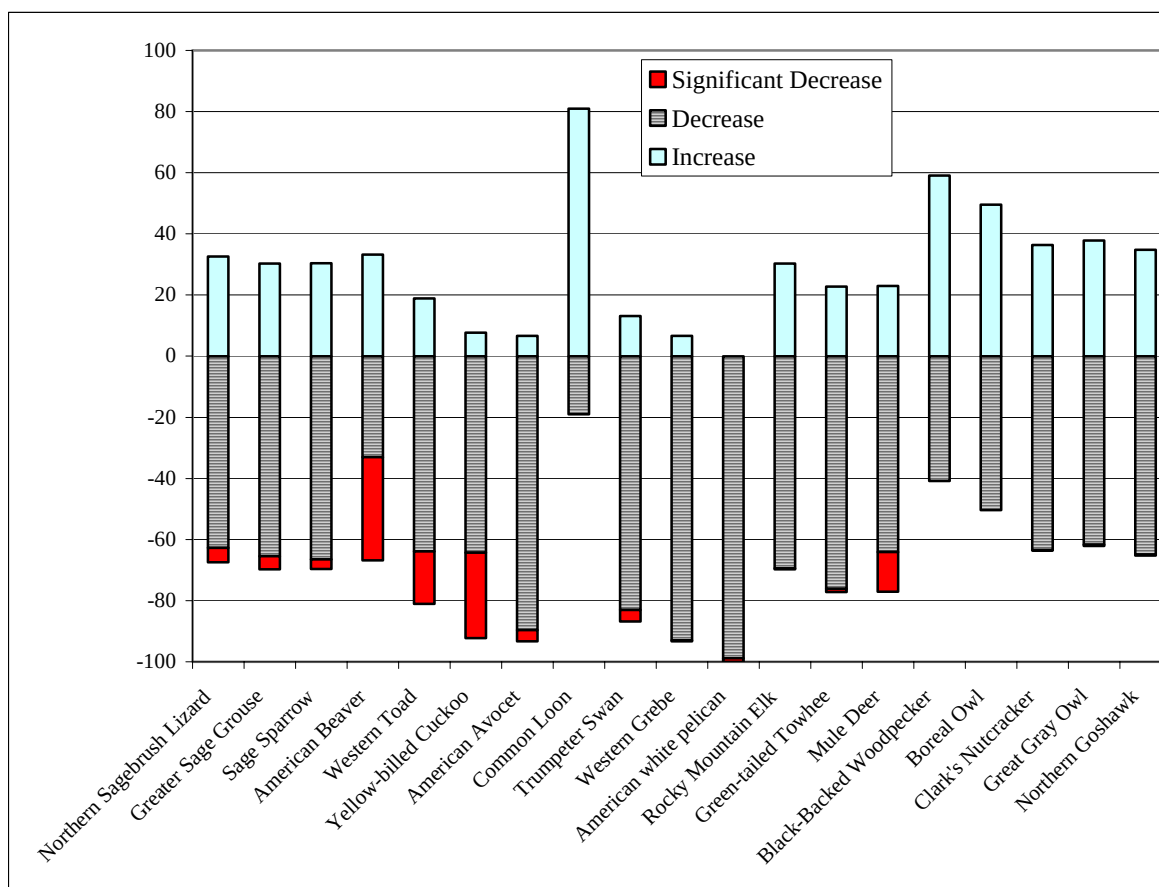


Figure 2-11. The percentage change in total functional diversity (TFD) for each focal species in its respective habitat in the Upper Snake province.

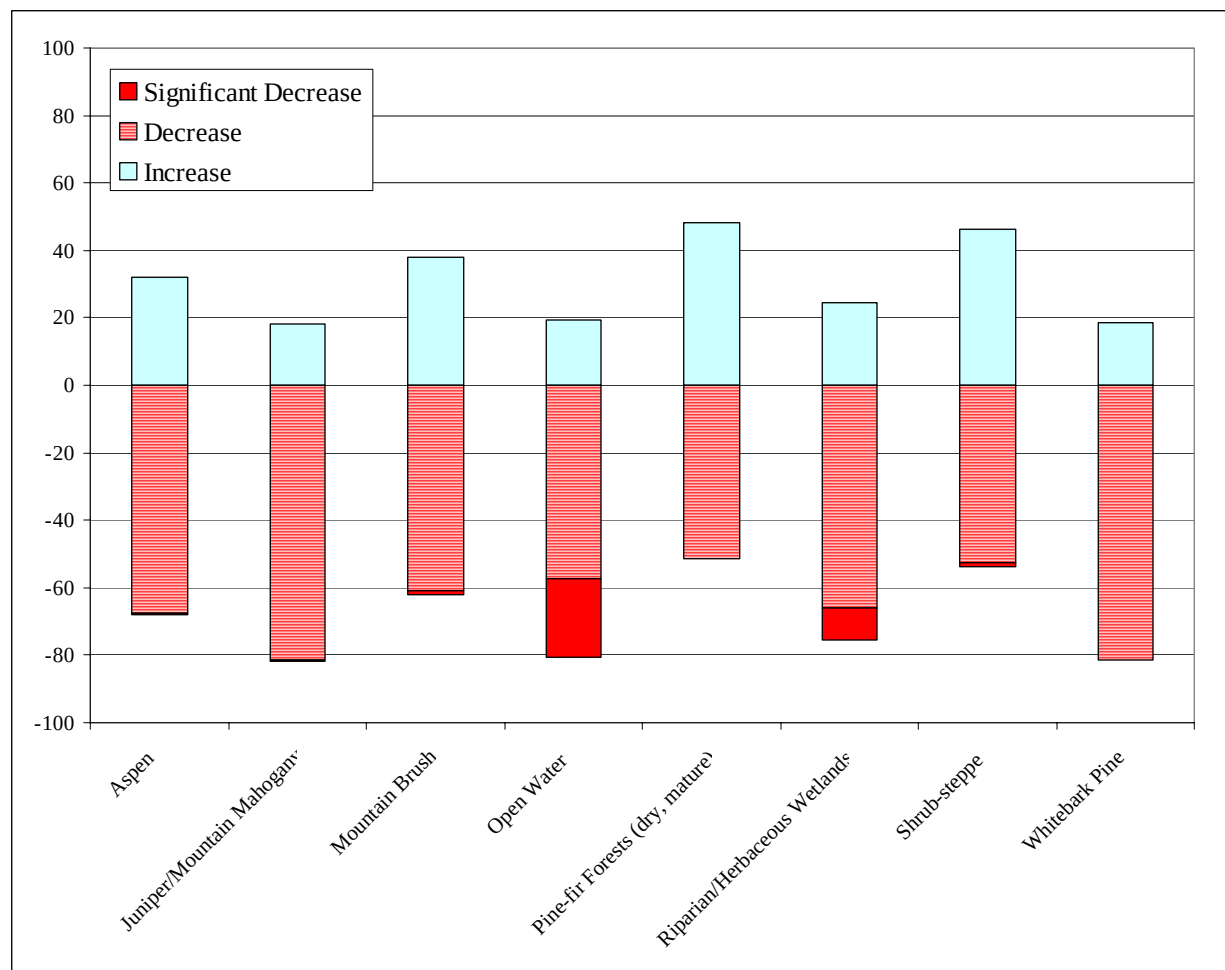


Figure 2-12. The percentage change in total functional diversity (TFD) for each of the focal habitats in the Upper Snake province.

2.2 Aquatic Resources

2.2.1 Focal Species

Focal species (Table 2-3) for the aquatic portion of this assessment were chosen according to guidelines provided by the Northwest Power and Conservation Council (NPPC 2001). These guidelines suggested inclusion of species that met the following criteria in order of importance: 1) designation as a federal endangered or threatened species, 2) ecological significance, 3) cultural significance, and 4) local significance. Further direction from the Independent Science

Review Panel was to use no more than five focal species for the assessment. Based on the above guidelines, the following focal species were chosen: 1) Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) because the species is widespread throughout the subbasin, it is a species about which the most information is known, and it is also socially and ecologically important; 2) bull trout because it is the only federally listed fish species in the subbasin; and 3) mountain whitefish because it is the only native salmonid in the Big Lost River drainage and because this population is genetically more distinct from other Snake River mountain

whitefish populations than the Yellowstone cutthroat trout is distinct from westslope cutthroat trout (Bart Gamett, U.S. Forest Service, personal communication). The fisheries technical teams considered other native fish species that were not chosen as focal species but that were considered important in the subbasin. A short discussion of important species is included in this assessment.

The watershed was chosen as the organizational unit for focal species discussions. The watershed is thought to be the appropriate unit to consider when dealing with aquatic species because the condition of an aquatic ecosystem is dependent on the land and water management in the watershed (Doppelt *et al.* 1993). Bull trout population delineations were identified by the U.S. Fish and Wildlife Service (USFWS 2002).

Table 2-3. Focal, important, and nonnative species in the Upper Snake province identified by the fisheries technical teams.

Focal Species	Important Species	Nonnative Species
Yellowstone cutthroat trout Bull trout Mountain whitefish Utah valvata snail Snake River physa snail	Speckled dace Longnose dace Leopard dace Peamouth chub Leatherside chub Chiselmouth chub Utah chub Tui chub Shorthead sculpin Mottled sculpin Torrent sculpin California floater <i>Margeterifera</i> spp.	Rainbow trout Brook trout Brown trout

2.2.1.1 Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*)

Two forms of the Yellowstone cutthroat trout have been identified but not differentiated genetically (May *et al.* 2003). These are the large-spotted form that was dominant in most of the upper Yellowstone River basin and the Snake River basin from Palisades Reservoir downstream to Shoshone Falls and the fine-spotted form that was dominant in portions of four watersheds in the upper Snake River basin. This assessment will treat both forms as Yellowstone cutthroat trout.

2.2.1.1.1 Conservation Status

In August 1998, Yellowstone cutthroat trout were petitioned for listing under the ESA; however, the U.S. Fish and Wildlife Service concluded that the petition did not contain sufficient or substantial information to indicate that listing was unwarranted at this time (USFWS 2001). The Yellowstone cutthroat trout are a state and federally recognized species of special concern.

All state and federal agencies that manage Yellowstone cutthroat trout consider this subspecies to be a game fish. Therefore, all

Yellowstone cutthroat trout populations have sport fish value and are managed as such by the various states and National Parks in which they occur, regardless of their genetic status. Many Yellowstone cutthroat trout are managed as “conservation populations,” with additional management emphasis placed on preserving the genetic makeup and/or other important attributes of these populations (May *et al.* 2003).

Meyer and Lamansky (2003) identified factors affecting the distribution and biomass of Yellowstone cutthroat trout in the upper Snake. They determined that the occurrence of nonnative salmonids might pose the largest threat to long-term cutthroat trout persistence in the upper Snake River basin. They suggest that management actions developed to restore or protect cutthroat trout populations in the upper Snake River basin should focus on controlling the threat posed by nonnative salmonids (see more about current status by river drainage and on recommendations for future research and management actions in Meyer and Lamansky (2003). Evidence provided by Rieman and McIntyre (1993) and Young (1995) indicate that the declines in distribution and abundance of native salmonids throughout North America, including areas in the Rocky Mountains, have been attributed to introductions of nonnative species introductions, habitat degradation, and overharvest. In general, populations of native salmonids that persist in western North America tend to be located in high-elevation, steep-gradient reaches that are relatively unproductive (Gresswell 1995, Rieman and McIntyre 1995, Young 1995).

2.2.1.1.2 Life History

Yellowstone cutthroat trout that inhabit larger rivers migrate to smaller streams to spawn (fluvial life history). High spring flows and movement of silt and gravels are thought to limit successful spawning in mainstem rivers,

therefore making tributary spawning habitat important for the long-term persistence of the species. Adult migration into spawning tributaries from the South Fork Snake River started as early as mid-February and continued as late as August for Wyoming tributaries and began in late April or early May, peaked in June, and continued through July on an Idaho tributary. Sex ratios are approximately 1:1 (Kiefling 1978). In populations upstream of Palisades Reservoir, spawning was initiated at age 3 and 4, with the oldest fish observed being age 7 (Kiefling 1978). For Yellowstone cutthroat trout populations in Idaho, maturation occurred at age 2 (29%), 3 (49%), or 4 (13%), with only three fish being over age 7 (<1%) and the oldest Yellowstone cutthroat trout being age 10 (Meyer *et al.* 2003a). Downstream migration of fry was documented in winter for tributary streams in Wyoming. Yellowstone cutthroat trout ranged in size from 2 to 7 kg, while some hybrids reached up to approximately 15 kg (Varley and Gresswell 1988). Yellowstone cutthroat trout also inhabit small streams, adopting a resident life history of spawning and rearing in the same stream.

The diet of the Yellowstone cutthroat trout is primarily aquatic and terrestrial insects, but the fish are opportunistic and larger individuals will feed upon small fish and mammals such as mice and voles (Kiefling 1978). The maximum age of Yellowstone cutthroat trout is variable and greatly influenced by environmental factors (Behnke 1992). In Yellowstone Lake, the average maximum age for Yellowstone cutthroat trout is about 7, but fish of 8 and 9 years of age have appeared in spawning runs. Protective regulations in some areas have greatly reduced mortality from angling (Gresswell and Varley 1988). The Yellowstone subspecies did not co-evolve with rainbow trout or redband trout, and sympatric populations of native Yellowstone cutthroat

trout fish and introduced rainbow trout (*Onchorhynchus mykiss*) (Behnke 1992). In areas where rainbow trout or other cutthroat subspecies have been stocked, introgression may be documented.

2.2.1.1.3 Population Trends and Distribution

Today, Yellowstone cutthroat trout persists in some Snake River tributaries between Shoshone Falls and Palisades Reservoir, but the species has been replaced by nonnative trout in other areas (Behnke 1992). As an example of this distribution, Behnke (1992) notes that the rainbow trout is now the dominant trout in the Henrys Fork. Special angling regulations have proved effective in increasing the abundance and proportion of older fish (5–7 years old) in Yellowstone cutthroat trout populations (Thurrow *et al.* 1988).

Historical Range

The known historical range of Yellowstone cutthroat trout is shown in Figure 2-13 (May *et al.* 2003). That range includes the upper portions of the Yellowstone River drainage within Montana and Wyoming and the upper Snake River drainage in Idaho, Wyoming,

Nevada, and Utah. Behnke (1992) considers the Yellowstone cutthroat trout as the original native trout to the entire Snake River system, including the upper Yellowstone River drainage. Behnke also concludes that “Yellowstone cutthroat trout had a much greater distribution before redband trout invaded the middle Columbia River basin in the late-glacial period.” Using Behnke’s statement as a starting point, May *et al.* (2003) assessed all streams within any 4th field HUC that was within the area that Behnke identified as being potentially part of the historically occupied habitat. In this multi-state assessment of Yellowstone cutthroat trout, May *et al.* (2003) also identified stream segments that should be excluded from historical range based on evidence for exclusion. Such evidence included 1) geological barriers above which there was no evidence that Yellowstone cutthroat trout inhabited waters; 2) tectonic events that would have made regions uninhabitable or caused ancient populations to go extinct and not be recolonized prior to 1800; and 3) habitat judged as unsuitable based primarily on thermal regime, stream channel gradient, and minimal stream flow (May *et al.* 2003).

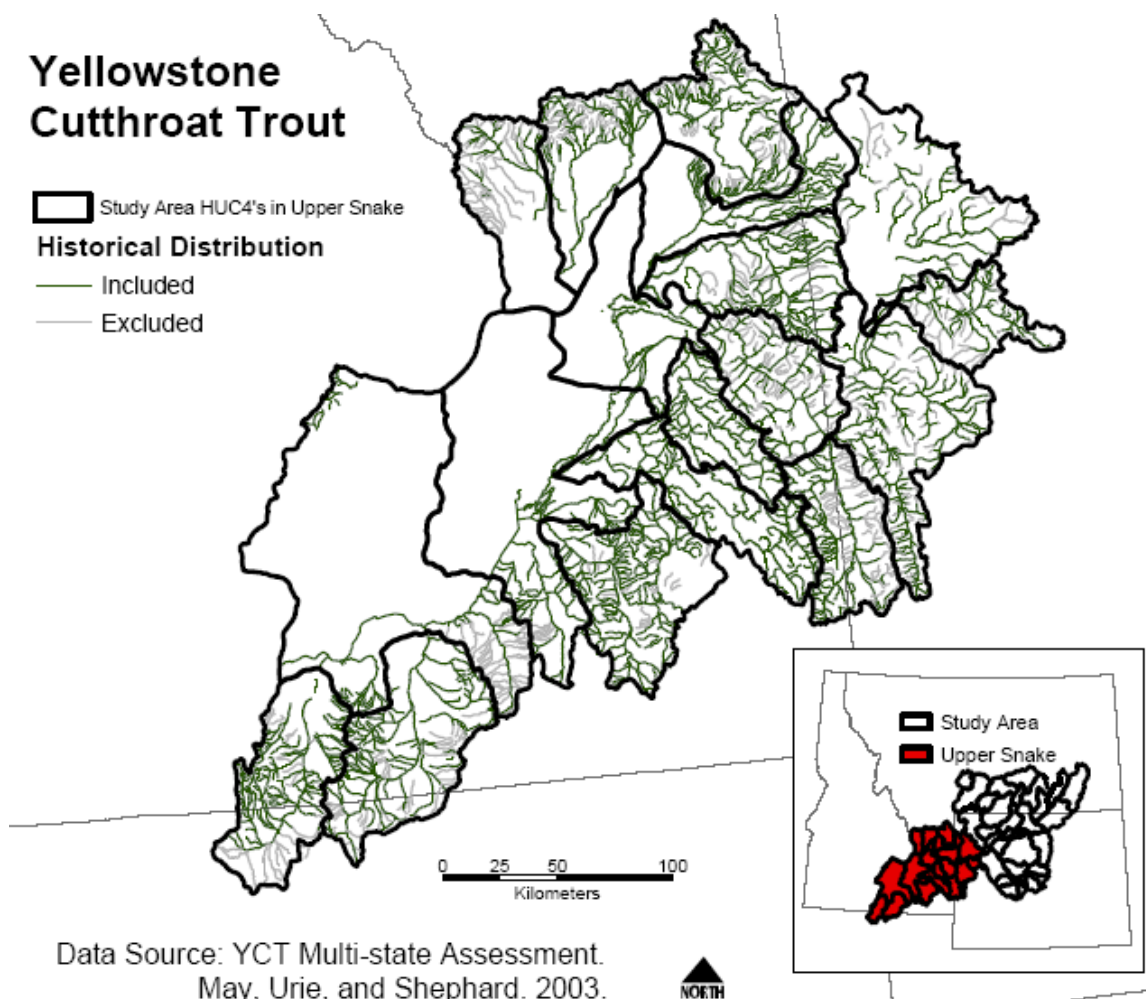


Figure 2-13. Historical range of Yellowstone cutthroat trout in the Upper Snake province (May *et al.* 2003).

In the upper Snake River drainage, Yellowstone cutthroat trout persist in Heart Lake and other waters above Jackson Lake (Behnke 1992). From Shoshone Falls to Palisades Reservoir, the Yellowstone cutthroat trout persists in some Snake River tributaries but has been replaced in others. In some areas, Yellowstone cutthroat trout have largely been replaced by brook, brown, and rainbow trout and by hybrid rainbow × cutthroat trout populations.

May *et al.* (2003) found that historically occupied habitat included stream segments occupied by both large-spotted and fine-

spotted forms of Yellowstone cutthroat trout, and in some cases both forms were present. Based on a StreamNet 1:100,000-scale hydrography layer, May *et al.* (2003) reported that there are approximately 6,269 miles of historic Yellowstone cutthroat trout range in Idaho (36% of total occupied historic lotic habitat [circa 1800] occupied by Yellowstone cutthroat trout in Montana, Idaho, Wyoming, Nevada, and Utah).

Current Distribution

May *et al.* (2003) identified the current distribution of Yellowstone cutthroat trout by

assessing all stream segments within the historical range, not including stocking by artificial propagation. They evaluated all waters that supported Yellowstone cutthroat trout and appeared on the StreamNet hydrography layer, regardless of level of introgression. In their multi-state assessment of Yellowstone cutthroat trout, May *et al.* (2003) also ranked the abundance of Yellowstone cutthroat trout inhabiting each stream segment. The most recent assessment indicates that Yellowstone cutthroat trout currently occupy over 2,100 miles of the historically occupied habitats found in Idaho (35% of historical).

Meyer and Lamansky (2003), in their study of 773 stream reaches throughout the upper Snake River basin in Idaho, found that in general, Yellowstone cutthroat trout presence at a specific site within a drainage was associated with a higher percentage of public property, higher elevation, more gravel and less fine substrate, and more upright riparian vegetation. However, there was much variation among drainages in the direction and magnitude of the relationships between stream characteristics and Yellowstone cutthroat trout occurrence and biomass, as well as variation in model strength. Meyer and Lamansky's report (2003) presents probably the most detailed records of the current distribution and occurrence of Yellowstone cutthroat trout by watershed in Idaho. Information below is from IDFG (2001) or Meyer and Lamansky (2003), unless otherwise noted.

Population status—A substantial amount of survey data on Yellowstone cutthroat trout exists in the Upper Snake province. However, using data to make comparisons between areas at a larger scale when the sampling scheme was not defined for that purpose can be problematic due to the nonrandom distribution of sampling points and the varying sample methods and sampling effort

that are frequently employed. For that reason, we are focusing this assessment using data collected by Meyer and Lamansky (2003) where available and supplemented with data from the Wyoming Game and Fish Department and Utah Division of Natural Resources. We assessed population status by normalizing the Yellowstone cutthroat trout density estimates available throughout the three subbasins and calculating a mean and standard deviation. Population strength was defined as follows: 1) normal densities were within $\frac{1}{2}$ standard deviation of the mean, 2) low densities were less than $\frac{1}{2}$ standard deviation of the mean, and 3) high densities were greater than $\frac{1}{2}$ standard deviation from the mean.

Hybridization and introgression from rainbow trout—Rainbow trout hybridization and introgression was evaluated on samples collected by Meyer and Lamansky (2003) using genetic and phenotype-based procedures. For the purposes of this assessment, populations were grouped into the following four categories: 'core populations', 'conservation populations', 'mixed populations', and 'hybrid populations'. Core populations were identified as populations in which no rainbow trout introgression was observed (1 diagnostic mtDNA marker and 3 diagnostic co-dominant nDNA markers), or, in the absence of genetic information, populations in which no hybrids were phenotypically identified. Conservation populations were identified as populations in which 1-10% rainbow trout introgression was observed, or in which 1-10% of the samples were phenotypically identified as hybrids. Mixed populations were those that were genetically identified with 10-20% rainbow trout introgression, or in which 10-20% of the individuals sampled were phenotypically identified as hybrids. Finally, populations that were genetically identified with greater than 20% rainbow trout introgression, or in which greater than 20% of the individuals sampled

were phenotypically identified as hybrids, were classified as 'hybrid' populations.

With regards to the accuracy of phenotypic versus genetic identifications: 1) genetic data corroborated our visual determination that hybridization was absent at 43 of 59 sites; 2) at the 7 sites where we visually failed to discern genetically-detected hybridization, the percent of rainbow trout alleles in the population were low ($< 1\%$) at all but two locations; and 3) where we detected hybridization both visually and genetically (9 sites), levels of hybridization were similar between methods (correlation coefficient $r = 0.80$; Meyer *et al.* IDFG unpublished data).

Genetic Variation of Yellowstone Cutthroat Trout in Idaho—Genetic results from a mtDNA RFLP screen on 40 Yellowstone cutthroat populations (>1000 samples), from across their range in Idaho, indicate that Yellowstone cutthroat trout populations are highly structured at the drainage level (IDFG, unpublished data). An analysis of molecular variance indicates that a substantial portion of the total genetic variation ($>46\%$) is partitioned between the major drainages (ex. Raft, Portnuef, Blackfoot, Willow Creek, S.F. Snake, etc.). This data suggests that the conservation of genetic diversity of Yellowstone cutthroat trout in Idaho will at least require the maintenance of healthy populations within each of the major drainages and provides a starting point for describing and prioritizing conservation management units for the subspecies.

Closed Basin Subbasin

Medicine Lodge and Beaver–Camas Watersheds

Several designated core and conservation cutthroat populations are present (Figure 2-14), and the middle Dry and Moose creeks populations appear to be isolated from rainbow and brook trout. Additionally, Yellowstone cutthroat trout is believed to be the only native salmonid to use these watersheds. Yellowstone cutthroat trout are found in many streams throughout the various drainages, but rainbow trout are the predominant fish throughout the drainages. Of the 50 sites that were sampled for fish and habitat in the Closed Basin subbasin, 14 were fishless. Yellowstone cutthroat trout were found in 10 of the remaining 36 sites but occurred without nonnative salmonids in only 2 locations (Table 2-4). In the Beaver–Camas watershed, populations of wild rainbow trout and brook trout (*Salvelinus fontinalis*) exist in most streams in the headwater areas. Several designated core and conservation cutthroat populations are present (Figure 2-14), and the middle Dry and Moose creeks populations are isolated from rainbow and brook trout. Several Yellowstone cutthroat trout populations were defined as hybrids. Brown trout (*Salmo trutta*) have been released into Camas Creek, and Lahontan Cutthroat trout are released into Mud Lake. For the Closed Basin subbasin, Yellowstone cutthroat trout distribution was too restricted for meaningful conclusions to be drawn about factors related to occurrence.

Table 2-4. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Beaver–Camas (BCM) and Medicine Lodge (MDL) watersheds within the Closed Basin subbasin. Density of rainbow trout (RBT) < 100 mm is listed as an index of further introgression risk.

Stream Name (watershed)	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
East Fork Rattlesnake Creek (BCM)	Core		1			
Middle Dry Creek (BCM)	Core	1				
Moose Creek (BCM)	Core			1		
Cold Creek (MDL)	Absent				1	
Fritz Creek (MDL)	Core			1		
Fritz Creek (MDL)	Hybrid			1		
Horse Creek (MDL)	Absent				1	
Indian Creek (MDL)	Absent				2	Normal–1
Irving Creek (MDL)	Absent				2	Normal–1
	Core			1		
Warm Creek (MDL)	Absent				2	Normal–1
Webber Creek (MDL)	Hybrid			1		
West Fork Indian Creek (MDL)	Conservation		1			
	Hybrid			2		Normal–1

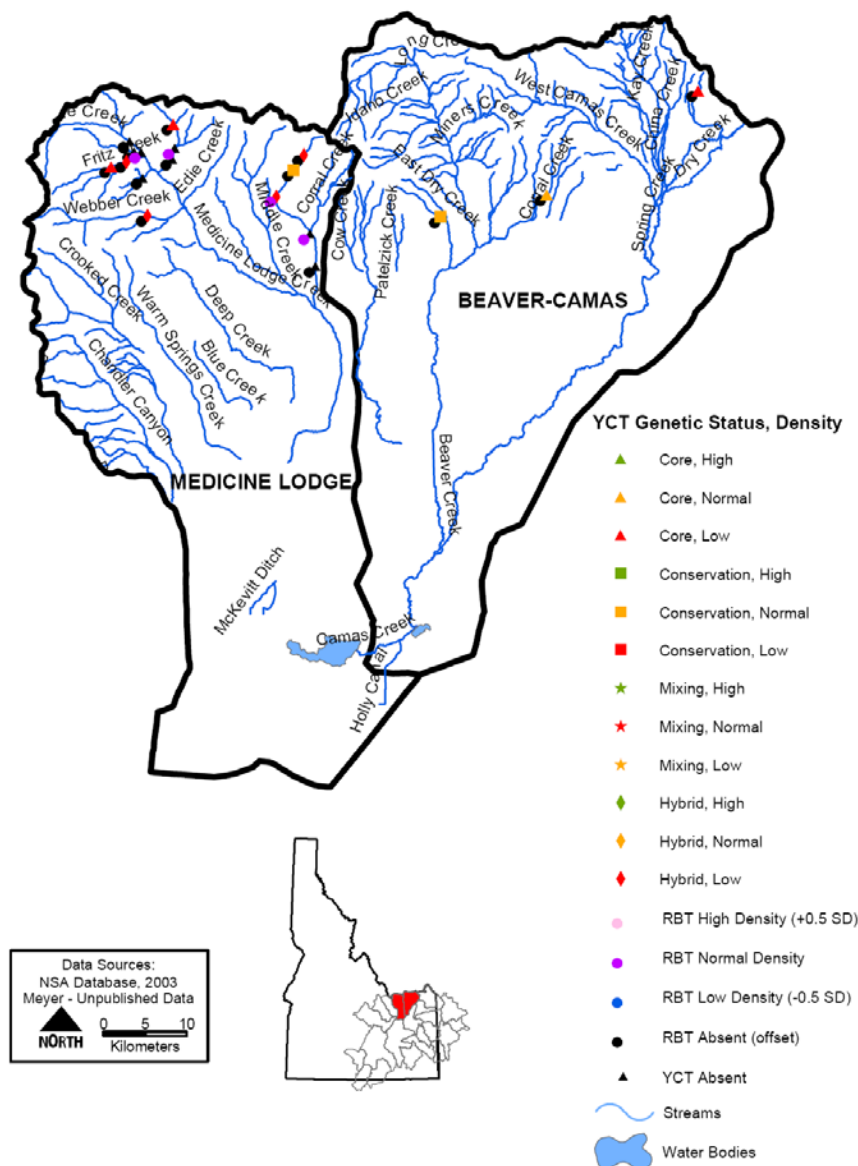


Figure 2-14. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Beaver–Camas and Medicine Lodge watersheds. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Upper Snake Subbasin

Henrys Fork of the Snake River (Upper Henrys Fork and Lower Henrys Fork Watersheds)—The Henrys Fork supports a small fraction of the Yellowstone cutthroat that it did prior to the 1900s. During the 1800s, the Yellowstone cutthroat population was prolific enough to support numerous

commercial fishing operations in the late part of the century (including Henrys Lake). The exploitation of these fish may have contributed to their decline; however, it is more likely that concurrent aggressive stocking programs using rainbow trout and brook trout had more to do with the loss of Yellowstone cutthroat trout throughout the

drainage (Van Kirk and Gamblin 2000). In 1958 and again in 1966, the entire drainage above the Island Park Dam was treated with pesticides to remove nongame fish. The cutthroat populations that still existed prior to that time were largely eliminated downstream to Mesa Falls. Following the treatments, the drainage was restocked with rainbow trout. In addition to the effects of exploitation, exotic fish stocking, and chemical treatments, habitat degradation and fragmentation likely played a role in the loss of cutthroat populations. Currently, Yellowstone cutthroat trout are considered rare in the mainstem Henrys Fork.

In the Henrys Fork drainage, sampling was conducted at 69 sites, with Yellowstone cutthroat trout occurring at 12 sites and nonnative salmonids present at 8 of those 12 sites. Within the Upper Henrys watershed, four Yellowstone cutthroat trout core populations were identified (Table 2-5). The majority of these populations were tributaries to Henrys Lake (Figure 2-15). Howard, Duck, Tyghee, and Timber creeks are known to provide spawning habitat for Yellowstone cutthroat trout from Henrys Lake. The

mainstem Henrys Fork is dominated by rainbow trout from Island Park Dam downstream to Mesa Falls, with rainbow trout and brown trout dominant from Mesa Falls downstream. From Henrys Lake Outlet to Island Park Dam, a remnant Yellowstone cutthroat trout population is present, and Yellowstone cutthroat trout are stocked in this stretch. Warm River is dominated by rainbow trout and brown trout. Efforts to reestablish Yellowstone cutthroat trout in portions of the drainage began in 1999 with the chemical treatment and restocking of Golden Lake and its tributaries.

In the Lower Henrys watershed, six core populations and one conservation population were identified in tributaries to the Falls River (Table 2-6 and Figure 2-16), which is the largest tributary to the Henrys Fork. Rainbow trout are dominant in the Falls River, with cutthroat and rainbow cutthroat hybrids incidental. Distribution was too restricted within the drainage for meaningful conclusions to be drawn about factors related to cutthroat trout occurrence.

Table 2-5. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Upper Henrys watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) < 100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Canyon Creek	Absent				1	
Duck Creek	Core			1		
Howard Creek	Core			1		
Sheridan Creek	Absent				3	Normal-1
Snow Creek	Absent				1	
Twin Creek	Absent				1	
	Hybrid			1		
Tyghee Creek	Core		2			
West Fork Hotel Creek	Absent				1	
Wyoming Creek	Absent				1	

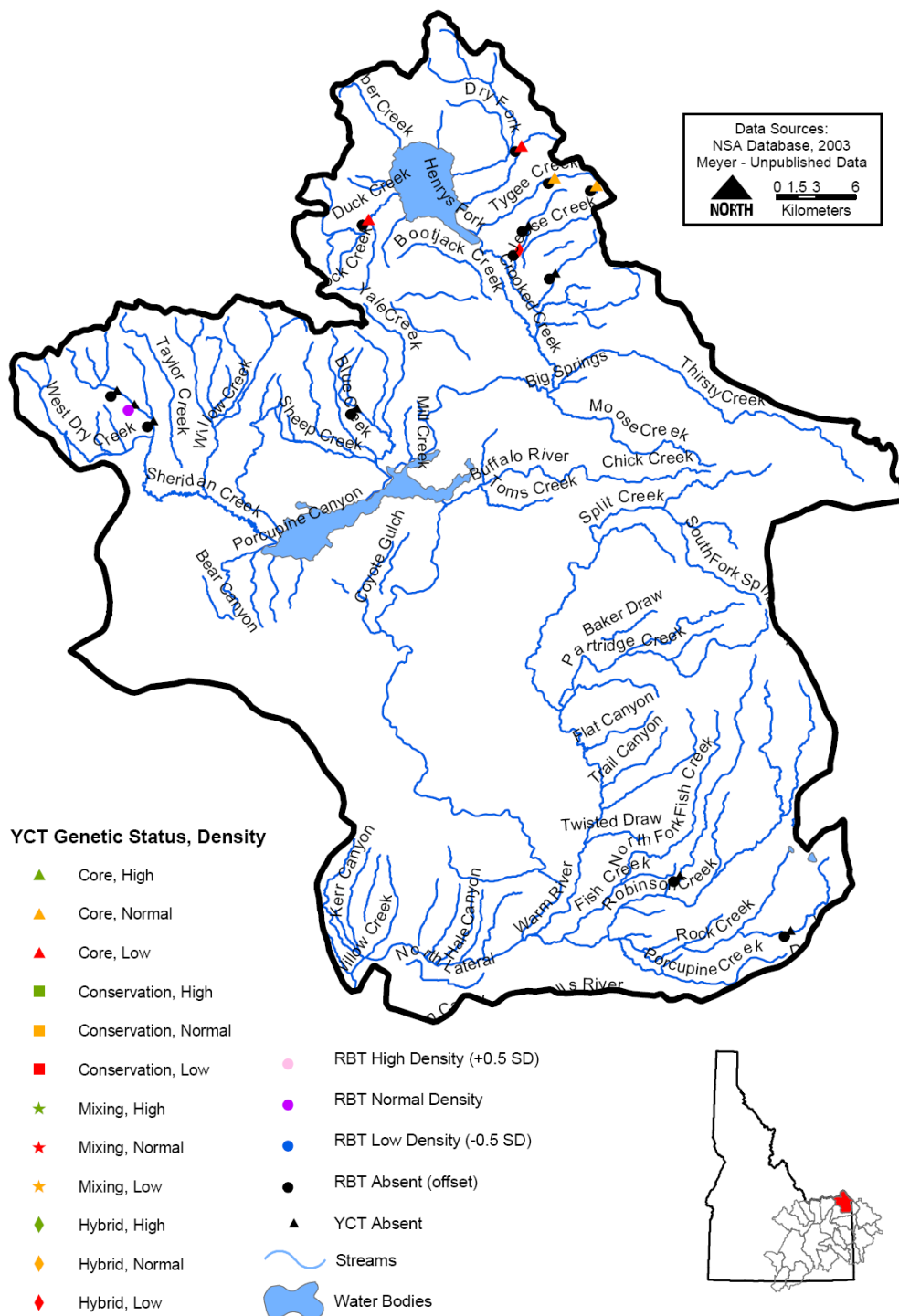


Figure 2-15. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Upper Henrys watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Table 2-6. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Lower Henrys watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) < 100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Calf Creek	Core		1			
Cascade Creek	Absent				1	Normal-1
Conant Creek	Absent				2	Normal-1
	Core			1		
Coyote Creek	Core			1		
Jackass Creek	Core		1			
North Boone Creek	Core			1		
South Boone Creek	Core			1		
Squirrel Creek	Absent				1	
	Conservation		1			
Unnamed tributary to Boundary Creek	Absent				1	Normal-1

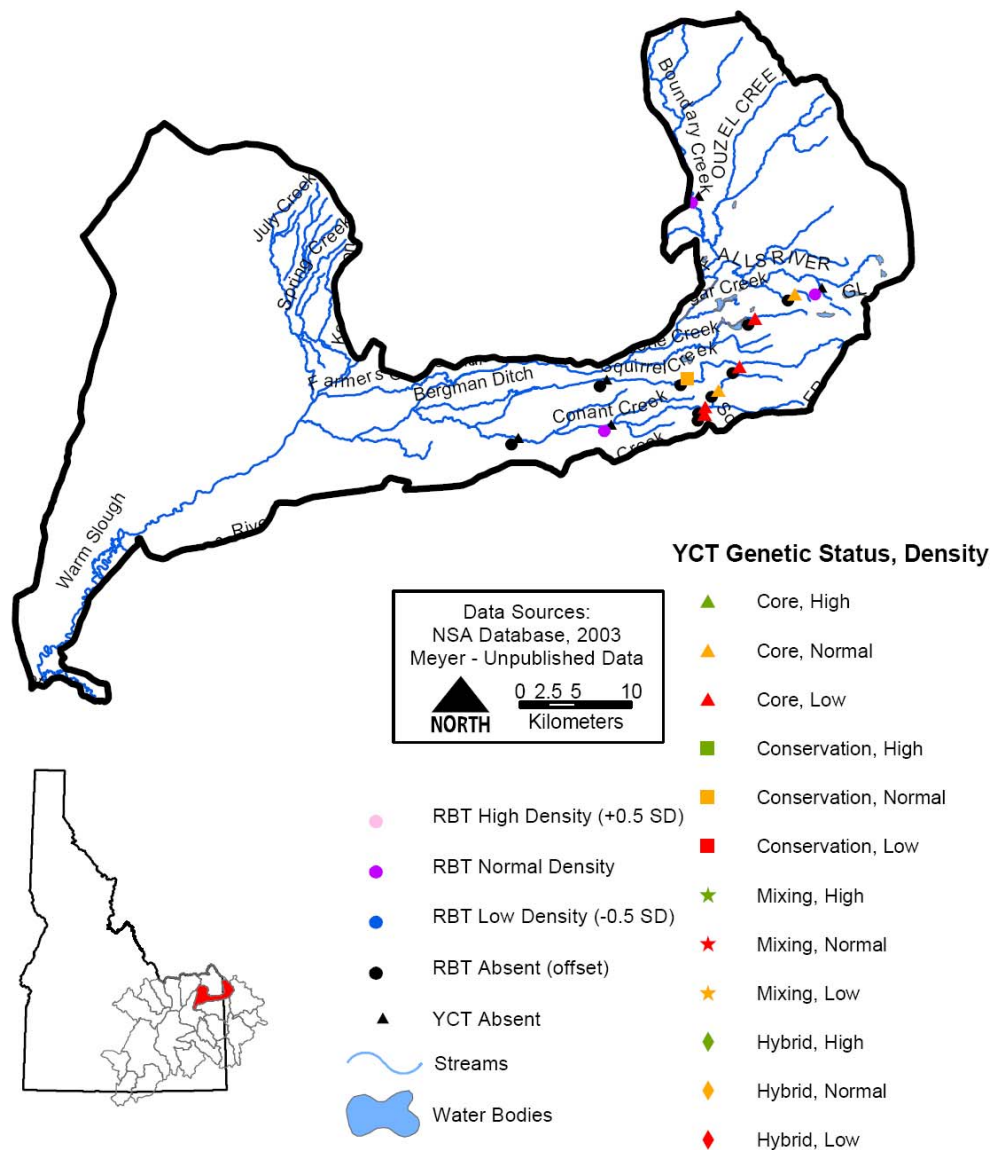


Figure 2-16. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Lower Henrys watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Teton Watershed—The Teton River was historically viewed as a stronghold of Yellowstone cutthroat trout. But recent surveys show severe population declines in the mainstem, with rainbow trout as the dominant trout there. Yellowstone cutthroat trout core and conservation populations were relatively widespread in tributaries in the Teton watershed (Figure 2-17), with

Yellowstone cutthroat trout present in 59% of sites containing perennial streamflow. Of the populations identified, 35 were classified as core, 3 as conservation, and 1 as hybrid (Table 2-7). Nearly all sites containing Yellowstone cutthroat trout also contained brook trout. In fact, brook trout were more widespread, existing in 75% of sites containing perennial streamflow and all sites

but five that contained fish of any species. Populations of Yellowstone cutthroat trout in the main Teton River have suffered substantial declines in recent years.

Occurrence of Yellowstone cutthroat trout in the Teton watershed was associated with lower elevations and a lower percentage of fine substrate, and the trout were more likely

to occur where nonnative salmonids were present (Table 2-18 and Table 2-19). However, none of these relationships was strong, and the inclusion of these variables in the logistic regression model relating stream conditions to cutthroat trout distribution explained only 17% of the variation in occurrence (Table 2-19).

Table 2-7. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Teton watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) <100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Canyon Creek	Absent				1	
	Conservation		1			
	Core		3			
Fish Creek	Core		2			
Game Creek	Core			1		
Garner Canyon	Core		1	1		
Horseshoe Creek	Conservation			1		
Little Pine Creek	Core		1			
Mahogany Creek	Core			1		
Mike Harris Creek	Core	1		1		
Moose Creek	Core			1		
North Fork Horseshoe Creek	Core	1	1			
North Fork Mahogany Creek	Core		1			
North Fork Packsaddle Creek	Conservation	1				
	Core	1				
North Leigh Creek	Core		1	1		
North Moody Creek	Core		2			
Sob Canyon	Core			2		
South Fork Badger Creek	Core	3				
South Fork Canyon Creek	Core		2			
South Fork Horseshoe Creek	Core			1		
South Fork Mahogany Creek	Core			2		
South Moody Creek	Core			2		
State Creek	Core			1		
Trail Creek	Core			1		
Warm Creek	Absent				1	
	Hybrid			1		Normal-1

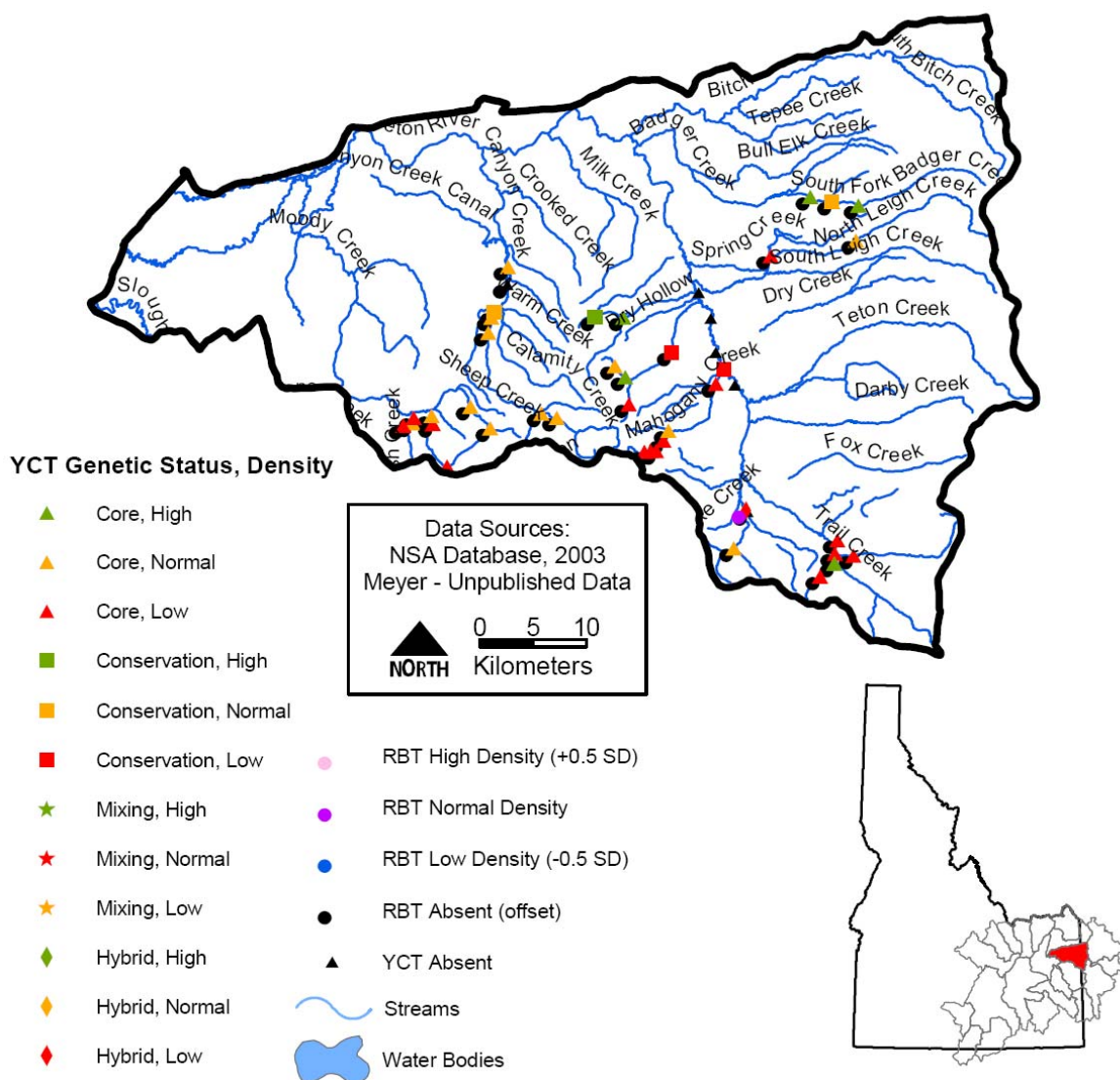


Figure 2-17. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Teton watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Idaho Falls Watershed—No core or conservation populations of Yellowstone cutthroat trout are known to occur in this watershed, though Yellowstone cutthroat trout are known to be present in low numbers within the main Snake River in the Idaho Falls watershed.

Willow Watershed—The Willow Creek drainage was unique in the Upper Snake subbasin because all (21) of the Yellowstone cutthroat trout populations identified were considered core populations, and no rainbow trout or hybrids were identified in the watershed (Table 2-8 and Figure 2-18). Yellowstone cutthroat trout were sympatric

with brook trout in three sites in the watershed. Cutthroat trout were more likely to be present in higher order, wider streams with more gravel substrate; public landownership also increased the likelihood of cutthroat trout presence (Table 2-18 and Table 2-19). These variables explained 58% of the variation in

cutthroat trout occurrence in the logistic regression model for this drainage. Most (71%) of the Yellowstone cutthroat trout populations in the Willow watershed were low density relative to other Yellowstone cutthroat trout populations within the species' Idaho range (Table 2-8).

Table 2-8. Introgression and status of Yellowstone cutthroat trout (YCT) populations sampled in the Willow watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) <100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Birch Creek	Core			1		
Brockman Creek	Core			1		
Corral Creek	Core		1	1		
Lava Creek, NF	Core			1		
	Core			1		
Lyons Creek	Core			2		
Mill Creek	Core			2		
Sawmill Creek	Core			1		
Sellars Creek	Core	1		3		
South Fork Sellars Creek	Core	2	1			
Tex Creek	Core			1		
Willow Creek	Core		1	1		

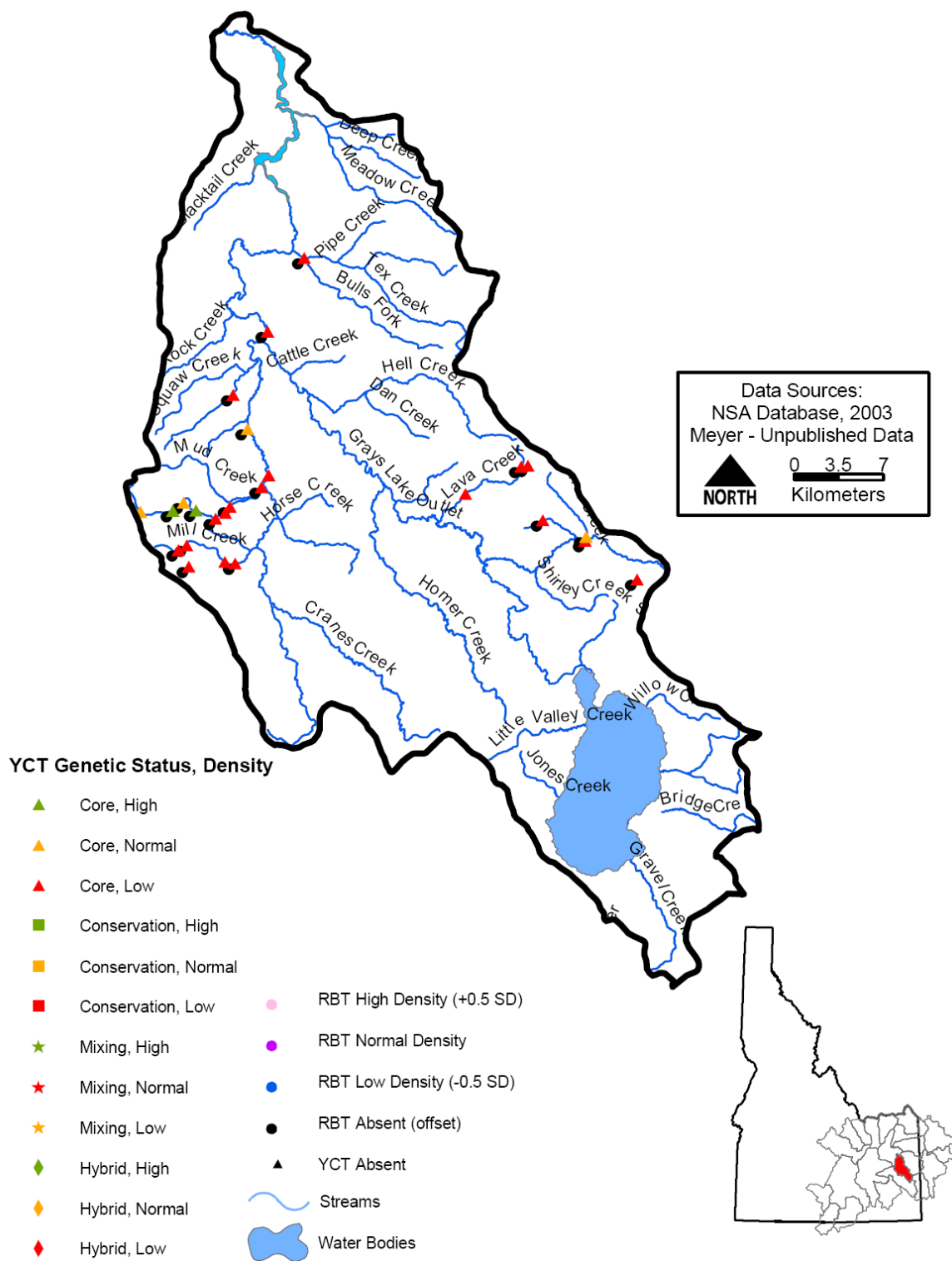


Figure 2-18. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Willow watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Blackfoot Watershed—In the Blackfoot watershed, Yellowstone cutthroat trout were found in 64% of study sites, while nonnative salmonids occurred in 23 sites, including 19 in sympatry with cutthroat trout (Figure 2-19). Above Blackfoot Reservoir, 79% of sites where fish were present contained Yellowstone cutthroat trout, but 55% also contained either rainbow trout or brook trout. Downstream of Blackfoot Reservoir, 59 and 26% of sites contained cutthroat trout and nonnative trout, respectively. In the Blackfoot watershed, 27 populations were classified as core, 11 as conservation, 4 as mixed, and 2 as hybrid (Table 2-9). An adfluvial population of

Yellowstone cutthroat trout exists in the Blackfoot watershed associated with Blackfoot Reservoir. A weir is operated yearly on the Blackfoot River to limit rainbow trout spawning in the upper Blackfoot River. Cutthroat trout were more likely to occur in higher-gradient, wider, headwater locations on public land and with higher amounts of gravel, cobble, and boulder substrate and less fine sediment substrate (Table 2-18 and Table 2-19). These variables explained 51% of the variation in cutthroat trout occurrence in the logistic regression model developed for this drainage (Table 2-19).

Table 2-9. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Blackfoot watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) <100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Angus Creek	Core			1		
Bacon Creek	Core		1	1		
Blackfoot River	Conservation			1		
	Core		1			
	Hybrid			1		
	Mixing		1	1		
Browns Canyon	Core	1	1			
Brush Creek	Conservation		1			
	Core		1			
Chippy Creek	Core			1		
Diamond Creek	Conservation	5				
	Core			2		
	Mixing	1				
Horse Creek	Core	1	1			
Kendall Creek	Core		1			
Lanes Creek	Core		1			
Miner Creek	Conservation	1				
	Core	1		1		
Poison Creek	Conservation	1				
	Core	2				
Rawlins Creek	Core		1	1		
	Mixing	1				

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Sheep Creek	Core	1	2			
South Fork Canyon Creek	Core			1		
Timber Creek	Hybrid			1		
Timothy Creek	Conservation		2			
	Core		1			
Wolverine Creek	Core	2				

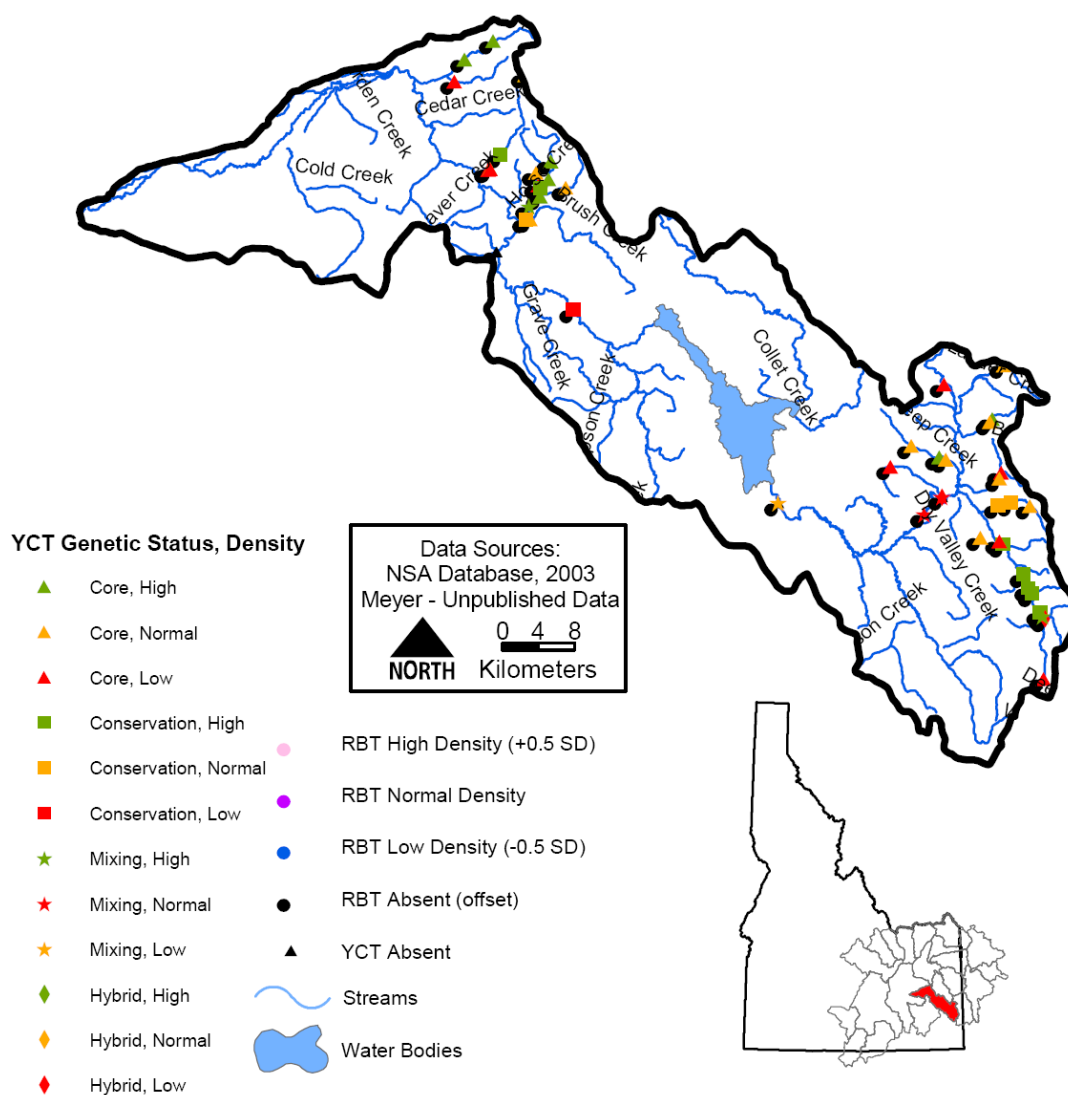


Figure 2-19. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Blackfoot watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Portneuf Watershed—In the Portneuf watershed (outside of the Fort Hall Indian Reservation boundary), Yellowstone cutthroat trout were present in 65% of sites sampled (Figure 2-20). Nonnative salmonids occurred at 26 locations, 21 of which were in sympatry with cutthroat trout. In the Portneuf watershed, 27 populations were classified as core, 8 as conservation, 4 as mixed, and 9 as hybrid (Table 2-10). Sites with cutthroat trout

tended to be wider and lower in elevation and tended to have more upright vegetation than sites without cutthroat trout. Cutthroat trout presence was also associated with public landownership, a higher percentage of cobble-boulder substrate, and higher stream order (Table 2-18 and Table 2-19). Using these variables in a logistic regression model, 63% of the variation in cutthroat trout occurrence was explained (Table 2-19).

Table 2-10. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Portneuf watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) <100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Bell Marsh Creek	Core		1	2		
Big Springs Creek	Conservation	1				
East Bob Smith Creek	Core		2			
Gibson Jack Creek	Core		1			
Gibson Jack Creek	Hybrid			2		Normal-1
Goodenough Creek	Core		1	1		
Harkness Creek	Core			1		
Inman Creek	Core		2	1		
Marsh Creek	Core			1		
Middle Fork Toponce Creek	Conservation		2			
	Hybrid		2			Normal-1
Mink Creek	Mixing		1			
North Fork Pebble Creek	Core		1			
North Fork Rapid Creek	Core	1	1			
Pebble Creek	Conservation	2				Normal-1
	Core	1				
Portneuf River	Hybrid			2		
Rapid Creek	Mixing	1		1		
Right Hand Fork Marsh Creek	Core			1		
Robbers Roost Creek	Core		1	1		
South Fork Toponce Creek	Conservation	2				
	Core		1			
	Hybrid			1		
	Mixing			1		
Toponce Creek	Core			1		
	Hybrid			1		

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Walker Creek	Core			2		
Webb Creek	Conservation		1			
	Core			1		
	Hybrid			1		
West Fork Mink Creek	Core		1	1		

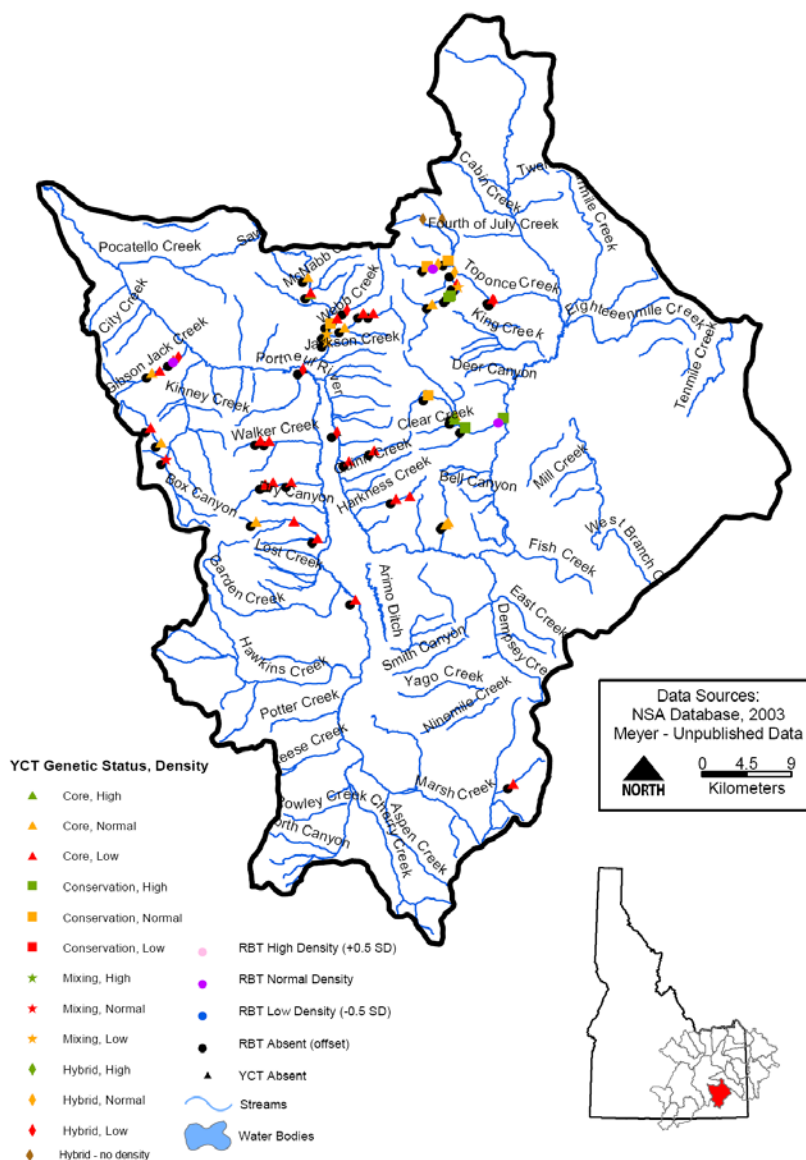


Figure 2-20. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Portneuf watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

American Falls Watershed—The American Falls watershed was historically Yellowstone cutthroat trout habitat. Currently, rainbow trout is the dominant trout in this watershed.

Three populations (outside of reservation boundaries) were identified as core populations (Table 2-11 and Figure 2-21).

Table 2-11. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the American Falls watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) < 100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Crystal Creek	Core		1			
Midnight Creek	Core	2				

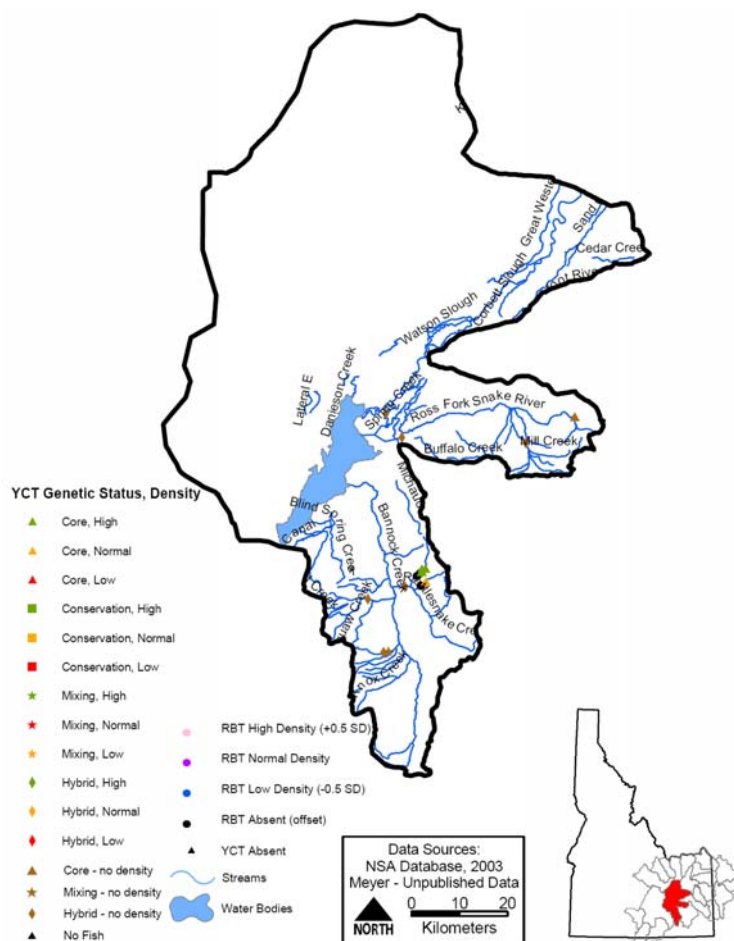


Figure 2-21. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the American Falls watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Lake Walcott Watershed—Waters within the Lake Walcott watershed were historically Yellowstone cutthroat trout habitat. Currently, rainbow trout are the dominant salmonid in

the drainage, and only one hybrid population of Yellowstone cutthroat trout was identified (Table 2-12 and Figure 2-22).

Table 2-12. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the American Falls watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) <100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
East Fork Rock Creek	Hybrid			1		Normal-1

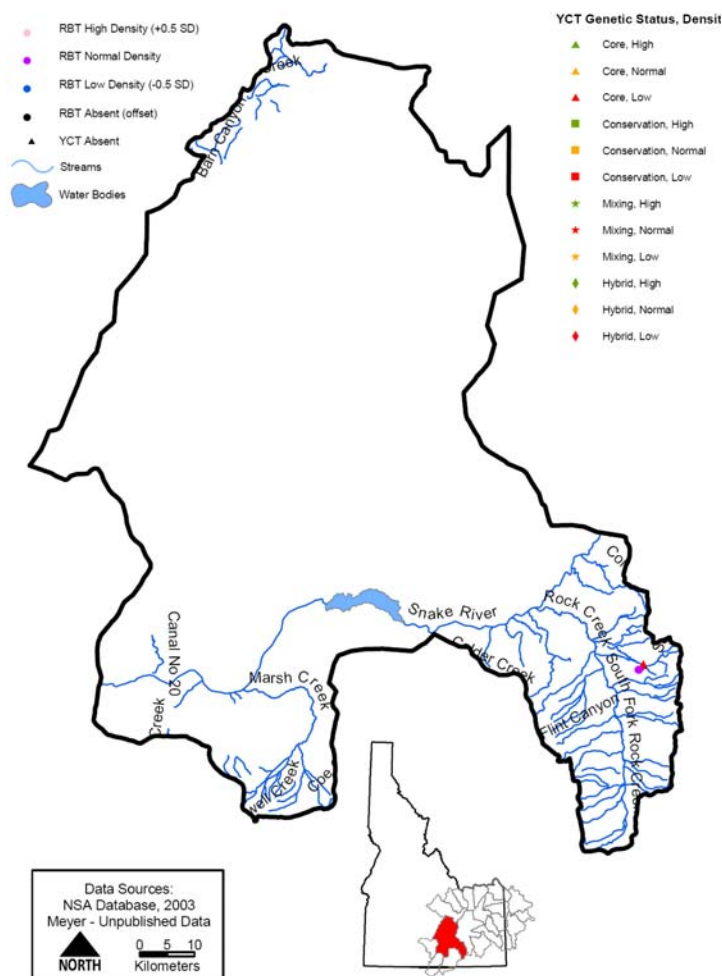


Figure 2-22. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Lake Walcott watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Raft Watershed—Yellowstone cutthroat trout were present in 61% of sites sampled in the Raft watershed (Figure 2-23). Nonnative salmonids occurred in 39 sites and were in sympatry with cutthroat trout at 22 locations. In the Raft watershed, 32 populations were classified as core, 1 as conservation, and 5 as hybrid (Table 2-13).

Higher elevations, more upright vegetation, and unstable banks were positively related and stream gradient and fine substrate were negatively related to cutthroat trout occurrence (Table 2-18 and Table 2-19), but these variables explained only 35% of the variation in cutthroat trout occurrence in the logistic regression model (Table 2-19).

Table 2-13. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Raft watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) < 100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Almo Creek	Core		1			
Basin Creek	Core		2	1		
Cassia Creek	Core	1		2		
	Hybrid			2		
Clear Creek	Absent				2	Normal-2
	Core		1			
Clyde Creek	Conservation		1			
	Core		2			
Cottonwood Creek	Core		1			
	Hybrid		1			
Cross Creek	Core			1		
Dry Creek	Core			2		
Edwards Creek	Core		1			
Eightmile Canyon	Core	1				
Fall Creek	Absent				1	High-1
Flat Canyon Creek	Core		1	1		
George Creek	Core	1				
George Creek	Hybrid		1	1		Normal-1
Grape Creek	Core		1			
Green Creek	Core			1		
Johnson Creek	Core		1	1		
Lake Fork	Absent				2	High-1
Left Fork Johnson Creek	Core	1				
Mahogany Creek	Core		1			
New Canyon Creek	Core		2			
North Fork Sublett Creek	Absent				2	Normal-2

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Rosevere Fork of Clear Creek	Absent				1	Normal-1
Sawmill Canyon Fork of One Mile Creek	Core		1			
Sixmile Creek	Absent				1	
South Fork Sublett Creek	Absent				1	
South Junction Creek	Core			2		
Stinson Creek	Core	1				
Wildcat Creek	Core			1		

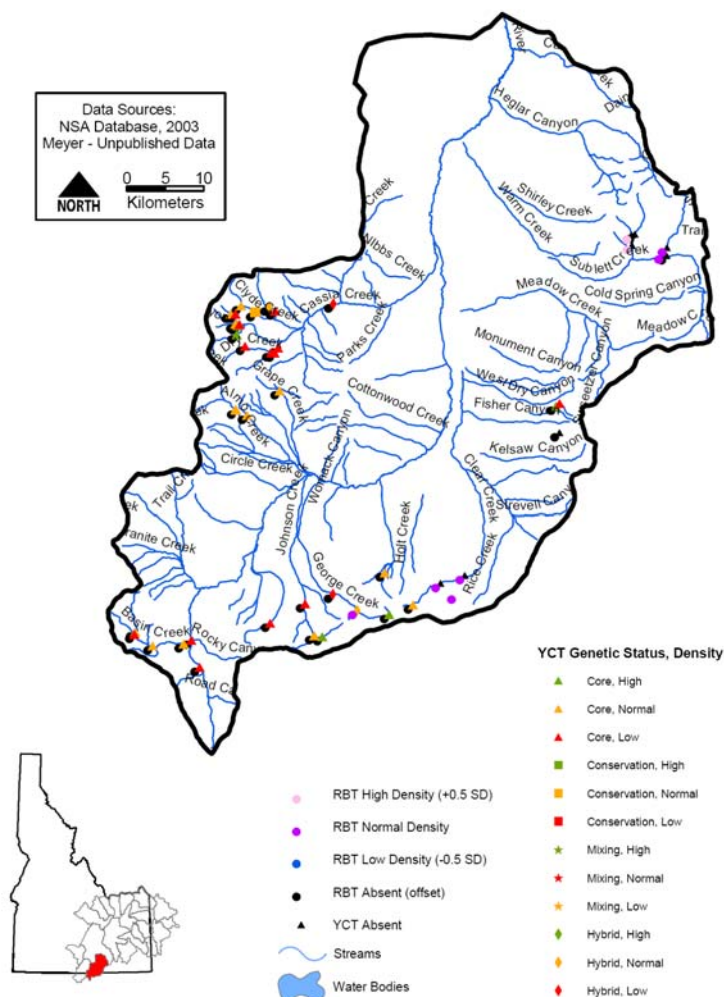


Figure 2-23. Distribution of sampling locations for Yellowstone cutthroat trout in the Raft watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Goose Watershed—In the Goose watershed, Yellowstone cutthroat trout occurred in 47% of sites sampled (Figure 2-24). Nonnative salmonids occurred at 24 sites, 7 of which also contained cutthroat trout. In the Goose watershed, 21 populations were classified as core, 1 as conservation, and 3 as hybrid (Table 2-14). Cutthroat trout were more often

found in wider, higher-elevation streams with public landownership, more stream shading, and more upright vegetation but with lower gradients and lower levels of gravel substrate (Table 2-18 and Table 2-19). The inclusion of these variables in a logistic regression model explained 68% of the variation in cutthroat trout occurrence (Table 2-19).

Table 2-14. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Goose watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) < 100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Big Cottonwood Creek	Core	5	1	2		
	Hybrid			1		
Birch Creek	Absent				1	
Cold Creek	Absent				1	
Ecklund Creek	Core	1	2			
Goose Creek	Core		2	4		
	Hybrid			1		
Little Cottonwood Creek	Absent				1	
Sawmill Creek	Core	2	1			
Squaw Creek	Absent				3	
Thoroughbred Creek	Core			1		
Trapper Creek	Absent				4	High-1, Low-1
Trout Creek	Conservation		1			
	Hybrid			1		
Willow Creek	Absent				1	Normal-1

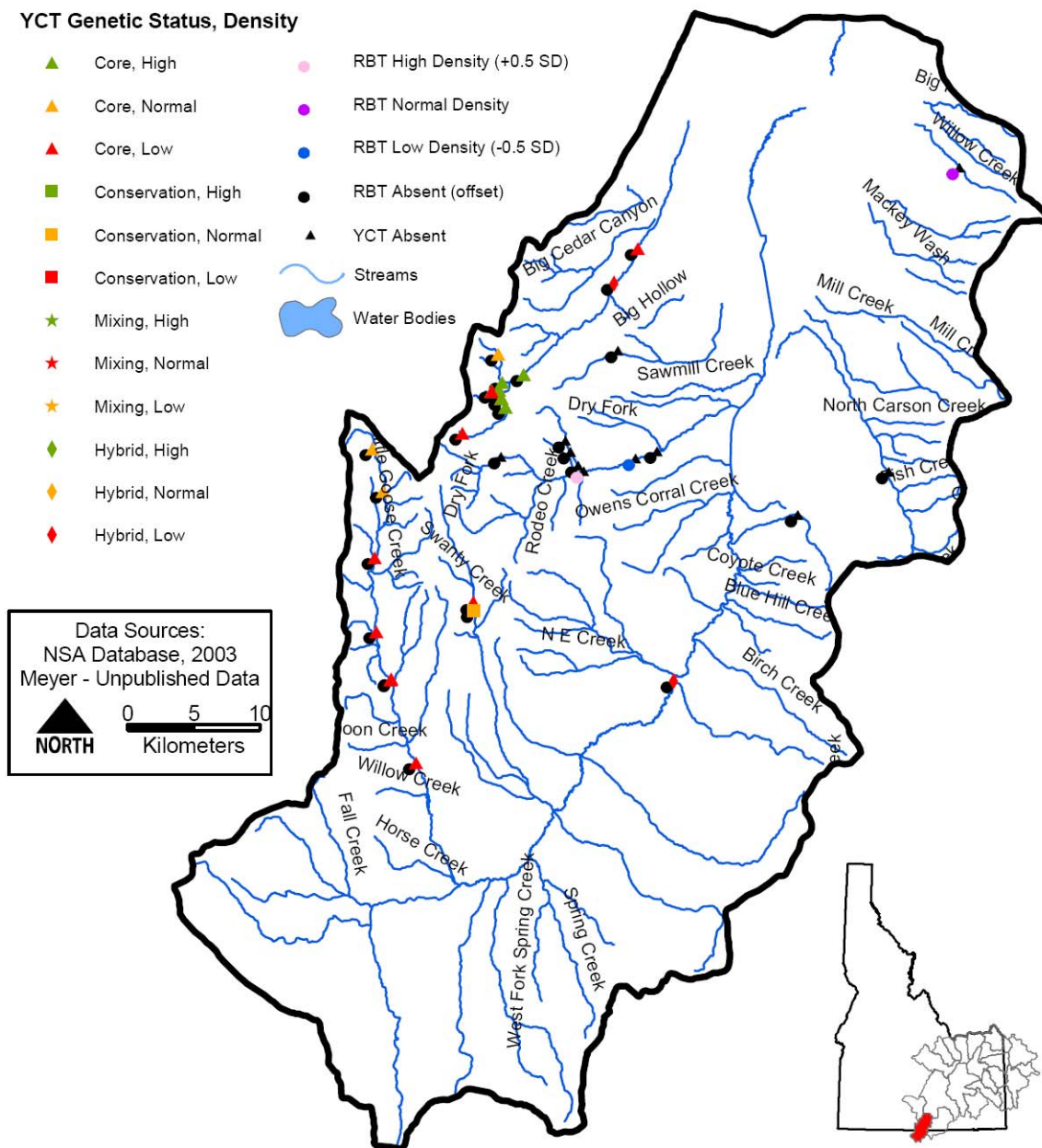


Figure 2-24. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Goose watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Upper Snake–Rock Watershed—In the Upper Snake–Rock watershed, 3 populations

were classified as core (Table 2-15 and Figure 2-25).

Table 2-15. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Upper Snake–Rock watershed in the Upper Snake subbasin. Density of rainbow trout (RBT) < 100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Dry Creek	Core		1			
East Fork Dry Creek	Core			2		

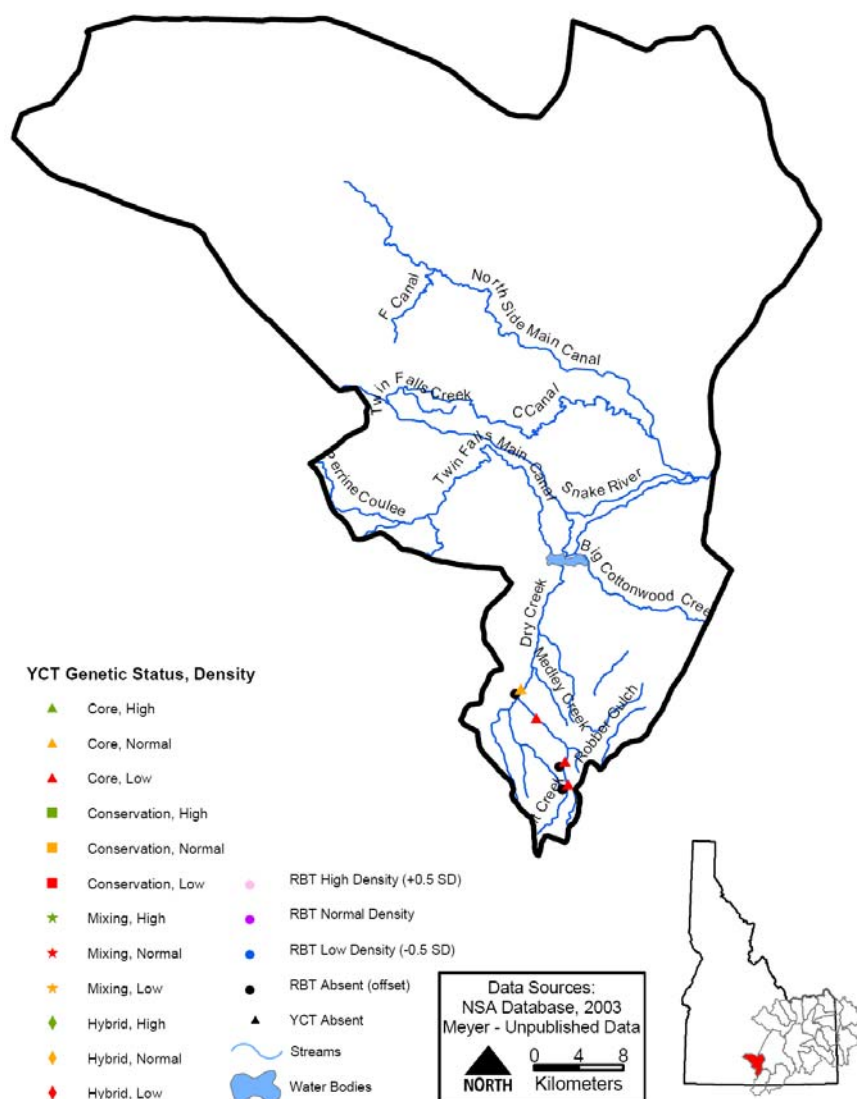


Figure 2-25. Distribution of sampling locations with known introgression status of Yellowstone cutthroat trout (YCT) in the Upper Snake–Rock watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Snake Headwaters Subbasin

Palisades Watershed—Yellowstone cutthroat trout occurred in 91% of sites sampled. Nonnative salmonids were detected in 23 sites, 15 of which contained rainbow trout or hybrids. In this watershed, 71

populations were classified as core populations (Table 2-16 and Figure 2-26). Distribution was too pervasive within the drainage for meaningful conclusions to be drawn about factors related to cutthroat trout occurrence.

Table 2-16. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Palisades watershed in the Snake Headwaters subbasin. Density of rainbow trout (RBT) < 100 mm is listed as an index of further introgression risk.

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Barnes Creek	Core		2			
Bear Creek	Core	1	2	1		
Big Elk Creek	Core	1	1			
Bilk Creek	Core			1		
Bitters Creek	Core			2		
Black Canyon	Core		1			
Burns Canyon	Conservation		1			
	Mixing	1				Normal-1
Camp Creek	Core		1			
City Creek	Core			2		
Clear Creek	Core		1	1		
Comb Creek	Core		1			
Corral Canyon	Core		2			
Corral Creek	Core			1		
Deadman Canyon	Core		1			
Dry Canyon	Core			1		
East Fork Palisades Creek	Core	2	1			
Elk Creek	Core	1	2			
Elk Flat Fork	Core			2		
Fall Creek	Core	1	1			
Fish Creek	Core	1	1	1		
Garden Creek	Core		2	1		
Iowa Creek	Core	1	2			
Jensen Creek	Core	1				
McCoy Creek	Core	2	1			
North Fork Palisades Creek	Core	2		1		
North Fork Pine Creek	Conservation	1				
	Core	1		1		
North Fork Rainey Creek	Core	1	1			

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Palisades Creek	Core	3				
Pine Creek	Conservation	3				
	Core	1				
Pole Creek	Core			2		
Pritchard Creek	Absent				1	
	Hybrid			2		
Rainey Creek	Conservation		1			
	Core		2			
South Fork Rainey Creek	Conservation		1			
	Core		2			
Spring Creek	Core			1		
Table Rock Canyon	Core			1		
Trout Creek	Core			1		
Unknown tributary to McCoy Creek	Core			1		
Unknown tributary to North Fork Bear Creek	Core		1	1		
West Pine Creek	Conservation		1			
	Core		1			
Williams Creek	Core		1			

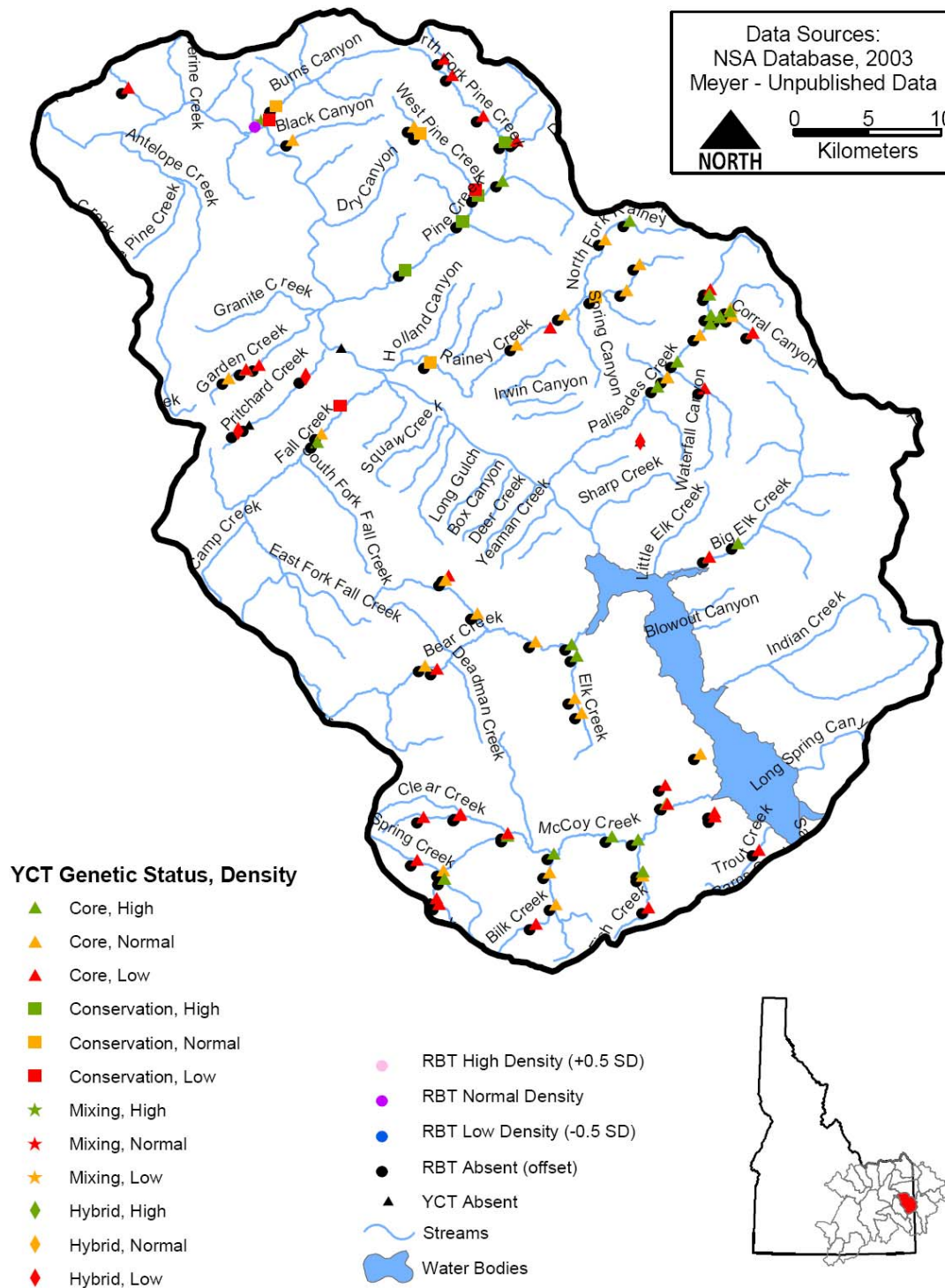


Figure 2-26. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Palisades watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Salt Watershed—Information on Yellowstone cutthroat trout populations in the Salt watershed was supplemented with data from D. Isaak (2001). In the Salt watershed, Yellowstone cutthroat trout were

widely distributed (Figure 2-x), and 107 populations were classified as core, with 1 classified as a mixed population (Table 2-17).

Table 2-17. Introgression and population status of Yellowstone cutthroat trout (YCT) for sampling locations in the Salt watershed in the Snake Headwaters subbasin. Density of rainbow trout (RBT) < 100 mm is listed as an index of further introgression risk (Dan Isaak, unpublished data).

Stream Name	Introgression Status	YCT Density				RBT Density
		High	Normal	Low	None	
Bear Canyon	Core	1				
Boulder Creek	Core	1	1			
Burns Creek	Core			2		
Cottonwood Creek	Core	2	3	1		
Crow Creek	Core	1	1	5		
Deer Creek	Core	1		4		
Dry Creek	Core			9		
Fish Creek	Core		2			
Horse Creek	Core	1	2	2		
Jackknife Creek	Core	1	7	3		
Nom Creek	Core			1		
North Fork Willow Creek	Core			1		
Rock Creek	Core		1	1		
Sage Creek	Core		1	3		
Salt River	Core	1	2	5		
South Fork Tincup Creek	Core	3				
	Mixing			1		
Spring Creek	Core	3	3	1		
Squaw Creek	Core	1	2			
Stump Creek	Core	1	2	5		
Timber Creek	Core		1			
Tincup Creek	Core	1	8	2		
Trail Creek	Core		1			
Wagner Creek	Core			1		
White Dugway Creek	Core			3		
Willow Creek	Core	1	2			

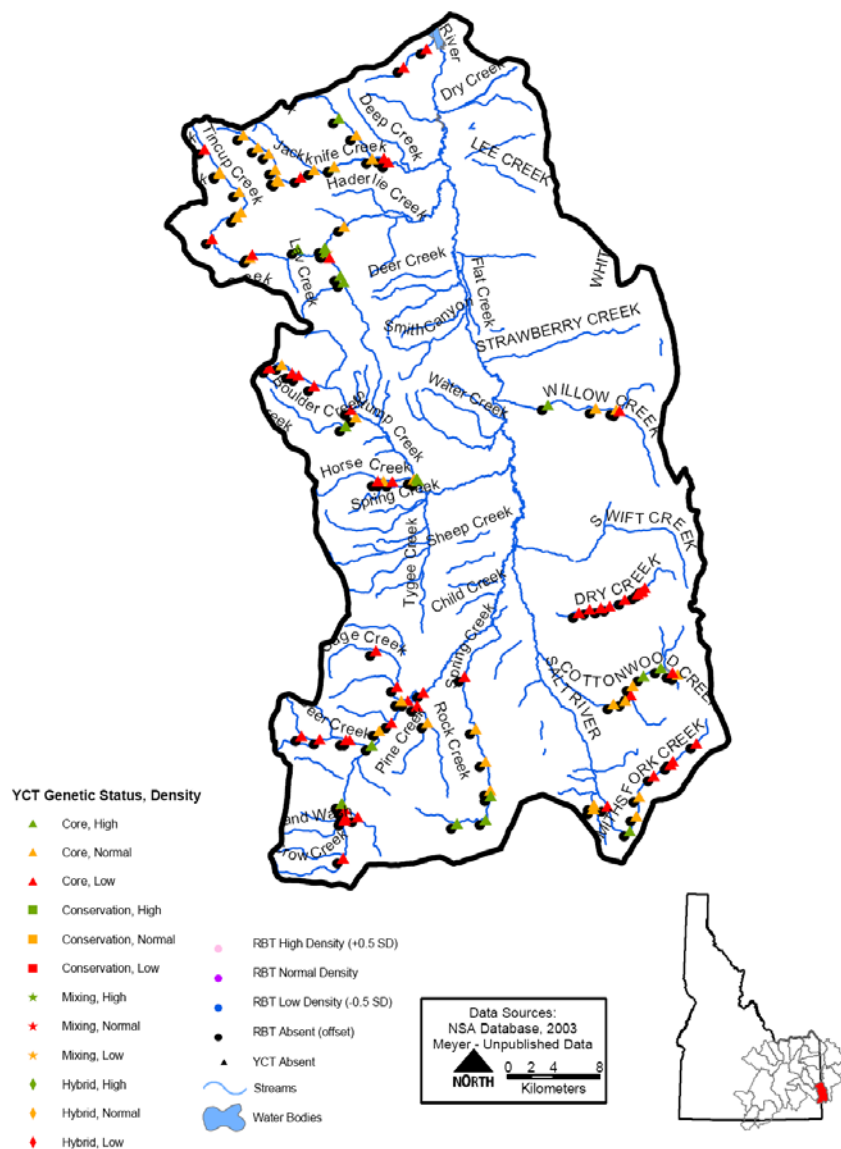


Figure 2-27. Distribution of sampling locations for Yellowstone cutthroat trout (YCT) in the Salt watershed. Rainbow trout (RBT) density < 100 mm is plotted as an index of further introgression risk.

Greys–Hoback Watershed—Yellowstone cutthroat trout are considered common and abundant in the Hoback River basin (WGFD 2004). No rainbow trout or hybrids are known to be present in this watershed.

Gros Ventre Watershed—Yellowstone cutthroat trout are considered abundant in the Gros Ventre River, while rainbow trout

are considered common and hybrids are considered rare (WGFD 2004).

Snake Headwaters Watershed—In the Snake Headwaters watershed, Yellowstone cutthroat trout are considered abundant, while rainbow trout are considered rare and hybrids were not classified (WGFD 2004).

Table 2-18. Mean values of stream characteristics in study sites with and without Yellowstone cutthroat trout within several river drainages in the Upper Snake subbasin, Idaho. Bold italics within each river drainage indicate variables that were subsequently included in logistic regression models (Meyer and Lamansky 2003).

	Teton River (n = 64)		Willow Creek (n = 32)		Blackfoot River (n = 61)		Portneuf River (n = 63)		Raft River (n = 64)		Goose Creek (n = 57)	
Variables	Absent	Present	Absent	Present	Absent	Present	Absent	Present	Absent	Present	Absent	Present
<i>n</i>	26	38	12	20	22	39	22	41	25	39	30	27
Stream order	1.6	1.9	1.3	2.2	2.6	2.0	1.5	1.9	2.0	2.0	1.9	2.3
Dominant riparian vegetation rating	3.2	3.2	2.7	2.7	2.3	2.6	2.6	3.4	2.5	2.9	2.7	3.6
Gradient (%)	3.8	3.0	3.5	2.2	1.5	1.9	3.1	3.7	4.0	3.9	5.3	3.1
Stream width (m)	2.4	3.2	1.5	2.2	2.7	2.7	1.8	2.8	2.1	2.3	1.9	2.7
Fines substrate rating	2.1	1.9	3.5	3.4	3.9	2.3	3.0	1.6	2.3	1.7	1.8	2.1
Gravel substrate rating	2.8	2.6	1.5	2.1	1.5	2.7	2.3	2.6	2.8	3.1	3.2	3.0
Cobble/Boulder substrate rating	1.3	1.5	0.6	0.6	0.7	0.9	0.5	1.8	1.1	1.6	1.3	1.5
Stream shading rating	1.8	1.5	2.0	1.7	1.2	1.4	2.7	2.7	1.9	2.3	2.0	2.6
Bank stability rating	0.6	0.7	0.5	1.5	2.2	1.2	1.0	1.1	1.3	1.3	1.3	0.9
% Private property	27	29	75	45	36	33	50	32	24	33	27	4
% Exotic salmonids present	58	87	17	15	18	49	23	51	68	56	57	26
Elevation (m)	6607	6432	6364	6349	6129	6370	5552	5458	5860	6263	5582	6277

Table 2-19. Summary of variables included in logistic regression models relating stream characteristics to the occurrence of Yellowstone cutthroat trout in the Upper Snake subbasin, Idaho. Up and down arrows indicate direct or indirect relationships between stream attributes and cutthroat trout presence, respectively (Meyer and Lamansky 2003).

	Teton River	Willow Creek	Blackfoot River	Portneuf River	Raft River	Goose Creek
Variables in model	Exotic salmonids ↑ Elevation ↓ Fines substrate ↓	Land ownership ↑ Unstable banks ↑ Stream order ↑ Gravel substrate ↑ Stream width ↑	Stream order ↓ Land ownership ↑ Fines substrate ↓ Gradient ↑ Stream width ↑ Cobble/boulder substrate ↑ Gravel substrate ↑	Elevation ↓ Land ownership ↑ Cobble/boulder substrate ↑ Stream width ↑ Stream order ↑ Riparian vegetation ↑	Gradient ↓ Fines substrate ↓ Elevation ↑ Riparian vegetation ↑ Unstable banks ↑	Elevation ↑ Gradient ↓ Riparian vegetation ↑ Gravel substrate ↓ Stream shading ↑ Stream width ↑ Land ownership ↑
Model output						
AIC	82.8	26.9	52.5	39.2	69.9	30
n	64	32	61	63	64	56
R ²	0.17	0.58	0.51	0.63	0.35	0.68

Artificial Propagation

Between 1899 and 1957, Yellowstone cutthroat trout eggs were collected at Yellowstone Lake (Gresswell and Varley 1988). Today, hatchery propagation of Yellowstone cutthroat trout is carried out in Idaho (Henrys Lake stock, Henrys Lake Fish Hatchery), Wyoming (South Paintrock Creek stock, U.S. Fish and Wildlife Service National Fish Hatchery at Jackson, WY), and Montana (McBride Lake stock) (Behnke 1992).

2.2.1.2 Bull Trout (*Salvelinus confluentus*)

2.2.1.2.1 Conservation Status

Bull trout (*Salvelinus confluentus*, [Suckley, 1858]) were listed under the ESA as threatened on November 1, 1999 (64 FR 58910). Earlier rulemakings had listed distinct population segments of bull trout as threatened in the Columbia, Klamath, and Jarbidge river basins (63 FR 31647, 63 FR 42747, 64 FR 17100). The Bull Trout Recovery Team developed a draft recovery plan that provided a framework for implementing recovery actions for the species. This draft recovery plan was also used as the principal basis for identifying critical habitat for species. The proposed designation of critical habitat was published on November 29, 2002 (67 FR 71236) and includes streams within the Upper Snake province.

2.2.1.2.2 Life History

Bull trout exhibit a number of life history strategies. They spawn more than once (i.e., iteroparous life history), and some may spawn in alternate years. Stream-resident bull trout complete their entire life cycle in the tributary streams where they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish usually rear from one to four years before migrating to either a

larger river (i.e., fluvial) or lake (i.e., adfluvial) where they spend their adult life, returning to the tributary stream to spawn (Fraley and Shepard 1989). Resident and migratory forms may be found together, and either form can produce resident or migratory offspring (Rieman and McIntyre 1993).

The size and age of bull trout are variable depending on life history strategy. Resident bull trout tend to be small, averaging 20 cm (8 inches) long and rarely exceeding 30 cm (12 inches). Adults that migrate to larger downstream rivers average about 40 cm and often exceed 61 cm (24 inches) (Goetz 1989). Maximum sizes are reached in large lakes and reservoirs, where adults can grow to over 69 cm (27 inches) long and 10 kg (22 lbs.) in weight (McPhail and Baxter 1996). Under appropriate conditions, bull trout regularly live to 10 years and, under exceptional circumstances, reach ages in excess of 20 years (Fraley and Shepard 1989, McPhail and Baxter 1996). Bull trout normally reach sexual maturity in 4 to 7 years.

The preferred spawning habitat of bull trout consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989). Bull trout typically spawn from August to November during periods of decreasing water temperatures (Swanberg 1997). However, migratory forms are known to begin spawning migrations as early as April and to move upstream as far as 250 km to spawning areas (Fraley and Shepard 1989, Swanberg 1997).

Depending on water temperature, egg incubation is normally 100 to 145 days (Pratt 1992). Water temperatures of 1.2 to 5.4 °C (34.2–41.4 °F) have been reported for incubation, with an optimum (i.e., best embryo survivorship) temperature reported to be from 2 to 4 °C (36–39 °F) (Fraley and Shepard 1989, McPhail and Baxter 1996).

Juveniles remain in the substrate after hatching, and the time from egg deposition to emergence of fry can exceed 200 days. During the relatively long incubation period in the gravel, bull trout eggs are especially vulnerable to fine sediments and water quality degradation (Fraley and Shepard 1989). Increases in fine sediment appear to reduce egg survival and emergence (Pratt 1992). High juvenile densities have been reported in areas characterized by a diverse cobble substrate and a low percentage of fine sediments (Shepard *et al.* 1984).

Bull trout are opportunistic feeders, with food habits that are primarily a function of size and life history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro-zooplankton, and small fish (Donald and Alger 1993, McPhail and Baxter 1996). Adult migratory bull trout feed almost exclusively on other fish (Rieman and McIntyre 1993).

2.2.1.2.3 Population Trends and Distribution

Information on distribution and abundance was taken from the Bull Trout Recovery Plan, Little Lost River Chapter (USFWS2002) as it contains the most comprehensive information on populations of bull trout available at the time of the assessment. Bull trout distribution within the recovery unit is based largely on presence-absence surveys and basinwide surveys that used electrofishing and snorkeling techniques. Surveys conducted from 1992 through 1999 indicate that bull trout have a wide, but fragmented, distribution in the Little Lost River watershed (Figure 2-28). Bull trout occupy approximately 164 km (101.9 miles) of streams and are the only salmonid present in approximately 32 km (19.8 miles) of streams (Gamett 1999). Bull trout occur in the following streams: the upper reach of Badger Creek, upper reach of Big Creek, lower reach

of Bunting Canyon Creek, lower reach of Camp Creek, Firebox Creek, Hawley Creek, Iron Creek, Jackson Creek, middle and upper reaches of the mainstem Little Lost River (including Sawmill Creek), Mill Creek, Quigley Creek, Redrock Creek, Smithie Fork, an unnamed tributary to Smithie Fork, Summit Creek, Timber Creek, Squaw Creek (Sawmill Canyon), North Fork Squaw Creek, lower reach of Slide Creek, upper reach of Warm Creek, Wet Creek (except for the middle section), and Williams Creek.

Bull trout were previously observed in some reaches and streams where they were not detected in recent surveys (1992 through 1999). Bull trout were found in the lower reach of the Little Lost River near Howe in 1983 (Corsi *et al.* 1986), which was prior to annual dewatering of the reach that began in 1985, indicating that bull trout probably occupied all reaches of the river. Bull trout were not found in the reach in 1987 (Corsi and Elle 1989) or more recently (Gamett 1999). Bull trout were reported from Big Springs Creek in 1977 (Gamett 1999), lower Squaw Creek (Wet Creek drainage) in 1987 (Corsi and Elle 1989), and Dry Creek during the 1920s and 1960s (Gamett 1999).

However, bull trout were not collected in these streams during surveys conducted in the 1990s (Gamett 1999). Because bull trout may exhibit a patchy distribution within a stream, detecting them may be difficult, even with relatively intensive sampling efforts (Gamett 1999).

Abundance of bull trout (expressed as density, or the number of individuals per kilometer of stream) has declined in some areas of the Little Lost River and its tributaries. In the reach of the Little Lost River from the confluence of Summit Creek upstream to the National Forest boundary, bull trout density declined 91% between 1984 and 1993 (Table 2-20) (Gamett 1999). In the reach of the river between the National Forest boundary

upstream to the confluence of Smithie Fork, bull trout density declined 62% between 1987 and 1995. Bull trout densities were higher in later surveys of both reaches (Table 2-20), a finding that suggests that bull trout declines were probably related to low water levels and associated high temperatures due to drought, degraded habitat conditions downstream of Warm Creek, and angler harvest.

Bull trout abundance has declined in other tributaries of the Little Lost River watershed.

According to personal communications with local residents, relatively large bull trout (300 to 500 mm [11.8–19.7 inches]) were caught by anglers during the 1940s through the 1960s in Big Creek, a tributary in the Wet Creek drainage (Gamett 1999). Bull trout were also reported in 2 of 7 years of creel census data collected from 1969 through 1979 (6 and 16% of all species in 1974 and 1977, respectively). In 1978, brook trout were introduced in Big Creek.

Table 2-20. Estimated densities (individuals per stream kilometer) of rainbow trout, brook trout, bull trout, and all species combined for two reaches of the Little Lost River from surveys conducted in the 1980s and 1990s (Garnett 1999).

Sample Date	Rainbow Trout	Brook Trout	Bull Trout	Species Combined
Little Lost River—Summit Creek upstream to National Forest boundary				
October 1984	713	27	45	245
July 1985	83	32	61	176
July 1986	123	21	45	189
July 1987	150	52	24	226
August 1993	203	20	4	227
July 1997	208	16	21	245
Little Lost River—National Forest boundary upstream to Smithie Fork Creek				
July 1987	423	90	162	675
August–September 1995	499	33	62	594
July 1997	366	74	87	527

Gamett (1999) noted that five sites were sampled in Big Creek during 1992 through 1997, and bull trout were collected at two sites. At these two sites, 2% and 6% of all trout collected were bull trout (2 bull trout and an apparent hybrid at one site; 7 apparent hybrids at the other), whereas 38% and 77% of all trout were brook trout. In 1999, no bull trout were collected at two other sites (USFS 1999). Presumed declines of bull trout in Big Creek are probably associated with brook trout interactions, and similar declines are probably occurring in Mill Creek and lower Squaw Creek (Sawmill Canyon). Sampling in

Wet Creek during 2001 suggests that adult bull trout have undergone substantial declines in abundance.

Both resident and migratory (fluvial) bull trout exist in the Little Lost River Recovery Unit. Bull trout in the Little Lost River below Iron Creek road are fluvial and migrate to headwater streams to spawn. The smallest bull trout captured in the Little Lost River downstream of Iron Creek Road (10 sampling sites) was 151 mm (5.1 inches) in total length (Gamett 1999). In 1987, Corsi and Elle (1989) found that age 1 and age 2 bull trout in the

Little Lost River watershed were 99 mm (3.4 inches) and 155 mm (5.3 inches) long, respectively. Data collected downstream of the National Forest boundary (Corsi *et al.* 1986, Corsi and Elle 1986, Elle *et al.* 1987, Corsi and Elle 1989) indicate a lack of small bull trout in the Little Lost River downstream of this point. This lack of young-of-the-year and age 1 bull trout in this area of the Little Lost River indicates that bull trout are spawning and rearing elsewhere.

The primary spawning areas for fluvial bull trout appear to be tributary streams in Sawmill Canyon. Bull trout over 300 mm (11.8 inches) long were observed in many streams of Sawmill Canyon during the spawning period in July, August, and September (Corsi and Elle 1989, Gamett 1999), indicating that these fish may be migratory. If so, fluvial bull trout may be migrating over 30 km (18.6 miles) to spawn, and historically, bull trout may have migrated the length of the Little Lost River, over 80 km (49.7 miles). High densities of young bull trout in Smithie Fork, the Little Lost River upstream of Smithie Fork, and Firebox Creek suggest that these streams are the most important spawning and rearing tributaries for fluvial bull trout. In 1995, bull trout densities (fish > 70 mm [2.8 inches]) were 30.3 fish per 100 square meters (2.8 fish/100 ft²) in Smithie Fork and 20.4 fish per 100 square meters (1.9 fish/100 ft²) in the Little Lost River upstream of Smithie Fork (Gamett 1999).

Relatively large bull trout have been observed in Wet Creek and in Big Creek, a tributary of Wet Creek, suggesting that these fish were fluvial (Gamett 1999). Bull trout up to 430 mm (16.9 inches) long have been recorded by electrofishing and creel surveys in Big Creek. Relatively large fish, up to 635 mm (25.0 inches) long and 3.9 kg (8.6 pounds) in weight and that appeared to be bull trout × brook trout hybrids, have been collected by electrofishing and angling in and

around a beaver pond near the head of Big Creek. In July 1996, snorkelers observed bull trout over 300 mm (11.8 inches) long in Wet Creek in the beaver ponds immediately below Hilts Creek. The large size of these fish in relation to the size of Little Lost/Wet Creek suggests that they were fluvial fish that migrated into these areas to spawn. For both Big Creek and Wet Creek, bull trout were probably migrating from lower Wet Creek and possibly from the Little Lost River. Length frequency data suggest that bull trout in Wet Creek above the falls that are located 0.8 km (0.5 miles) above Hilts Creek are resident fish. The old diversion structure, falls, and cascades at this point are probably a barrier to upstream fish movement.

There is insufficient data to determine whether migratory bull trout occur in Mill Creek, Quigley Creek, Squaw Creek (Sawmill Canyon), Slide Creek, North Fork Squaw Creek, Warm Creek, or Badger Creek (Gamett 1999). Data on length frequency and length at sexual maturity suggest that bull trout in upper Squaw Creek (Sawmill Canyon) are resident fish. It is likely that fluvial bull trout from the Little Lost River historically used all of these streams for spawning and rearing. However, the bull trout currently found in these streams may be only remnants of a former fluvial population that has reverted to residency. In addition, resident fish may be sympatric with fluvial fish in streams such as Smithie Fork (Gamett 1999).

In the past, fluvial bull trout probably migrated into Williams Creek, but bull trout there now are residents (Gamett 1999). Since the late 1800s, Williams Creek has been permanently diverted for irrigation, and flow does not reach the Little Lost River. Therefore, bull trout inhabiting Williams Creek are completely isolated from fish in other portions of the Little Lost River watershed.

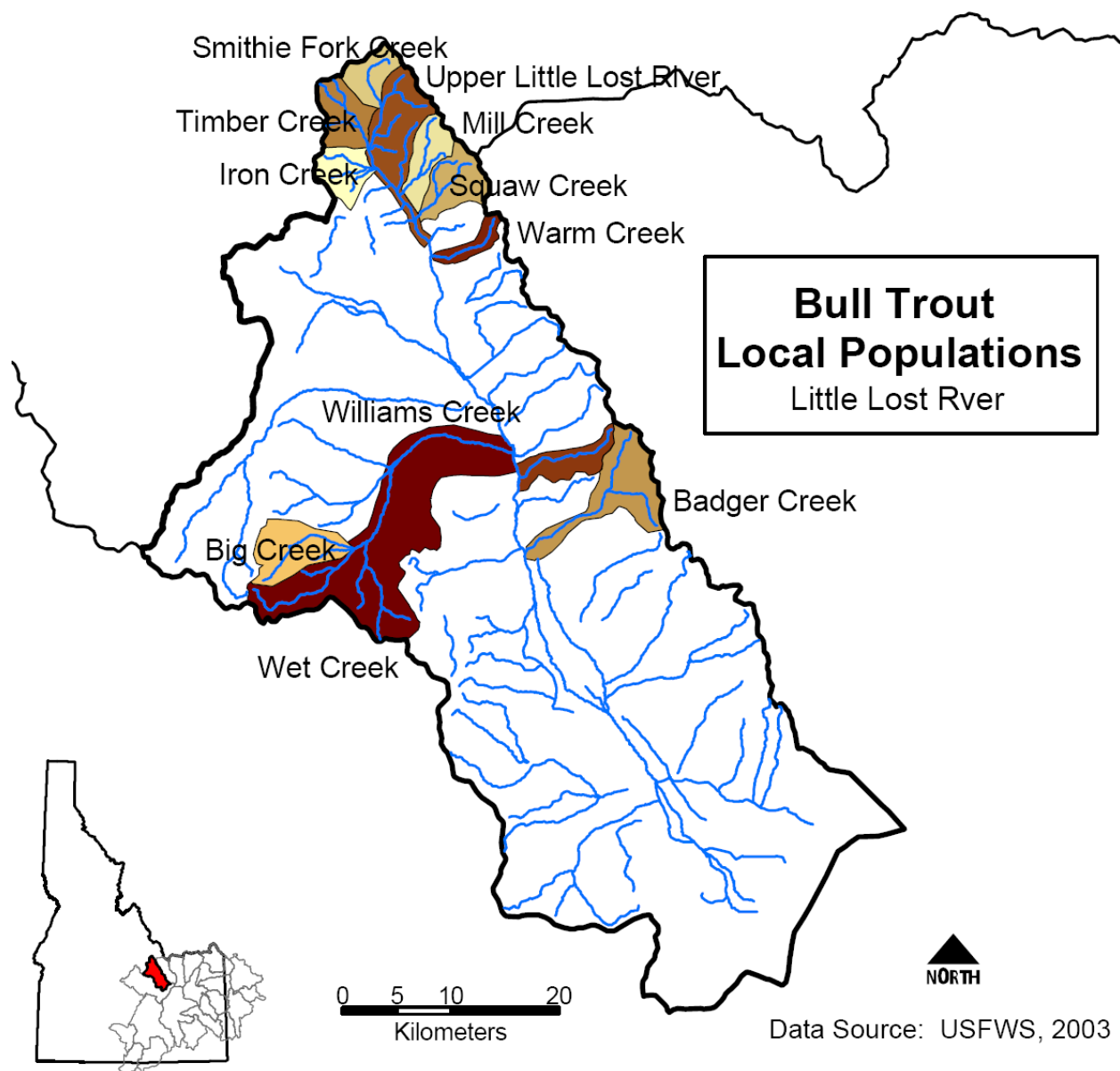


Figure 2-28. Bull trout populations in the Little Lost River watershed in the Closed Basin subbasin of the Upper Snake province.

2.2.1.3 Mountain Whitefish (*Prosopium williamsoni*)

2.2.1.3.1 Conservation Status

The mountain whitefish is widely distributed throughout the western United States and considered abundant throughout all major river drainages in Idaho (Simpson and Wallace 1982).

2.2.1.3.2 Life History

The preferred habitat of mountain whitefish is cold mountain streams (Simpson and Wallace 1982), where they are found predominantly in riffle areas during summer and deep pools during winter (Wydoski and Whitney 1979). Mountain whitefish mature at about 3 years of age. They are fall spawners, typically spawning in riffle areas during late October or early November when water temperatures range between 40 and 45 °F; in some instances, spawning is known to occur along gravel shores in lakes or reservoirs. Eggs are adhesive and stick to the substrate following spawning. Hatching occurs in March (Simpson and Wallace 1982).

Mountain whitefish spend much of their time near the bottom of streams and feed mainly on aquatic insect larvae (AFS 2000). Mountain whitefish also feed on terrestrial insects on the surface and on fish eggs (Simpson and Wallace 1982). Although growth is variable, most mountain whitefish in Idaho are typically 3 to 4 inches at the end of their first year and 6 to 7 inches after 2 years (Simpson and Wallace 1982).

2.2.1.3.3 Population Trends and Distribution

A native fish species, the mountain whitefish is probably the most widely distributed native fish species of the *Salmonidae* family found in Idaho. The species has persisted without population augmentation or special

management. In many areas, mountain whitefish provide an important winter fishery because they feed more actively than most salmonids during this period.

Mountain whitefish in the Big Lost River watershed, a hydrologically isolated stream basin, are believed to have originated from the upper Snake River sometime during the last several million years. Previous work has shown that this population is genetically distinct from other mountain whitefish populations and may constitute an endemic subspecies. A study by Gamett *et al.* (2004) indicated that there has been a substantial decline in the distribution of mountain whitefish in the drainage. It is estimated that prior to the arrival of European settlers in the late 1860s, mountain whitefish occupied approximately 300 km of stream in the Big Lost River watershed. However, it appears that the fish now occupy only about 80 km of stream, indicating that distribution has decreased to approximately 27% of historic levels. Furthermore, in areas that are still occupied by the species, there appears to have been large declines in abundance. Major factors contributing to the declines appear to be dewatered streams, habitat fragmentation, flow alteration, habitat alteration, and drought.

2.2.1.4 Molluscs

The Snake River upstream from Shoshone Falls provides habitat for the two Snake River snails listed as threatened on January 13, 1993: the Utah valvata snail (*Valvata utahensis*) and Snake River physa snail (*Physa natricina*) (Figure 2-29). The Snake River physa snail can be regarded as riparian associates and are heavily affected by management of terrestrial riparian zones. The Utah valvata snail is generally a lake-dwelling species and exists in reservoirs and stream reaches with fine sediments. Most mollusc species that we considered for focal species

status prefer relatively undisturbed cool and shaded streams, lakes, springs, seeps, or other permanent water habitats.

The Snake River ecosystem has undergone significant transformation from a primarily free-flowing, cold-water system to a slower-moving, warmer system. The habitat requirements for mollusc species generally include cold, clean, well oxygenated, flowing water of low turbidity. The Snake River molluscs are vulnerable to continued adverse

habitat modification and deteriorating water quality from one or more of the following: hydroelectric development, load-following (the practice of artificially raising and lowering river levels to meet short-term electrical needs by hydroelectric projects) effects of hydroelectric project operations, water withdrawal and diversions, water pollution, inadequate regulatory mechanisms, and the possible adverse effects of invasive exotic species (such as the New Zealand mudsnail).

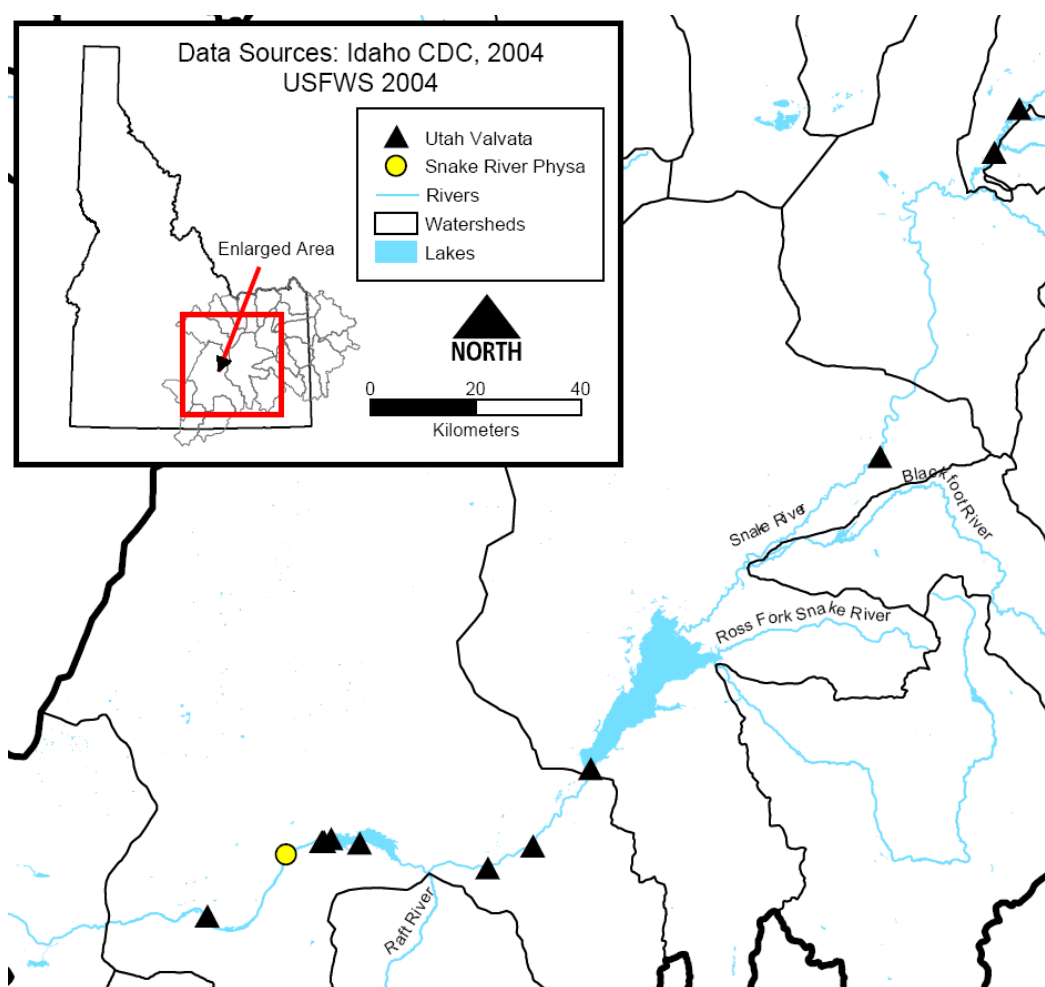


Figure 2-29. General locations where focal mollusc species are present in the Upper Snake province (IDCDC 2004). There are no distribution records for either the Idaho springsnail or the California floater. What does color difference mean? There is no legend.

The Snake River aquatic species recovery plan (USFWS 1995) identifies specific recovery areas and short-term recovery goals that will provide downlisting/delisting criteria for each of the five listed snail species. Actions needed to initiate recovery include:

- Ensure water quality standards for coldwater biota and habitat conditions so that viable, self-reproducing snail colonies are established in free-flowing mainstem and coldwater spring habitats within specified geographic ranges, or recovery areas, for each of the 5 species.
- Develop and implement habitat management plans that include conservation measures to protect coldwater spring habitats occupied by Banbury Springs limpet, *Lanx*, Bliss Rapids snail, and Utah valvata snail from further habitat degradation.
- Stabilize the Snake River Plain aquifer to protect discharge at levels necessary to conserve the listed species' coldwater spring habitats.
- Evaluate the effects of nonnative flora and fauna on listed species in the Snake River from C.J. Strike Dam to American Falls Dam.

2.2.1.4.1 Utah Valvata Snail (*Valvata utahensis*)

The Utah valvata snail, also known as the desert valvata, inhabits areas between sand, silt, and mud grains in shallow shoreline waters, pools adjacent to rapids, perennial flowing waters associated with large spring complexes, and reservoir habitats. The species avoids areas with heavy currents or rapids. This snail generally requires flowing water that is cold, clean, and well oxygenated. The snail prefers well-oxygenated areas of limestone mud or mud-sand substrate among

beds of submergent aquatic vegetation. It is absent from pure gravel-boulder substrate.

The Utah valvata is primarily a detritivore, grazing along the mud surface ingesting diatoms or small plant debris. Common plant associates are *Chara*, *Elodea*, *Myriophyllum*, *Ceratophyllum*, and *Potamogeton* spp. (Frest and Johannes 1995). Other mollusc associates include *Physella gyrina*, *Valvata humeralis*, and *Fluminicola* spp. (Frest and Johannes 1995).

Free flowing, coldwater environments required by the Utah valvata snail have been altered by reservoir development, river diversions, and habitat modification. Water quality has deteriorated in the Snake River due to altered natural flow and pollution. Water quality and habitat conditions in the mainstem Snake River must be improved to begin to recover the snail. Additional studies are needed to address the temperature, substrate, and flow requirements.

The species historically occurred in the middle Snake River from about Weiser to American Falls. The species also occurred at sites in southeastern Idaho and at Utah Lake, Utah. The species appears to have been extirpated from most of its historical range.

In the mid-1990s, the Utah valvata snail was located in the upper Snake River, and in 2001, the species was found in the Big Wood River. It appears to be very abundant in the Snake River near the Payne boat ramp (D. Gustafson, personal communication, 2001), occurring with *Valvata humeralis* and *Fluminicola* spp. At the boat ramp, the river is lake-like and has few of its normal insects left. Further downstream at the Twin Bridges site at Blackfoot, *Valvata* and *Fluminicola* drop out and *Physella* and *Stagnicola* are abundant (D. Gustafson, personal communication, 2001). The species currently exists in disjunct populations from the

Thousand Springs complex upstream to Rexberg, Idaho, in the Henrys Fork of the Snake River, including Lake Walcott (reservoir) and American Falls Reservoir.

2.2.1.4.2 Snake River Physa Snail (*Physa natricina*)

The Snake River physa snail occurs on the undersides of gravel to boulder-size substrate in swift current in the mainstem Snake River. Living specimens have been found on boulders in the deepest accessible part of the river at the margins of rapids. Because of the rarity of this species and the difficulty sampling the habitat in which it resides, not much is known about the snail's life history or distribution.

The snail is known to be associated with gravel-boulder substrate that is basalt derived and a few macrophytes or epiphytic algae (Frest and Johannes 1995). Other freshwater snails that associate with the Snake River physa snail include *Fluminicola* spp., *Taylorconcha serpenticola*, and *Vorticifex effusus* (Frest and Johannes 1995).

Taylor (1982) believed that much of the habitat for this species was deep water beyond the range of routine sampling. The modern historic range in the Snake River extends from Grandview upstream through the Hagerman reach (RM 573) (Taylor 1982). Currently, two populations (or colonies) are believed to remain in the Hagerman and King Hill reaches, with possibly a third colony immediately downstream of Minidoka Dam. However, recent surveys have failed to collect these snails in the Hagerman reach, including the type locality of the species.

2.2.2 Important Species

2.2.2.1 Speckled Dace (*Rhinichthys osculus*)

A bottom dweller, the speckled dace inhabits shallow, rocky, headwater streams with relatively swift flow, sometimes in areas with considerable aquatic vegetation (Sublette *et al.* 1990). The species has a relatively low tolerance for elevated temperatures and reduced oxygen (Lowe *et al.* 1967, Sublette *et al.* 1990).

This species feeds principally on benthic insects but also takes algae, other aquatic invertebrates, and detritus (Scott and Crossman 1973).

Spawning usually occurs once a year from June through August in animals older than 2 years (Cannings and Ptolemy 1998). During reproductive periods, males develop a red spawning dress similar to that of the leopard dace (*Rhinichthys falcatus*). Breeding occurs in riffles with a clean gravel substrate, and males clean and prepare the gravel with their mouths prior to spawning. During breeding, many males accompany a single female; she deposits adhesive eggs into prepared substrate.

2.2.2.2 Longnose Dace (*Rhinichthys cataractae*)

The longnose dace seeks the interstices between stones in gravel-rock substrates of riffle areas of streams or the surge zone or deeper water of lakes (Sublette *et al.* 1990). Longnose dace occupy perennial mainstream and tributary habitat at higher elevations (Bestgen and Platania 1990). The longnose dace feeds on the bottom, principally on chironomids, mayflies, and simuliids, but it also takes algae and plant material. In Montana, Gerald (1966) found that size influenced diet, with dace up to 49 mm long

taking mostly algae, the 50- to 69-mm fish preferring Chironomidae, and the 70- to 100-mm class taking Chironomidae and Baetidae equally.

Spawning occurs from early spring to early summer in riffles with a water velocity of 45 to 60 cm per second or on wave-swept shores over a coarse substrate with crevices into which eggs are deposited. Eggs are demersal and adhesive. According to McPhail and Lindsey (1970), the incubation period is from 7 to 10 days at 15.6 °C.

2.2.2.3 Leopard Dace (*Rhinichthys falcatus*)

The leopard dace averages 7 to 10 cm (about 3 inches) long and is creamy in color, somewhat darker on the back, with many large irregularly shaped spots.

The species prefers rivers with a cobble or stone bottom and relatively warm, productive waters. When the leopard dace occurs in the same river systems as the longnose dace, the two species have quite different current-flow preferences: the leopard dace prefers slow-moving currents, probably less than 0.5 meters per second, and the longnose dace prefers more rapid water (Scott and Crossman 1973).

Yearling leopard dace are commonly found in shallow cobble habitat near current. The dace uses very different habitat for nursery areas than it uses for adult habitat. The sun warms the shallow nursery zone in summer. This warmth probably adds to the productivity and metabolic activity of young dace in these habitats.

Little information is known about female reproduction. Beyond observations of dace seeking refuge under rocks, no information is available on their behavior since they have not been observed in open water. Stomach

contents saved from collected specimens appear to contain mostly remains of insect larvae. Stomach contents have not been identified completely, but algae are not seen as a major component in the food habits of the species. Predation and competition by sympatric prickly sculpin (*Cottus asper*), torrent sculpin (*C. rhotheus*), or rainbow trout (*Oncorhynchus mykiss*) may affect dace abundance, although hiding under rocks could provide the species with protection from predation.

2.2.2.4 Peamouth Chub (*Mylocheilus caurinus*)

The peamouth chub is endemic to western North America and the sole member of the genus *Mylocheilus* (Bailey *et al.* 1970). Peamouth chub are commonly found in the weedy shallows of rivers and lakes. They grow to a maximum of about 35 cm.

Spawning takes place in the inlets, outlets, and gravel shallows of lakes during May and June once waters reach about 12 °C (Wydoski and Whitney 1979). During spawning, peamouth chub aggregate in schools. Then females broadcast release large numbers of sticky, greenish eggs that hatch in 7 to 8 days depending on water temperatures. Male and female peamouth chub are dimorphic during the breeding season, with the ripe males developing tubercles on the head, pectoral, and pelvic fins. Breeding males also develop a dark lateral stripe flanked with tinges of red and exhibit a dark green dorsal surface. Ripe females are less colorful than the males are and lack well-developed lateral stripes.

Like many cyprinids, peamouth chub hybridize easily with other family members, and in 1856, a specimen was described from the lower Columbia River as a new species, *Cheonda cooperi* (Carl *et al.* 1967). Nearly 100 years later, a similar specimen was found in Flathead Lake, Montana, and correctly

identified as a hybrid between the redbside shiner and peamouth chub (Weisel 1954). A similar case of hybridization has been noted for northern squawfish (*Ptychocheilus oregonensis*) and peamouth chub (Scott and Crossman 1973).

2.2.2.5 Leatherside Chub (*Gila copei*)

The leatherside chub is a small minnow native to streams and rivers of the southeastern portion of the Lake Bonneville basin. It was once common throughout its native range, but currently, the species has suffered substantial decreases in population levels. Consequently, the leatherside chub is listed as a species of special concern in the State of Idaho. The species is rare, and there is little information on its population status, distribution, and/or habitat requirements.

Leatherside chub live up to 8 years, and adults reach a maximum length of 150 mm. The body is bluish above and silvery below, and males have bright orange-red coloration on the axils of the paired fins. The skin has a leathery texture with very small scales (75–85 in the lateral line), and the anal and dorsal fins have 8 fin rays. The leatherside chub tends to inhabit rocky, flowing pools and sometimes riffles of creeks and small rivers. This chub probably spawns in midsummer. It may serve as forage for other fishes.

The leatherside chub is present in the Upper Snake province in the Goose Creek drainage, Trapper Creek, and the top end of the Salt River.

Although Simpson and Wallace (1982) listed this species as native to the upper South Fork Snake River in Idaho, it is possible that the species was introduced because it was not collected from the upper Snake until the 1930s. In their list of fishes found in Idaho, Wydoski and Whitney (1979) seemed to suggest that this species was introduced into

the Snake River drainage and Lake Bonneville basin in Idaho. However, Sigler and Sigler (1987) listed it as native to the eastern Lake Bonneville basin that includes Idaho.

2.2.2.6 Chiselmouth Chub (*Acrocheilus alutaceus*)

The average length of the adult chiselmouth is 6 to 7 inches (15–18 cm). The head of the fish is blunt, and the eyes are relatively large. The lower lip is covered with a hard cartilaginous sheath with an almost straight cutting edge, rather like a chisel, giving the fish the ability to scrape algae from rocks. The overall coloration of the chiselmouth chub is a rather drab, dark brown, with lighter sides covered in many small black dots.

The species seems to prefer faster water of warm streams but is also found in backwaters of larger rivers and in small kettle lakes and large lakes. Although spawning has not been observed, it occurs in streams. Biology and critical habitat requirements are still largely unknown.

Although the species' range is confined and its distribution spotty, the fish is found in numerous localities and a variety of waterbody types, and it has no obvious threats (Cannings and Ptolemy 1998). Young chiselmouth feed mainly on insects, while adults feed largely on diatoms that they scrape from rocks or other substrate with their lower chisel-like jaw. Spawning usually occurs in late June to early July when water warms up. During spawning, eggs have been found on the open bottom and buried among boulders (Scott and Crossman 1973). Maturity occurs at age 3 or 4 years, and the fish may live to 6 years (Cannings and Ptolemy 1998).

2.2.2.7 Utah Chub (*Gila atraria*)

The Utah chub is found in the upper Snake River system in Wyoming and Idaho, as well as in the Lake Bonneville basin (including Great Salt Lake drainage and Sevier River system) in southeastern Idaho and Utah. The species occurs in lakes, quiet pools of headwaters, creeks, and small to medium-sized rivers, and it is often found in vegetation over mud or sand.

2.2.2.8 Tui Chub (*Gila bicolor*)

The tui chub is widely distributed throughout the hydrographic Great Basin Region in much of the area formerly occupied by Lake Lahontan and other pluvial lakes during the Pleistocene (Grayson 1993). The disappearance of these lakes isolated various populations, and some became more differentiated than others; 13 subspecies have been recognized (Smith 1979).

The species prefers to inhabit lakes and quiet, vegetated, mud- or sand-bottomed pools of headwaters, creeks, and small to large rivers. Distinct subspecies are *G. b. snyderi* (protected) in Owens River, California; *G. b. mohavensis* (protected) in Mojave River, California; *G. b. bicolor* in the Klamath River system in Oregon and California; *G. b. obesa*, a stream- and spring-inhabiting form in the Lake Lahontan basin; and *G. b. pectinifer*, a lake-inhabiting form, also in the Lake Lahontan basin, Nevada.

Tui chubs are small fish, rarely exceeding 6.7 inches (170 mm) standard length (tip of snout to end of vertebral column) but occasionally reaching 8.7 inches (220 mm) and possibly 10 inches (254 mm). The body is stocky, with a large, slightly concave head, and short rounded fins. Larger fish may develop a pronounced hump behind the head. Both sexes exhibit similar size and outward appearance.

Tui chubs initiate spawning when water temperatures approach 64 °F (18 °C) and continue to some degree while water temperatures range from 63 to 79 °F (17–26 °C). Spawning occurs through the spring (with some indication of fall spawning) and involves groups of chubs releasing eggs over vegetation to which the eggs become attached. The adhesive eggs are about 0.04 inches (1 mm) in diameter and hatch in 6 to 8 days at temperatures of 64 to 68 °F (18–20 °C). Hatchlings spend about 12 hours on the bottom and then swim to the surface. Young fish, or fry, then form small schools in shallow areas of their habitat.

Little is known about the feeding habits of the tui chub.

2.2.2.9 Shorthead Sculpin (*Cottus confusus*)

The shorthead sculpin is found in several seemingly disjunction areas in the Pacific Northwest (Wydoski and Whitney 1979, Page and Burr 1991). The distribution of shorthead sculpin in the Upper Snake province is uncertain because of the difficulty in distinguishing this species from the mottled sculpin.

Shorthead sculpins inhabit cold, fast riffles in streams with gravel and rubble (Brown 1971, Wydoski and Whitney 1979) but are sometimes in slower water (Peden and Hughes 1984). In some localities, this species is more abundant in headwaters of drainages than other sculpin species (Maughan and Saul 1979, Wydoski and Whitney 1979); elsewhere, the pattern is the opposite (Hughes and Peden 1984). Water temperatures in summer are somewhat cooler than for other sculpin species (45.5–60.8 °F [7.5–16 °C]) (Wydoski and Whitney 1979, Roberts 1988); mean summer temperature for occupied streams in northwestern Montana was 45 °F (7 °C) (Gangemi 1992).

2.2.2.10 Mottled Sculpin (*Cottus bairdi*)

The mottled sculpin is a bottom dweller, living between and beneath rocks in riffles of cool streams or, occasionally, in lakes. Spawning in this polygynous species occurs in spring when water temperatures are 5.6 to 16.7 °C (42–62 °F), with females mating preferentially with larger males that exhibit distinct territoriality (Savage 1963). Mating success depends to some extent on the size of the rock covering the nesting burrow (Downhower and Brown 1980). Eggs are laid in nests under rubble or among gravel or under objects and adhere to the undersurface of the nest cover. They hatch in 20 days at water temperatures of 55 to 59 °F (13–15 °C).

The mottled sculpin is a benthic feeder, feeding at night from underneath or between rocks, taking mostly chironomid larvae, as well as amphipods, other insects, invertebrates, and some plant material. It feeds on trout eggs rarely and may take young trout on occasion (Bailey 1952, Zarbock 1952). Prime feeding time is in late evening, extending into the night. The lateral line is used extensively for locating prey (Hoekstra and Janssen 1985). Sculpins are cannibalistic, and large males may eat small females; therefore, the female has to be a certain size during mate selection to avoid being devoured (Downhower *et al.* 1983).

2.2.2.11 Torrent Sculpin (*Cottus rhotheus*)

Life history information for the torrent sculpin is limited, as it is for most sculpin species. Little information exists on home range size and dispersal. Pre-spawning upstream movements (January–March) and post-spawning downstream movements (April–June) have been reported in Washington (Thomas 1973); distances of

these movements were not determined and may be relatively small.

Sexual maturity is reached at 2 years of age (Northcote 1954, Brown 1971, Wydoski and Whitney 1979), at about 5.5 cm standard length. Adults can live at least six years and reach 15.2 cm (Wydoski and Whitney 1979). Torrent sculpins ($n = 119$) collected from Libby Creek, Montana, in October fell into two size groupings of five total age classes (Gangemi 1992): group 1 = 3.5 to 5.1 cm and group 2 = 7.1 to 10.8 cm. The larger individuals were probably 5 years old (Wydoski and Whitney 1979).

Spawning occurs in April and May, according to Northcote (1954) and Wydoski and Whitney (1979), but Thomas (1973) noted egg-laying only in April during four years. Eggs are laid on the undersides of rocks. Fecundity is positively related to female size and varies among localities (Wydoski and Whitney 1979). First fry are found in August (Northcote 1954, Brown 1971).

Torrent sculpins eat a large variety of prey; larger organisms can be consumed because torrent sculpins have large mouths (Scott and Crossman 1973, Wydoski and Whitney 1979, Lee *et al.* 1980). Five insect orders, fingernail clams, crustaceans, and two fish species were in the diet in British Columbia (Northcote 1954). Several species of salmonids and other game fishes feed on this sculpin (Brown 1971, Wydoski and Whitney 1979). At least three species of parasites have been reported in torrent sculpins (Hoffman 1967).

2.2.2.12 Western Pearlshell (*Margaritifera falcata*)

The western pearlshell is a freshwater bivalve mussel and a member of the Unionoida, an order of bivalve molluscs. Unrelated to true clams or mussels, the western pearlshell appears to be derived from the marine

trigonioideans, a once diverse fossil group that is represented today by only a few species. These species belong to two families. The Margaritiferidae are few in number and limited in distribution, with only five taxa in North America. The other family, the Unionidae, has perhaps 300 species.

The western pearlshell is a filter feeder and essentially an immobile animal, except during its larval stage. It acquires oxygen and food across its extensive gill surface and releases metabolic waste into the surrounding water. Because North American species lack true siphons, or tubes for water intake and release, most species are confined to burrowing only as deep as the posterior edge of the shell, rendering them susceptible to predators, desiccation, and temperature extremes. Nevertheless, many species live 20 to 30 years, some up to 140 years (Bauer 1987). The *Margeterifera* larvae, called glochidia, are parasitic and depend on the blood of a host to meet oxygen and nutrient needs. The glochidia attach themselves to the gills of a host fish. The fate of the glochidia host also limits and determines the distribution of the species. Host fish for the *Margeterifera* glochidia include Chinook salmon, rainbow trout, brown trout, brook trout, speckled dace, Lahontan redbreast, and Tahoe sucker (Clark 1981).

Natural predators of metamorphosed mussels consist of fishes, birds, muskrats, and raccoons. Muskrats ate up to 37,000 mussels in a year in an Alberta lake (Hanson *et al.* 1989, Convey *et al.* 1989). Other important predators are sturgeon.

Historically, the western pearlshell ranged from southern Alaska to central California and eastward to western Montana, western Wyoming, and northern Utah (Taylor 1981). Currently, the status of the interior populations needs further investigation (Frest and Johannes 1995). The species is extinct in

the Okanogan River, and populations persist locally in parts of the Coeur d'Alene system, including the Coeur d'Alene River and St. Maries River.

As filter feeders on microscopic food items, freshwater mussels are very susceptible to smothering by silt and other sediments in the water (Ellis 1936) and to harm from pollutants carried by these sediments. Siltation may also result in reduced dissolved oxygen and increased organic material (Ellis 1936, Harman 1974). At sublethal levels, silt interferes with feeding and metabolism in general (Aldridge *et al.* 1987). Susceptibility to silt differs from species to species (Marking and Bills 1980). Although effects of pesticides vary from species to species, sublethal levels of polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), Malathion, Rotenone, and other toxic compounds generally inhibit respiratory efficiency and accumulate in the tissues (Jacobson *et al.* 1993). Mussels are more sensitive to pesticides than many other animals tested. They may act as first alerts to pollutants long before effects are seen in other organisms. More research is needed to determine lethal and sublethal levels.

2.2.2.13 California Floater (*Pisidium ultramontanum*)

A large freshwater mussel in the family Unionidae, the California floater was used as a food source by Native Americans. This species is most commonly found in large streams and lakes, only in relatively slow current. The snail is also found in coldwater springs or reservoirs in relatively stable, oxygenated mud-to-fines gravel beds. The California floater is a low-elevation species.

Very little is known regarding the floater's life history. It is a filter feeder, like all unionaceans. The host fishes for the glochidial stage of this bivalve are unknown.

Historically, the California floater occurred in the lower Willamette and Columbia rivers. The species also occurred in larger, slow streams of northern California to as far south as the northern San Joaquin Valley. The species range also included the Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat coasts in Washington; Clatsop, Columbia, Multnomah, Hood River, and Wasco coasts in Oregon; and Siskiyou, Shasta, Lassen, Modoc and Tehama coasts in California.

Taylor (1981) reports that this species is probably eradicated over much of its original range. Frest and Johannes (1995) report that the species appears to be extinct or nearly extinct in Utah and Nevada and is very limited in distribution in Arizona. No living specimens were found between 1988 and 1990 in the Willamette and lower Columbia rivers. The species is extinct in the upper Sacramento River but still survives in the Fall River, Pit River, and Shasta coast in California. The Snake River populations are much circumscribed but may be the best populations extant (Frest 1992). In the Snake River, the species is often found immediately upstream or downstream of rapids.

2.2.3 Nonnative Species Descriptions

Rainbow trout are native to Idaho in the Snake River downstream of Shoshone Falls. Naturally reproducing populations occur throughout the Upper Snake province as a result of introductions. Rainbow trout can pose a substantial risk to the long-term persistence of Yellowstone cutthroat trout through hybridization and introgression.

The brook trout is native to eastern North America. It was introduced in Idaho in the 1800s and has been introduced throughout the Upper Snake province. Brook trout can be locally abundant, but abundance varies significantly throughout the subbasin (Levin *et al.* 2002). Brook trout may displace native

salmonids, prey on juveniles, and hybridize with bull trout.

The brown trout is native to Europe and western Asia and was introduced into North America in 1883. It can be found in most waters in Canada, except for Prince Edward Island and Manitoba. Introductions or invasions of brown trout and brook trout have led to displacement of cutthroat trout throughout the western United States (Behnke 1992).

2.3 Terrestrial Resources

The distribution and abundance of fish and wildlife depend on the distribution and types of vegetation cover, as well as on other parameters including geomorphology and climate. Many wildlife species demonstrate close relationships with and, at times, dependence upon certain vegetation complexes. For example, the interaction between whitebark pine and the Clark's nutcracker (*Nucifraga columbiana*) results from coevolution and is mutualistic (Tomback 1982). Clark's nutcrackers have evolved a sublingual throat pouch in which to carry pine seeds to sites where they cache them (Bock *et al.* 1973). Seed dispersal by this nutcracker has resulted in ring tree cluster growths and altered the whitebark pine's genetic population structure in comparison to wind-dispersed pines (Furnier *et al.* 1987, Schuster and Mitton 1991, Carsey and Tomback 1994, Tomback and Schuster 1994). Ecological relationships like that of the whitebark pine and Clark's nutcracker—between vegetation cover and wildlife species—within habitats are sometimes complex and difficult to quantify or qualify but are important to consider when attempting to protect, restore, or recover species and habitats.

The terrestrial assessment team identified nine focal habitats for the Upper Snake province (Table 2-1). Using the criteria from Section 2.0, as a starting point the technical team initial discussions were based primarily upon a list of 24 habitat classifications derived from the IBIS database. Focal habitat discussions evolved over the course of four meetings as both upper and lower technical teams settled upon habitat classification questions that incorporated multiple species benefits as well as addressing high conservation priorities.

Appendix 2-3 includes detailed descriptions of all the focal habitats. Historical records of habitats in the Upper Snake province suggest that much of the province was shrub-steppe, with aspen forests dominating in the eastern watersheds (Figure 2-30). Current records of habitats suggest that aspen forests have declined and become fragmented from historic times and appear to have almost disappeared or been replaced with old, dry pine/fir forests (Figure 2-31). The shrub-steppe focal habitat still appears to occupy the greatest amount of area in the province, while the open water habitat occupies the least

(Table 2-21). Riparian/herbaceous wetlands, mountain brush, whitebark pine, and juniper/mountain mahogany habitats are scarce throughout the province, appearing only in fragmented allotments (Table 2-21 and Figure 2-31).

We estimated changes in the focal habitats from historical conditions in the Upper Snake province (Table 2-22). The data suggest that the areas for all focal habitats have declined, with the exception of shrub-steppe and mountain brush habitats. The mountain brush habitat appears to have increased in area in both the Upper Snake and Closed Basin subbasins (Table 2-22). Although riparian/herbaceous wetlands make up the most important focal habitat, the riparian/herbaceous wetland habitats have not been assessed in the GAP II dataset (Appendix 2-1). Therefore, it is impossible to quantify the percentage of change between historical and current conditions for this habitat. However, anecdotal information overwhelmingly suggests that riparian/herbaceous wetland habitats have declined from historical conditions.

Table 2-21. Percentage representation of the current terrestrial focal habitats, by major watershed, for the Upper Snake province (GAP II) (see Table 1-1 for watershed code definitions).

Snake Headwaters Subbasin	Percentage (%) of major hydrologic unit (watershed)				
	GHB	GVT	PAL	SAL	SHW
Riparian/herbaceous wetlands	3	2	2	1	5
Open water???		<1	2	<1	6
Shrub-steppe	12	6	14	8	6
Pine/fir forest	51	33	19	17	65
Juniper/mountain mahogany			<1		
Whitebark pine			<1	<1	3
Aspen	5	1	20	12	1
Mountain brush			<1	<1	
Other	29	15	12	14	67

Upper Snake Subbasin	Percentage (%) of major hydrologic unit (watershed)											
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL
Riparian/herbaceous wetlands	3	4	<1	1	3	2	2	3	8	<1	1	11
Open water	2	2	<1	<1	<1	<1	<1	<1	2	<1	3	<1
Shrub-steppe	44	88	112	22	11	71	74	4	14	5	178	35
Pine/fir forest	1	7	3	<1	26	7	3	22	51	<1	3	2
Juniper/mountain mahogany	<1	<1	12	<1	<1	1	14	<1	<1	<1	3	<1
Whitebark pine		<1			1			<1	<1		<1	<1
Aspen	1	15	2	1	9	8	4	17	16	<1	2	24
Mountain brush	<1	2	<1	4	15	2	<1	<1	<1	<1	<1	<1
Other	47	24	44	72	34	27	72	52	22	22	192	25

Closed Basin Subbasin	Percentage (%) of major hydrologic unit (watershed)				
	BCM	BCK	BLR	LLR	MDL
Riparian/herbaceous wetlands	2	<1	3	1	<1
Open water	<1	<1	<1	<1	<1
Shrub-steppe	53	64	59	53	54
Pine/fir forest	13	10	10	13	8
Juniper/mountain mahogany	<1	<1	<1	<1	<1
Whitebark pine	<1	8	8	9	3
Aspen	4	<1	<1	<1	<1
Mountain brush	4	2	1	3	1
Other	24	15	19	21	33

Table 2-22. Percentage changes in area (km²) from historical to current for the focal habitats in the three subbasins of the Upper Snake province using ICBMP Historic and GAP II vegetation classifications (see Table 1-1 for watershed code definitions). (See Appendix 2-1 for data limitations. For instance, there is no reliable information on the current distribution of riparian/herbaceous wetland area in the Upper Snake province.)

Snake Headwaters Subbasin	Percentage (%) of major hydrologic unit (watershed)				
	GHB	GVT	PAL	SAL	SHW
Riparian/herbaceous wetlands	?	?	?	?	?
Open water			2,168		-15
Shrub-steppe	2,603	3,087	1,929	2,359	1,143
Pine/fir forest	142	58	-35	-31	68
Juniper/mountain mahogany	-100				
Whitebark pine	-100	-100	-81	-100	-91
Aspen	-92	-94	-38	-48	-98
Mountain brush			589		
Other	1,164	939	66	930	514

Upper Snake Subbasin	Percentage (%) of major hydrologic unit (watershed)											
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL
Riparian/herbaceous wetlands	?	?	?	?	?	?	?	?	?	?	?	?
Open water		519							275			
Shrub-steppe	-52	-3	-27	-76	-74%	-13	-45	-89	602	-81	-51	41
Pine/fir forest	75	16	341	-92	143	-3	5	123	67		407	-83
Juniper/mountain mahogany	-46	-72	14	-62	-97	-14	-37		-99	-7%	-66	-14
Whitebark pine		-91			-91	-100		-99	-99			
Aspen	-66	-63	-58	-76	-63	-69	-29	-31	-64		-67	-41
Mountain brush	165	-44	-14	1,208	9,218	119	-65	-95	0	369	-55	552
Other	21,487	3,060	1,354	4,667	567	4,606	2,098	7,517	107	23,865	11,930	136

Closed Basin Subbasin	Percentage (%) of major hydrologic unit (watershed)				
	BCM	BCK	BLR	LLR	MDL
Riparian/herbaceous wetlands	?	?	?	?	?
Open water					835
Shrub-steppe	2	-6	-5	-18	39
Pine/fir forest	43	-11	-50	-2	-53
Juniper/mountain mahogany	-100	706	-97	-87	-100

Closed Basin Subbasin	Percentage (%) of major hydrologic unit (watershed)				
	BCM	BCK	BLR	LLR	MDL
Whitebark pine	-98	12	-5	74	-65
Aspen	-50	-83	-26	-69	-98
Mountain brush		5,530	6,569	3,771	379
Other	67%	107	180	110	252

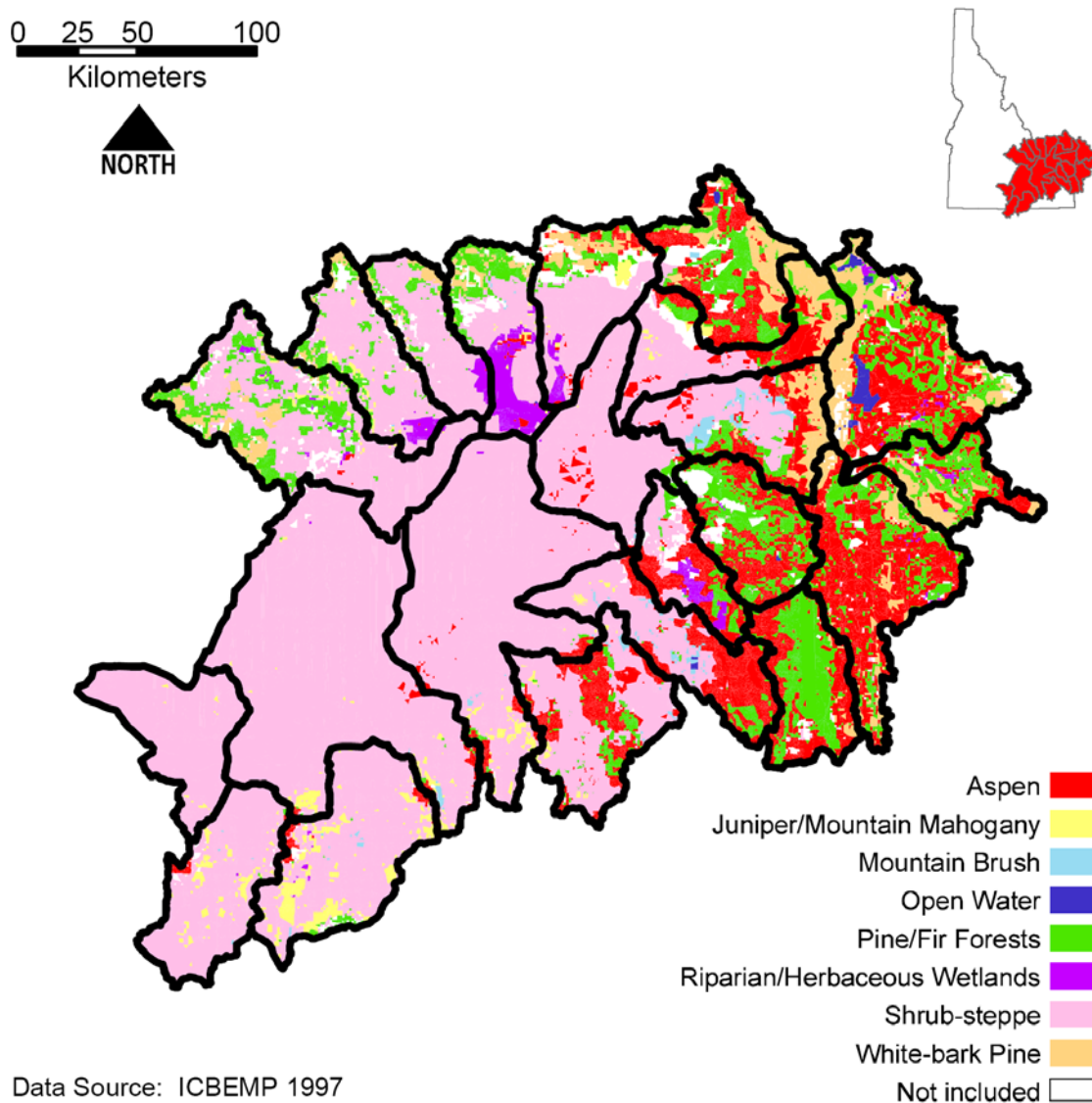


Figure 2-30. Historical occurrences of the focal habitats in the Upper Snake province.

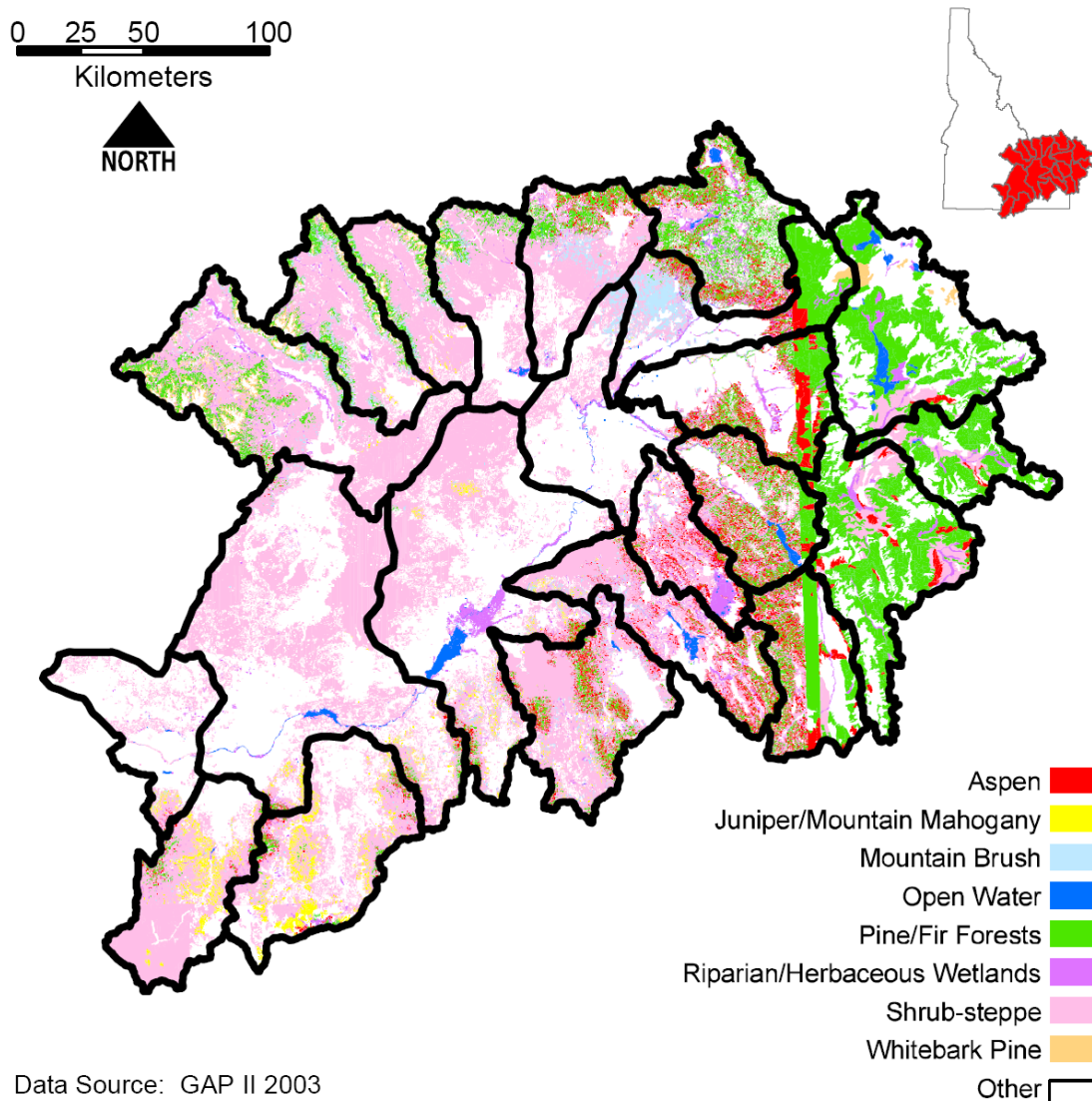


Figure 2-31. Current occurrences of the focal habitats in the Upper Snake province.

2.3.1 Riparian/Herbaceous Wetlands

By virtue of its high productivity, diversity, continuity, and critical contributions to both aquatic and upland ecosystems, riparian/herbaceous wetland habitat provides a rich and vital resource to the fish and wildlife resources in the Upper Snake province (Figure 2-32). Riparian areas contain

elements of both aquatic and terrestrial ecosystems that mutually influence each other and occur as transitions between aquatic and upland habitats (WDFW 2003). Riparian habitat forms natural corridors that are important travel routes between foraging areas, breeding areas, and seasonal ranges, and that provide protected dispersal routes for young (WDFW 2003).

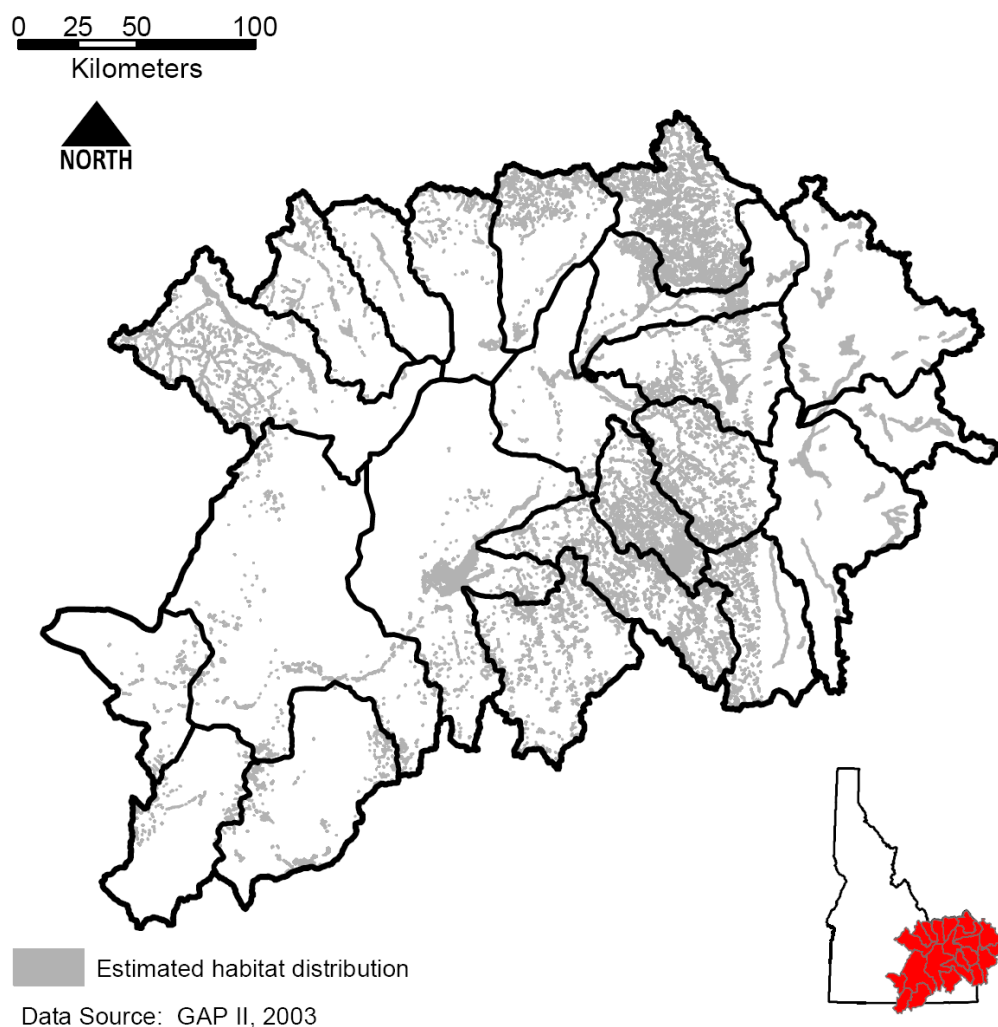


Figure 2-32. Estimated distribution of riparian/herbaceous wetlands in the Upper Snake province.

Riparian habitat is limited geographically, however, and is vulnerable to loss and degradation through human activities and land uses. Since the arrival of settlers in the early 1800s, from 50 to 90% of riparian habitat in Idaho has been lost or extensively modified (Saab and Groves 1992). Protecting riparian habitat may yield the greatest gains for fish and wildlife across the landscape while involving the least amount of area (WDFW 2003). Forested riparian habitat has an abundance of snags that are critical to cavity-nesting birds and mammals and to many insectivorous birds. Downed logs are

common and provide cover and resting habitat for amphibians, reptiles, and small mammals. Intact riparian habitat has well-developed vegetation, usually with multiple canopy layers. Each layer consists of unique habitat niches that together support a diversity of bird and mammal species (WDFW 2003).

Wetlands are one of the more valuable habitats to humankind. The value of nonwildlife functions in wetlands may exceed the value of the wildlife functions. Fifty-six percent of the wetlands in Idaho have been lost in the past 200 years (Dahl 1990).

Wetlands are among the most important habitats for birds, supporting a large number of bird species and individuals, including many high-priority species (IDPIF 2000).

2.3.1.1 Focal Species

The western toad, yellow-billed cuckoo (*Coccyzus americanus*), and American beaver are focal species for the riparian/herbaceous wetland habitats (Table 2-23).

Cottonwood/willow riparian forest is a dynamic community; dependent upon periodic flooding to provide substrate and nutrients and to cycle the community back to earlier successional stages.

The western toad is an indicator of the health of the riparian/herbaceous wetland habitats, primarily because it feeds in water on decomposing benthic substrate and aids in physical transfer of substances for nutrient cycling. The toad functions in both the aquatic and terrestrial environments (Figure 2-10) but requires water for breeding (Verner and Boss 1980). Interestingly, all breeding members of a local population tend to lay

their eggs in the same location, which is used repeatedly from year to year.

The yellow-billed cuckoo is a migratory bird that has evolved to increase its reproductive success by laying eggs in other (host) species' nests. The yellow-billed cuckoo also acts as an indicator species for riparian habitat quality because it eats insects in the riparian vegetation (Table 2-23).

Beaver activity can be beneficial to some wildlife species and also improve fish habitat (Gard 1961, Johnson 1989, Van Deelen 1991). Waterfowl often benefit from the increased edge, diversity, and invertebrate communities created by beaver activity (Van Deelen 1991). Occupied beaver-influenced sites produce more waterfowl because of improved water stability and increased brood-rearing cover. Also, beaver ponds provide habitat for invertebrate populations, which are prey for amphibians, birds, and fish.

Table 2-23. Status and life history information for vertebrate focal species selected for riparian/herbaceous wetland habitats in the Upper Snake province. See Appendix H for detailed life history and biological information for each of the focal species.

Focal Species	Western Toad	Yellow-billed Cuckoo	American Beaver
Conservation Status	Protected nongame species in Idaho	Protected nongame species in Idaho	State game species in Idaho
Population Status	Not rare and apparently secure, but with cause for long-term concern. Fairly common winter resident in Idaho.	Critically imperiled because of extreme rarity or because some factor of its biology makes it especially vulnerable to extinction	Demonstrably widespread, abundant, and secure
Age at First Reproduction	Males 3 years; females probably 4 or 5 years	Little information available; most likely both sexes breed at about 1 year (first spring following birth).	Between 2 and 3 years of age

Focal Species	Western Toad	Yellow-billed Cuckoo	American Beaver
Frequency of Reproduction	Iteroparous; eggs are laid in open water from February to July, with peak activity occurring in April. Males breed every year; females breed at less regular intervals.	Iteroparous; eggs laid once a year	Iteroparous; only the colony's dominant female breeds, producing one litter a year.
Number of Offspring/ Fecundity	Eggs are laid in gelatinous strings of 13 to 52 eggs per inch, in masses of up to 16,500 per clutch. Metamorphosis is usually completed within 30–45 days.	Females lay 1–5 eggs, with 2–3 eggs being usual.	Average litter size varies from 2–3 kits.
Life span/ Longevity	Maximum age of at least 9 years; females of at least 10–11 years have been reported.	At least 4 years; very little information available	Up to 11 years in the wild and 15–21 years in captivity
Predators	Preyed upon by fish, amphibians, reptiles, birds, and mammals. Mortality is greatest during the larval and juvenile stages but is slight thereafter.	Eggs and nestlings are taken by avian predators, mammals, and snakes. Raptors are an important cause of mortality in adults, especially during migration or upon arrival to wintering grounds following migration.	Few natural predators; however, in certain areas, beavers may face predation pressure from wolves, coyotes, lynx, fishers, wolverines, and occasionally bears. Minks, otters, hawks, and owls periodically prey on kits. Humans kill beaver for fur.
Diet	Bees, beetles, ants, and arachnids. Other foods include crayfish, sowbugs, grasshoppers, trichopterans, lepidopterans, and dipterans.	Primarily large insects like caterpillars, katydids, cicadas, grasshoppers, and crickets	Appears to prefer herbaceous vegetation to woody vegetation during all seasons if it is available
Trophic Relationships	Heterotrophic consumer, primary consumer, aquatic herbivore, secondary consumer (consumer or predator of herbivorous vertebrates); feeds in water on decomposing benthic substrate; eats terrestrial invertebrates and aquatic macroinvertebrates	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore), prey for secondary or tertiary consumer (primary or secondary predator); eats terrestrial invertebrates	Heterotrophic consumer, primary consumer (aquatic herbivore and folivore [leaf eater]), bark/cambium/bole feeder, browser (leaf, stem eater)

2.3.2 Open Water

Open water habitat in the Upper Snake province (Figure 2-33), also known as lacustrine habitat, is characterized by 1) high diversity of fish and wildlife species, 2) important fish and wildlife breeding habitat, 3) important fish and wildlife seasonal ranges, 4) important fish and wildlife movement corridors, 5) high vulnerability to habitat alteration, and 6) unique or dependent species. Lacustrine wetlands are associated with lakes and large ponds. The margins or fringes of lakes and large ponds support wetlands that are maintained by lake levels. The open lake includes both the inshore and offshore waters of the lakes and reservoirs. The inshore waters begin at the offshore edge of the coastal wetlands and extend lakeward to the point where vertical thermal stratification can be measured in summer (Dodge and Kavetsky 1995). Fish are the dominant fauna of the open lake. During the summer, coldwater fishes including trout and whitefish occupy the deeper, colder offshore waters, while coolwater and warmwater fishes inhabit the shallower, warmer, inshore waters (IDPIF 2000). In areas without human disturbance, large numbers of waterfowl may use open water sites for molting. Open water sites often support large waterfowl concentrations during spring and fall staging and migration. Drawdowns in mid and late summer, a period of high irrigation demand, expose mudflats that provide feeding sites for migrating shorebirds (IDPIF 2000).

Lacustrine open water wetlands are used for irrigation storage, fishing, and water sports.

In Idaho, all of the larger lakes and many of the smaller ones have dams that maintain lake levels. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation. Altered hydrological regimes often reduce wetland habitat or convert it to a different type. Fluctuating levels in response to power or irrigation demands on some reservoirs have created steep eroding banks on islands and lake shores with little emergent habitat (IDPIF 2000). American Falls Reservoir, located in the Upper Snake subbasin, is the second largest reservoir in the state and provides shallow feeding areas for waterfowl and mudflats for migrating shorebirds. This site also contains some excellent bottomland cottonwood forests, mostly on the Fort Hall Indian Reservation. The avifauna in the area is among the most diverse in Idaho. American Falls Reservoir supports a population of breeding and wintering trumpeter swans, a wintering population of bald eagles, and a significant breeding population of colonial waterbirds. The reservoir also supports thousands of ducks, geese, and shorebirds during the spring and fall migrations and is a fall staging area for migrating sandhill cranes. Perhaps the most significant conservation issue for American Falls Reservoir is the occasional outbreak of avian botulism resulting from the annual irrigation drawdown.

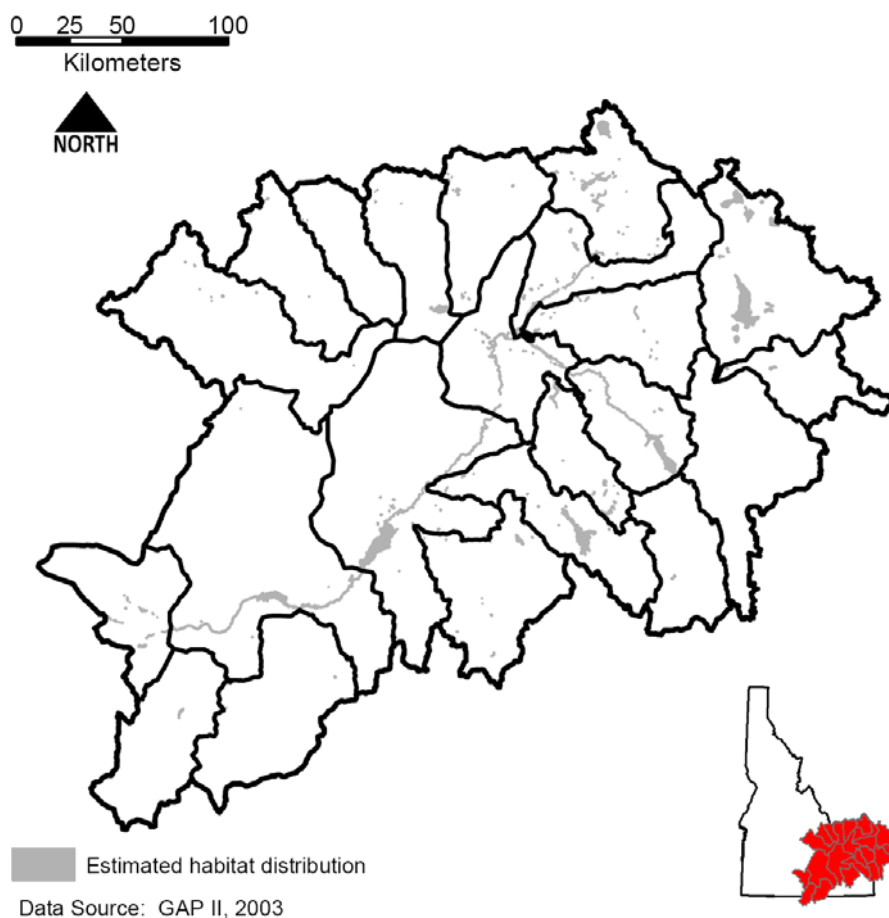


Figure 2-33. Estimated distribution of open water habitats in the Upper Snake province.

2.3.2.1 Focal Species

The focal species for open water habitats in the Upper Snake province include the western grebe, American white pelican, trumpeter swan, American avocet (*Recurvirostra americana*), and common loon (Table 2-24). Open water habitats that support populations of grebes, loons, or white pelicans most likely have high water quality and support healthy fish populations because all three of these focal species consume a lot of fish. The also eating fish, the avocet eats primarily aquatic invertebrates. The avocet feeds by thrusting its bill underwater and swinging it from side to side along the bottom to stir up aquatic insects (Hamilton 1975). Because the avocet eats mostly aquatic invertebrates, this species

is also an indicator of open water habitat quality.

The trumpeter swan is categorized as a species of special concern in Idaho and Montana and as a priority 1 species in Wyoming. Trumpeter swans eat the roots, stems, leaves, and/or seeds of a variety of aquatic vegetation, and they occasionally eat insects. Trumpeter swans are also sensitive to human activities on their breeding grounds. Intrusions by humans at nesting wetlands have caused temporary and permanent nest abandonment, as well as movements from breeding and staging areas.

Table 2-24. Status and life history information for vertebrate focal species selected for open water habitat in the Upper Snake province. See Appendix H for detailed life history and biological information for each of the focal species.

Focal Species	Western Grebe	American White Pelican	Trumpeter Swan	American Avocet	Common Loon
Conservation Status	Protected nongame species in Idaho	Protected nongame species in Idaho	Species of special concern in Idaho	Protected nongame species in Idaho	Protected nongame species in Idaho
Population Status	Not rare and apparently secure, but with cause for long-term concern	Critically imperiled because of extreme rarity	Critically imperiled because of extreme rarity	Demonstrably widespread, abundant, and secure in Idaho	Critically imperiled because of extreme rarity in Idaho
Age at First Reproduction	Probably breeds in first year	3 years	Forms pair bonds when 2 or 3 years old and first nests when 4 or 5 years old	Usually breeds at 2 years old, but some individuals breed in first year	No data, but thought to be no earlier than 4 years; may be as late as 7 years
Frequency of Reproduction	Iteroparous; one clutch per season is normal, but replacement clutches are common.	Iteroparous; one clutch per season	Iteroparous; eggs laid once a year	Iteroparous; eggs laid once a year	Iteroparous; eggs laid once a year. Clutches are replaced if eggs are lost.
Number of Offspring/Fecundity	Mean clutch size is 2–3 chicks.	One offspring per clutch is the norm, even if 2 chicks hatch.	Female lays 5–6 eggs.	Female lays 2–4 eggs, usually 4.	Clutch size is generally 2 eggs, rarely 3.
Life span/Longevity	Up to 14 years, but most banded birds have been recovered at minimum ages of 6–7 years.	Maximum reported life span is 26 years.	Up to 35 years in captivity but usually not more than 12 years in the wild	At least 9 years, but probably much longer	No data, but survival is assumed to be similar to that of the Artic loon (25–30 years). At least 9 years.
Predators	Bald eagles and mink; raccoons will take nesting adults and eggs. Eggs are consumed by common ravens and pecked or eaten by coots and Forster's terns, especially after human disturbance. Chicks are also vulnerable to predation by bass and pike.	Adults are rarely preyed upon. Eggs and young rarely taken at undisturbed colonies, unless low water makes them accessible to coyotes. Scavenging gulls are the main predator at disturbed colonies.	Except for humans, few natural enemies after flying age is reached. Young are susceptible to predation from birds of prey and mammals.	Predators of adults include the peregrine falcon, prairie falcon, great horned owl, and northern harrier. Falcons, harriers, and mink are known to prey on young. Predators of eggs are gulls, ravens, badgers, striped skunks, long-tailed weasels, coyotes, raccoons, red fox, and gopher snakes.	Very few predators of adults. Nest predators include American crows, ravens, gulls, striped skunks, raccoons, minks and weasels. Young chicks are taken by northern pike, muskellunge, snapping turtles, bald eagles, and gulls.

Focal Species	Western Grebe	American White Pelican	Trumpeter Swan	American Avocet	Common Loon
Diet	Fish are the main food items, reportedly composing 81–100% of the diet.	Small schooling fish; also larger sluggish bottom feeders, salamanders, and crayfish	Roots, stems, leaves, and/or seeds of a variety of aquatic vegetation; occasionally insects	Primarily aquatic invertebrates; also terrestrial invertebrates, small fish, and seeds	Live fish, other aquatic vertebrates, some invertebrates, and occasionally vegetation
Trophic Relationships	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore); piscivorous (fish eater); eats terrestrial invertebrates and aquatic macroinvertebrates	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore), vertebrate eater (consumer or predator of herbivorous vertebrates); piscivorous (fish eater)	Heterotrophic consumer; primary consumer (herbivore), foliovore (leaf-eater), aquatic herbivore, spermivore (seed-eater), grazer (grass, forb eater), secondary consumer (primary predator or primary carnivore); eats terrestrial invertebrates and aquatic macroinvertebrates	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore), vertebrate eater (consumer or predator of herbivorous vertebrates); eats terrestrial invertebrates and aquatic macroinvertebrates	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore), vertebrate eater (consumer or predator of herbivorous vertebrates); eats aquatic macroinvertebrates; piscivorous (fish eater)

2.3.3 Shrub-steppe

Shrub-steppe habitat is found throughout the Upper Snake province (Figure 2-34).

Shrubland birds show the most consistent population declines over the last 30 years of any group of bird species (Paige and Ritter 1999). Researchers suggest that shrub-steppe habitat be given the highest conservation priority based on trends in bird populations (Saab and Rich 1997). Still, comparatively high wildlife density and species diversity characterize shrub-steppe habitat.

Approximately 100 bird and 70 mammal species can be found in sagebrush habitats. Some of these species are sagebrush obligates or near obligates. Sagebrush and the native

perennial grasses and forbs of the shrub-steppe are important sources of food and cover for wildlife. Native perennial bunchgrasses serve a keystone role in maintaining vegetative and watershed stability and resilience to disturbance events and environmental change. Loss of the abundance and vigor of bunchgrasses triggers the unraveling decay of watershed integrity and the capability of these sites to produce wildlife habitat and commercial resource values (Rust *et al.* 2000). This habitat provides important wildlife breeding habitat and seasonal ranges.

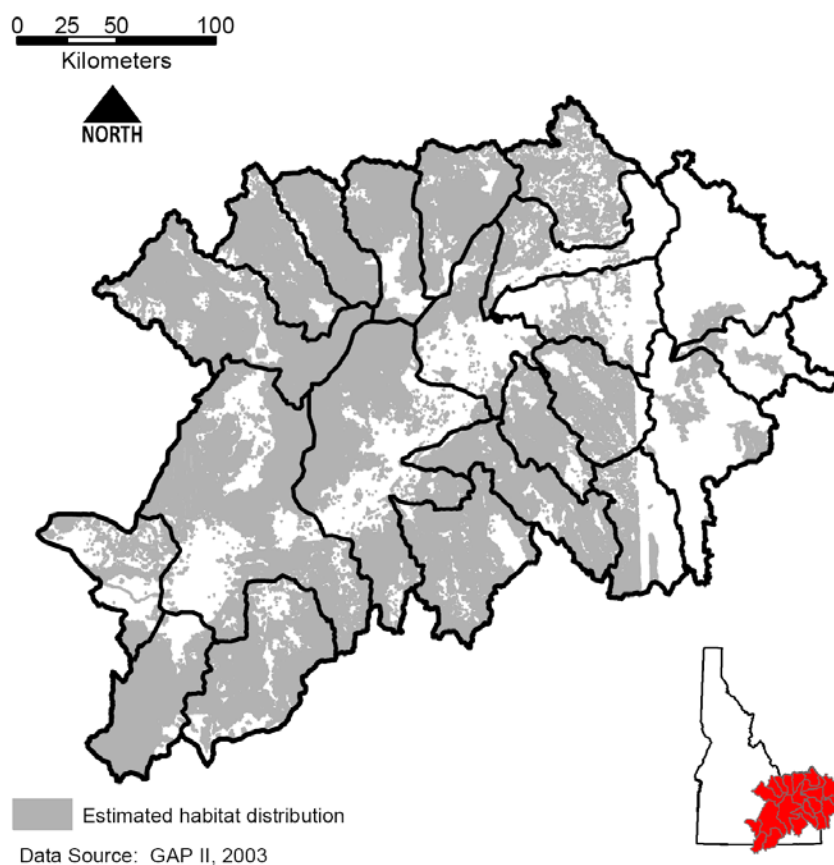


Figure 2-34. Estimated current distribution of shrub-steppe habitat in the Upper Snake province.

2.3.3.1 Focal Species

Sagebrush species, plus the northern sagebrush lizard (*Sceloporus graciosus graciosus*), greater sage grouse (*Centrocercus urophasianus*), and sage sparrow (*Amphispiza belli*) are focal species for the shrub-steppe habitat in the Upper Snake province (Table 2-25).

Different species of sagebrush provide food, cover, and nesting substrate, especially for sage-steppe obligates such as the greater sage-grouse during winter months. The sagebrush sometimes protects other native forbs and grasses from overgrazing and acts to stabilize soil. Sagebrush species also tend to be drought tolerant and cycle nitrogen. Three sagebrush species are highlighted in the shrub-steppe habitat: Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), mountain big sagebrush (*Artemisia tridentata* var. *vaseyana*), and black sagebrush (*Artemisia nova*).

Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) is a native shrub (Balliet *et al.* 1986, Dorn 1988, Hickman 1993, Cronquist *et al.* 1994) and is the most drought tolerant of the three major big sagebrush subspecies (Meyer and Monsen 1993). Wyoming big sagebrush is also a long-lived species; maximum life span may exceed 150 years (Ferguson 1964). This sagebrush is preferred browse for wild ungulates (Peek *et al.* 1979, Welch and McArthur 1986, Shaw and Monsen 1990, Bray *et al.* 1991), and Wyoming big sagebrush communities are important winter ranges for big game (McArthur *et al.* 1977, Tweit and Houston 1980, Hironaka *et al.* 1983, Mueggler and Stewart 1981).

Pronghorn usually browse Wyoming big sagebrush heavily (Allen *et al.* 1984). On the Idaho National Engineering and Environmental Laboratory, for example, the

shrub comprised 90% of the diet of pronghorn from fall through spring. Lagomorphs may browse Wyoming big sagebrush heavily in winter (Gates and Eng 1984). Wyoming big sagebrush is a crucial food item for the greater sage grouse and part of the bird's critical habitat (Tweit and Houston 1980, Clifton 1981, Autenrieth *et al.* 1982, Welch *et al.* 1991, Fischer *et al.* 1993, Fischer *et al.* 1996). Fire is the principal means of renewal for decadent stands of Wyoming big sagebrush (Blank *et al.* 1994).

Mountain big sagebrush (*Artemisia tridentata* var. *vaseyana*) is also a long-lived (50+ years), native shrub (Beetle and Johnson 1982, Blank *et al.* 1994). Mountain big sagebrush is readily killed by fire and requires at least 15 years to recover after fire (Bunting *et al.* 1987). There has been extensive documentation that many wild animals rely on the big sagebrush ecosystem for both food and cover (McGee 1979, Nagy 1979, Peek *et al.* 1979, Blaisdell *et al.* 1982, Hironaka *et al.* 1983, Noste and Bushey 1987, Shaw and Monsen 1990, Wambolt *et al.* 1994, Welch *et al.* 1996). Wildlife researchers have argued that neither the importance of sagebrush as forage nor the effects of foraging on sagebrush are fully appreciated (Wambolt 1995, 1996; Welch and Wagstaff 1992).

A native evergreen shrub, black sagebrush (*Artemisia nova*) is small, spreading, and aromatic. Black sagebrush is a significant browse species within the Intermountain region (McMurray 1986) and provides highly nutritious winter forage. Although black sagebrush is not as productive as many other forage species, its winter nutritive quality is second only to big sagebrush (Cook and Stoddart 1953, Behan and Welch 1986).

Table 2-25. Status and life history information for vertebrate focal species selected for shrub-steppe habitat in the Upper Snake province. See Appendix H for detailed life history and biological information for each of the focal species.

Focal Species	Northern Sagebrush Lizard	Greater Sage-Grouse	Sage Sparrow
Conservation Status	Protected nongame species in Idaho	Game species in Idaho	Protected nongame species in Idaho
Population Status	Demonstrably widespread, abundant, and secure	Not rare and apparently secure, but with cause for long-term concern	Not rare and apparently secure, but with cause for long-term concern
Age at First Reproduction	?	Females are sexually mature their first fall and nest the following spring; males are sexually mature the spring following their first winter.	Both sexes breed in their first year.
Frequency of Reproduction	Iteroparous; adult females produce 2 clutches annually.	Iteroparous; hens attempt to raise one brood in a season.	Iteroparous; annual breeders. Produce 2–3 clutches per year.
Number of Offspring/Fecundity	A single clutch of 1–8 eggs	Hens incubate 7–15 eggs for about 25–27 days. After hatching, chicks wait until they are dry before leaving the nest.	Females lay 1–4 eggs, usually 3.
Life span/Longevity	?	Thought to be up to 10 years in the wild, but in one study, average in both hunted and protected populations was 1–1.5 years; in another study, 3–4 years was considered old.	3 years for males, 2 years for females; banded birds known to live for 6 years
Predators	Include striped whipsnakes, night snakes, and a variety of predatory birds	Raptors and crows are the primary predators, while coyotes, bobcats, minks, badgers, and ground squirrels are the most important ground predators.	Townsend's ground squirrels, loggerhead strikes, and common ravens take eggs and young. Great horned owls are known to take adults.
Diet	Insects (e.g., beetles, flies, ants, caterpillars, etc.), spiders, ticks, mites, and aphids	Sagebrush, grasses, forbs, and insects comprise the annual diet.	Insects and seeds. Diet changes with the season: 44% animal and 56% seed and plant material in fall, 13% animal and 87% seed and plant material in winter.

Focal Species	Northern Sagebrush Lizard	Greater Sage-Grouse	Sage Sparrow
Trophic Relationships	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore); eats terrestrial invertebrates	Heterotrophic consumer, primary consumer (aquatic herbivore and foliovore), flower/bud/catkin feeder, frugivore (fruit-eater), secondary consumer (primary predator or primary carnivore of terrestrial invertebrates)	Heterotrophic consumer, primary consumer (herbivore), spermivore (seed-eater), secondary consumer (primary predator or primary carnivore); eats terrestrial invertebrates

2.3.4 Pine/Fir Forests (Dry, Mature)

The majority of the xeric, old forest habitat in the Upper Snake province is found in the uppermost and eastern portions of the province (Figure 2-35) and is significantly less in extent than it was before 1900 (Quigley and Arbelbide 1997). Quigley and Arbelbide (1997) included much of this habitat in their dry forest potential vegetation group, which they concluded has departed from natural succession and disturbance conditions. The greatest structural change in this habitat is the reduced extent of the late seral, single-layer condition (4–24% canopy cover and > 53 cm diameter at breast height [dbh]). Important components of this habitat are large downed material, snags, and decadence. This habitat is generally degraded because of increases in exotic plants and decreases in native bunchgrasses (IBIS 2003). One-third of the dry Douglas-fir or grand fir community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al.* 1998). Important components of mesic, old forest types are large snags and large trees for nesting habitat for habitat specialists. Large logs provide foraging and nesting habitat. Early seral forest that results from timber harvest is different from forest created by fire. Large overstory trees that remained after fire contributed a snag component that is missing under a logged regime.

2.3.4.1 Focal Species

The black-backed woodpecker, great gray owl, boreal owl, and northern goshawk (*Accipiter gentilis atricapillus*) were chosen as focal species for the pine/fir forest (xeric, old) habitat in the Upper Snake province (Table 2-26).

The black-backed woodpecker (*Picoides arcticus*) is dependent on fire landscapes and other large-scale forest disturbances (Hutto 1995, Caton 1996, Murphy and Lehnhausen 1998, Hoyt 2000). Fire suppression and post-fire salvage logging are detrimental to this species and have reduced its habitat. The woodpecker is designated as a species of special concern in Idaho.

The great gray owl's diet consists almost entirely of small rodents. About 90% of the diet is made up of pocket gophers (*Thomomys* spp.) and voles (*Microtus* spp.) (Franklin 1988). The primary foods of the boreal owl are small mammals, birds, and insects. Voles are this owl's preferred food and may make up as much as 75% of the diet (Palmer 1986, Hayward *et al.* 1993). The role of prey availability in both nomadic movement patterns and yearly variation in nesting success and productivity suggests that food supply may regulate owl abundance in some portions of its range (Hayward and Hayward 1993). In addition, researchers suggest that

timber harvest has potential impacts on populations (Bull and Duncan 1993).

The northern goshawk uses stands of old-growth forest as nesting sites (DuBois *et al.* 1987). The diet of the northern goshawk

changes with the season. In spring and summer, the bird takes mainly birds and a few small mammals. In winter, the diet consists of prey species that do not migrate or hibernate. The goshawk is also an important predator of the boreal owl.

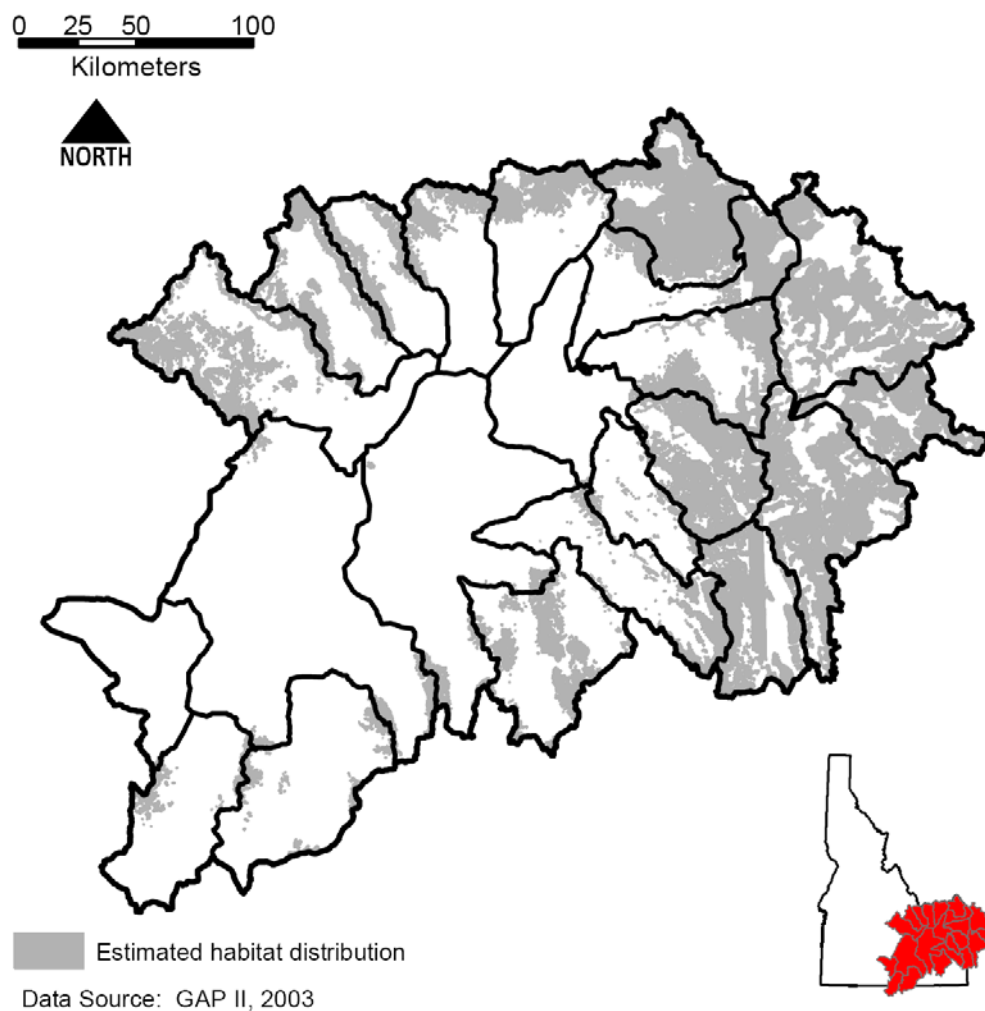


Figure 2-35. Estimated current distribution of pine/fir forests (dry, mature) habitat in the Upper Snake province.

Table 2-26. Status and life history information for vertebrate focal species selected for pine/fir forest habitat in the Upper Snake province. See Appendix H for detailed life history and biological information for each of the focal species.

Focal Species	Black-backed Woodpecker	Great Grey Owl	Boreal Owl	Northern Goshawk
Conservation Status	Protected nongame species in Idaho	Protected nongame species in Idaho	Protected nongame species in Idaho	Protected nongame species in Idaho
Population Status	Rare or uncommon but not imperiled in Idaho	Imperiled because of rarity in Idaho	Imperiled because of rarity in the Idaho	Not rare and apparently secure, but with cause for long-term concern
Age at First Reproduction	No data	Commonly at 3 years; some birds will occasionally breed at 2 years and rarely in the first year.	Both sexes can breed the year after hatching.	25% breed as yearlings; another 25%, their second year; and the remainder, their third year.
Frequency of Reproduction	Iteroparous; one clutch per season	Iteroparous; one clutch per season	Iteroparous; one clutch per season	Iteroparous; one clutch per season
Number of Offspring/Fecundity	6 eggs (usually 4) are laid	Clutch size is 3–5 eggs.	Clutch size ranges from 2–4 eggs, with 3 being more common.	Females lay 1–5 eggs; 3 is the usual number
Life span/Longevity	As long as 8 years	At least 13 years	Known to live for almost 16 years. Adult annual survival was 46%.	Maximum life span is at least 11 years.
Predators	Little information is available on the causes of mortality, but predation by raptors is presumed to be a cause.	Frequent predation on juvenile owls is by northern goshawks and great horned owls; red-tailed hawks are known to attack juveniles. Lynx and great horned owls may occasionally kill an adult. Other potential predators are black bears and fishers.	Marten are important predators of owlets and adult females at the nest site; another nest predator is the pine squirrel. Important predators of young and adults include the Cooper's hawk, northern goshawk, and great horned owl.	Predators are large avian species such as the bald eagle and golden eagle.

Focal Species	Black-backed Woodpecker	Great Grey Owl	Boreal Owl	Northern Goshawk
Diet	Includes 75% insects such as wood-boring beetles, grubs, weevils, ants, other beetles, and spiders. Berries and other small fruits, acorns, and nuts are also eaten.	Almost entirely small rodents. About 90% of the diet consists of pocket gophers and voles. Other small mammals include shrews, mice, squirrels, young rabbits, hares, rats, moles, and weasels. Small birds, ducks, and grouse are also taken. There's a report of a sharp-shinned hawk taken.	Primary foods are small mammals, birds, and insects. Voles are the preferred food, making up as much as 75% of the diet.	Diet changes with the season. Spring and summer—mainly birds, with a few small mammals. In the winter, their diet consists of prey species that do not migrate or hibernate.
Trophic Relationships	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore), vertebrate eater (consumer or predator of herbivorous vertebrates); eats terrestrial invertebrates	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore), vertebrate eater (consumer or predator of herbivorous vertebrates)	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore), vertebrate eater (consumer or predator of herbivorous vertebrates)	Heterotrophic consumer, secondary consumer (primary predator or primary carnivore), vertebrate eater (consumer or predator of herbivorous vertebrates)

2.3.5 Juniper/Mountain Mahogany

Juniper/mountain mahogany habitats are an integral component of wildlife seasonal ranges within the Upper Snake province (Figure 2-36). Curl-leaf mountain mahogany is an excellent food source for all classes of browsing animals in both summer and winter; it is one of the few browse species that meets or exceeds the protein requirements for

wintering big game animals. In mature mountain mahogany stands, much of curl-leaf mountain mahogany foliage is out of reach of browsing animals but provides excellent winter cover. Mountain mahogany has a limited distribution and is very vulnerable to habitat alteration. It occurs at high elevations on xeric, south-facing aspects on low-productivity sites. Habitat development occurs at geologic timescales.



Figure 2-36. Estimated current distribution of juniper/mountain mahogany habitats in the Upper Snake province.

One-third of the Pacific Northwest mountain mahogany community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al.* 1998). Western juniper, although less important than mountain mahogany as a food source, provides thermal

cover and access to important understory forage species under natural fire regimes. Lengthened fire intervals have allowed junipers to encroach into mountain sagebrush-grassland communities. As the juniper communities mature, the perennial herbaceous understory is lost due to

competition, reducing the wildlife value of the habitat. The biggest conservation concern with western juniper habitat is the continued maturation and expansion into shrub-steppe habitat and subsequent loss of habitat diversity across the landscape. Although juniper habitat covers significantly greater area than it did before 1900, the habitat is generally degraded because of increased amounts of exotic plants and decreased native bunchgrasses. One-third of Pacific Northwest juniper community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al.* 1998).

2.3.5.1 Focal Species

A native, xerophytic, evergreen shrub or small tree, curl-leaf mountain mahogany (*Cercocarpus ledifolius*) can be extremely long-lived. It is good forage for all classes of browsing animals in both summer and winter (Stanton 1974, Davis 1990).

Curl-leaf mountain mahogany is one of the few browse species that meets or exceeds the protein requirements for wintering big game animals (Davis 1990). In Idaho, it is very palatable to bighorn sheep and mountain goats (Dittberner and Olson 1983). In mature stands, much of curl-leaf mountain mahogany foliage is out of reach of browsing animals but provides excellent winter cover (Stanton 1974).

As a codominant member of the sagebrush-forest ecotone in Idaho, curl-leaf mountain mahogany is associated with snowberry (*Symphoricarpos* spp.), mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg bluegrass (*Poa secunda*), Idaho fescue (*Festuca idahoensis*), and Columbia needlegrass (*Achnatherum* spp.) (Scheldt and Tisdale 1970).

Curl-leaf mountain mahogany may be planted to help stabilize soil in disturbed areas such as roadcuts and mine spoils (Hungerford 1984). Because of its tolerance to heat and drought, curl-leaf mountain mahogany can be used for water-efficient landscaping in arid environments (Gutknecht 1989).

Fire usually kills curl-leaf mountain mahogany. Curl-leaf mountain mahogany seedlings establish after fire, although establishment may be slow and influenced by the amount of rainfall.

2.3.6 Whitebark Pine

Whitebark pine (*Pinus albicaulis*) habitats have fire-dependent ecological characteristics with several obligate or near obligate wildlife species. Most of the whitebark stands appear to occur in the Closed Basin and Snake Headwaters subbasins (Figure 2-37). Whitebark pine habitats provide important seasonal ranges and a high-value seed crop for wildlife. They are also a culturally significant source of food for Native Americans. Whitebark pine seeds are a preferred food of the threatened grizzly bear and many other mammals and birds. An assessment of the interior Columbia River basin found that the area of whitebark pine cover types has declined 45% since 1900 (Keane 1995b). Most of this loss occurred in the more productive, seral whitebark pine communities; 98% of these communities have been lost. Practically all the remaining whitebark pine stands are old. Whitebark pine is reported to be functionally extinct on the Mallard-Larkins Pioneer Area in the Idaho Panhandle National Forest (Zack 1995). Sixty years of fire suppression have advanced forest succession at the expense of seral whitebark pine communities. Successional replacement due to fire exclusion is a major cause of whitebark pine decline (Keane *et al.* 1994).

Whitebark pine cannot maintain its functional role in mountain ecosystems unless areas suitable for its regeneration are available across the landscape (Kendall 2003). An exotic fungus, white pine blister rust, has killed many whitebark pine trees in the moister parts of its range. White pine blister rust, which was introduced from Europe to western North America around 1910, has spread to most whitebark pine forests. Although white pine blister rust can damage all North American white pine species, whitebark pine is the most vulnerable. Rust infection rates in the Sawtooth National Recreation Area in central Idaho are generally light, but low elevations may harbor some heavily infected sites (Smith 1995). It is clear

that the blister rust epidemic in whitebark pine has not yet stabilized, even in regions with the longest history and highest infection levels of rust. The most likely prognosis for whitebark pines in sites already heavily infected with rust is that they will continue to die until most of the trees are gone (Kendall 2003). In the future, whitebark pine trees will be all but absent in most areas, and small, isolated populations will be lost until rust-resistant types evolve. Without intervention, such resistance is expected to require hundreds—if not thousands—of years because whitebark pine matures slowly and most of the population soon will be lost (Kendall 2003).

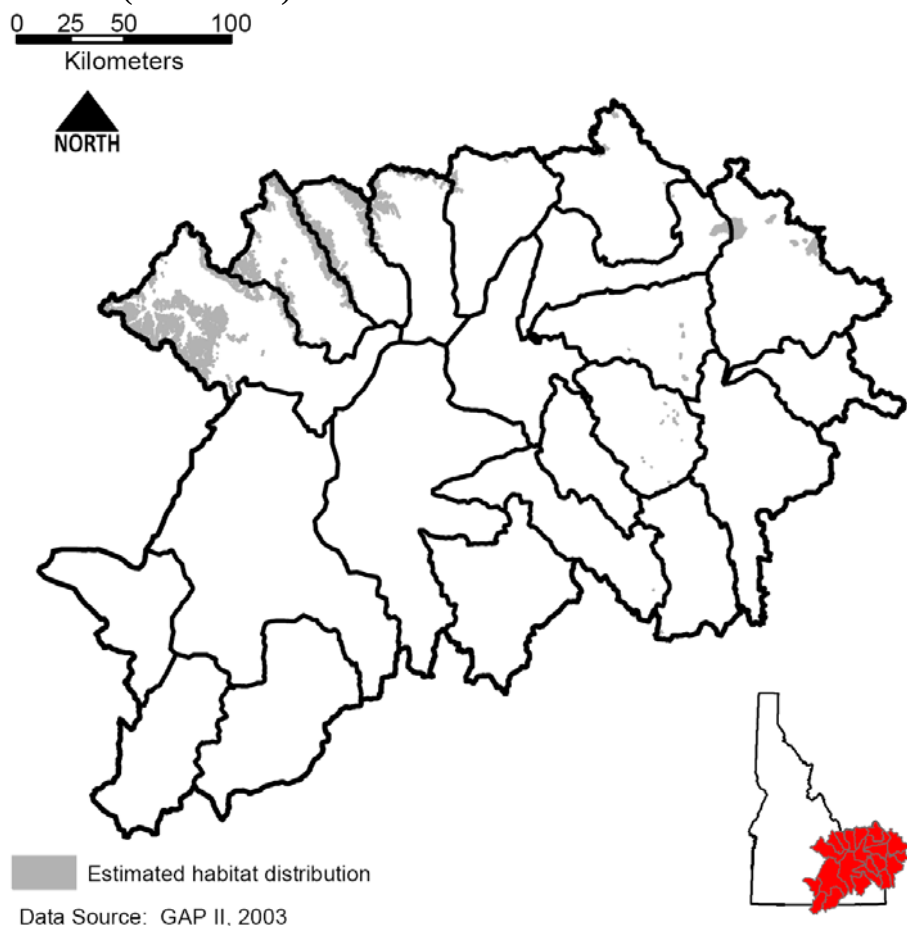


Figure 2-37. Estimated current distribution of whitebark habitat in the Upper Snake province.

2.3.6.1 Focal Species

The focal species for the whitebark pine habitat are whitebark pine (*Pinus albicaulis*) and the Clark's nutcracker (Table 2-27).

Whitebark pine is a slow-growing, long-lived, ectomycorrhizal, and native conifer characteristic of the tree line (Ahlenlager 1987). Trees often reach 400 to 700 years of age, and the minimum seed-bearing age of whitebark pine trees is between 20 and 30 years. Whitebark pine grows on dry, rocky sites on high mountains between 5,900 and 9,940 feet (1,800–3,030 m), and the dispersal of whitebark pine seeds by Clark's nutcrackers strongly affects the distribution and abundance of this species (Tomback 1977). Whitebark pine survives where tree

growth is limited and provides hiding and thermal cover for wildlife (Ahlenlager 1987). Cavity-nesting birds use tree trunks and snags. Mule deer, elk, and predatory animals also use whitebark habitat (Pfister *et al.* 1977, Tomback 1981).

Trees in well-developed stands are 49 to 66 feet (15–20 m) tall and 23 to 35 inches (60–90 cm) in diameter (Ahlenlager 1987). Growing at the uppermost limits of growth, trees are usually dwarfed or contorted. At the upper tree line, this species takes on a spreading growth form and grows in isolated cushions of "alpine scrub" between 1 and 3.3 feet (0.3–1 m) (Ahlenlager 1987).

Table 2-27. Status and life history information for vertebrate focal species selected for whitebark habitat in the Upper Snake province. See Appendix H for detailed life history and biological information for the focal species.

Focal Species	Clark's Nutcracker
Conservation Status	Protected nongame species
Population Status	Demonstrably widespread, abundant, and secure
Age at First Reproduction	First breeding in second winter/spring
Frequency of Reproduction	Iteroparous; annual breeder unless cone crop of major seed sources failed the previous fall; one clutch per season.
Number of Offspring/Fecundity	Range is 2–6 young (average is 2–3 young).
Life span/Longevity	Known to live up to 17 years
Predators	Little information; predation by raptors
Diet	Pine seeds are the primary food for both adults and nestlings, although the bird is known to eat insects, acorns, berries, snails, carrion, and sometimes eggs of small birds (Mulder <i>et al.</i> 1978, Tomback 1978, Tomback and DeWolfe 1981). The Clark's nutcracker is also aggressive enough to prey on small vertebrates, such as ground squirrels (<i>Spermophilus</i> spp.), chipmunks (<i>Tamias</i> spp.), and voles (<i>Microtus</i>) (Mulder <i>et al.</i> 1978).
Trophic Relationships	Heterotrophic consumer, primary consumer (herbivore), spermivore, frugivore, secondary consumer (primary predator or primary carnivore of terrestrial invertebrates; ovivorous (egg eater)
Key Ecological Role	Prey for secondary or tertiary consumer (primary or secondary predator); disperses seeds/fruits (through ingestion or caching)

2.3.7 Aspen

The widespread distribution of quaking aspen (*Populus tremuloides*) forests on the region's high plateaus and mountain ranges and the aspen's importance to many wildlife species make these forests a significant biotic community in the Upper Snake province (Figure 2-38). The understory of most aspen communities is luxuriant when compared with those of associated coniferous forests and results in greater animal diversity. Understory vegetative diversity is dependent upon the localized moisture regime (CPLUHNA 2003). Aspen stands are in decline across the West.

The combination of modern fire suppression and a steady increase in domestic animal grazing and elk herbivory has prevented aspen regeneration in many forests; conifer understories are now widely overtopping aspen stands (CPLUHNA 2003). Because aspen stands are so different from conifer stands, they are very important for landscape diversity and wildlife habitat. Although aspen stems are short lived and snags do not stand long, the wood is soft, often decayed, and therefore useful to snag and cavity-dependent species. Young aspen sprouts are an important food source for mule deer and Rocky Mountain elk.

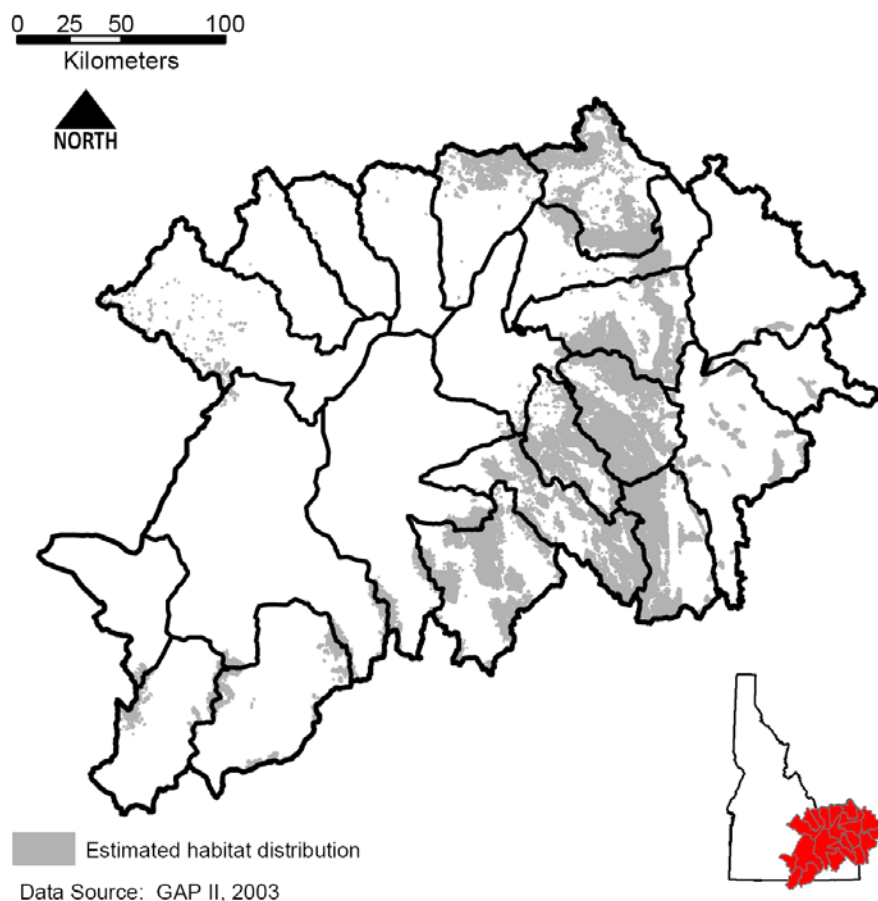


Figure 2-38. Estimated current distribution of aspen habitat in the Upper Snake province.

2.3.7.1 Focal Species

Quaking aspen (*Populus tremuloides*) is a native deciduous tree that forms clones connected by a common parent root system. Quaking aspen is the most widely distributed tree and a major cover type in North America. Even though quaking aspen is an important mid-seral species, maps showing the distribution of the species in the Upper Snake province are currently incomplete.

Throughout its range, quaking aspen occurs in mid to upper riparian zones (Franklin and Dyrness 1973, Perala 1990). Quaking aspen is not shade tolerant (Perala 1990); neither does it tolerate long-term flooding nor waterlogged soils (Perala 1990). Even if quaking aspen survives flooding in the short term, stems subjected to prolonged flooding usually develop a fungus infection that greatly reduces stem life (and renders the wood commercially useless) (Davidson *et al.* 1959). Quaking aspen readily colonizes after fire, clearcutting, or other disturbances.

Quaking aspen forms clones connected by a common parent root system. It is typically dioecious, with a given clone being either male or female; however, some clones produce both stamens and pistils (Jones and DeByle 1985). Quaking aspen stands may consist of a single clone or aggregates of clones. Clones can be distinguished by differences in phenology, leaf size and shape, branching habit, and bark character and also by electrophoresis (Perala 1990).

Quaking aspen forests provide important breeding, foraging, and resting habitat for a variety of birds and mammals. Wildlife and livestock utilization of quaking aspen communities varies with species composition

of the understory and relative age of the quaking aspen stand. Young stands generally provide the most browse. Although many animals browse quaking aspen year-round, it is especially valuable during fall and winter when its protein levels are high relative to other browse species (Tew 1970).

2.3.8 Mountain Brush

Mountain brush habitat is sparsely scattered throughout the Upper Snake province (Figure 2-39). The mountain brush habitat includes mesic upland deciduous shrub communities and warm mesic shrubs, which are upland shrublands that occur naturally or are initiated by fire or clearcutting. The mesic upland deciduous shrub communities include alder (*Alnus rhombifolia*), maple (*Acer grandidentatum*), hawthorn (*Crataegus douglasii*), tobacco brush (*Ceanothus velutinus*), buffaloberry (*Shepherdia canadensis*), chokecherry (*Prunus virginiana*) Prince's pine, huckleberry (*Gaylussacia dumosa*), whortleberry (*Vaccinium scoparium*), ocean spray (*Holodiscus discolor*), raspberry, rose (*Rosa* spp.), and spirea (*Spiraea betulifolia*). The warm mesic shrublands include alder, serviceberry (*Amelanchier alnifolia*), Oregon grape (*Mahonia aquifolium*, formerly *Berberis aquifolium*), snowberry (*Symphoricarpos albus*), tobacco brush, ninebark (*Physocarpus* spp.), chokecherry, rose, currant, willow, elderberry (*Sambucus racemosa*), and spirea. Mountain big sagebrush may also be present. The sharp-tailed grouse depends on this type for wintering habitat. Mountain brush is widely regarded as important to wildlife for its food and cover values, as well as important for providing integral components of watershed stability and species diversity.



Figure 2-39. Estimated current distribution of mountain brush habitat in the Upper Snake province

2.3.8.1 Focal Species

The focal species for mountain brush habitat in the Upper Snake province include antelope bitterbrush (*Purshia tridentata*), green-tailed towhee (*Pipilo chlorurus*), mule deer (*Odocoileus hemionus*), and Rocky Mountain elk (*Cervus elaphus nelsoni*) (Table 2-28).

A native, deciduous shrub, antelope bitterbrush is important browse for wildlife and livestock (Murray 1983, Noste and Bushey 1987, Vander Wall 1994); it also supports several insect populations. Pronghorn (Gullion 1964, Young 1989), mule deer (Gullion 1964, Williams and Aldon 1976), elk (Hobbs et al. 1981), bighorn sheep,

and moose utilize antelope bitterbrush extensively (Murray 1983). Ungulates, birds, and rodents also use antelope bitterbrush for cover (Parker 1975, Griffith and Peek 1989).

Elk and mule deer are migratory species, moving to lower elevations in winter to feed (Figure 2-40 and Figure 2-41). Primarily browsers, mule deer feed on several thousand different plant species across their range and are capable of altering or severely damaging plant communities through overbrowsing (Reed 1981). Elk are grazers rather than browsers. They prefer to forage on grasses and forbs, but they utilize woody browse in the mountain brush habitat during winter.

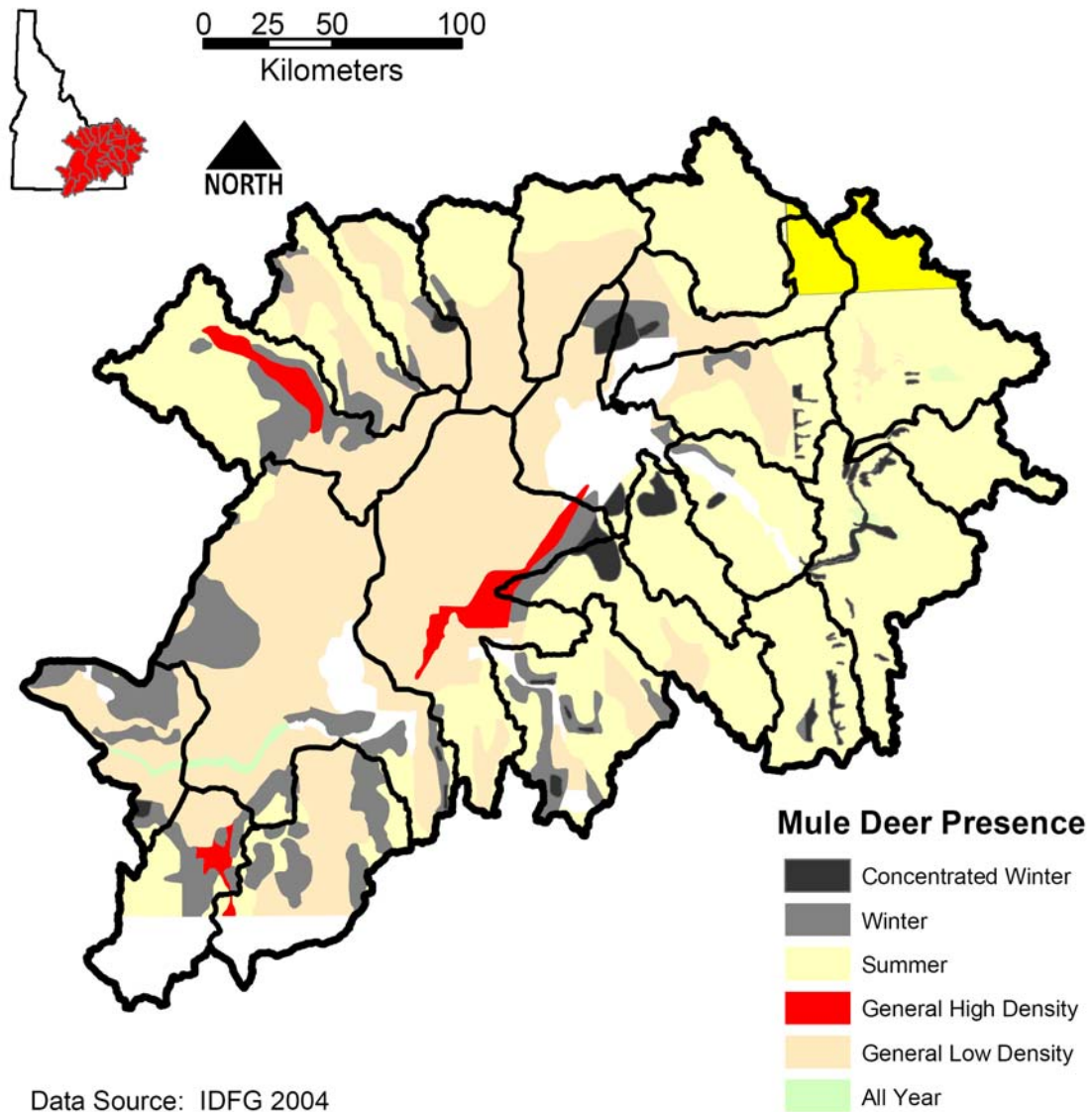


Figure 2-40. Estimated current mule deer distribution in the Upper Snake province.

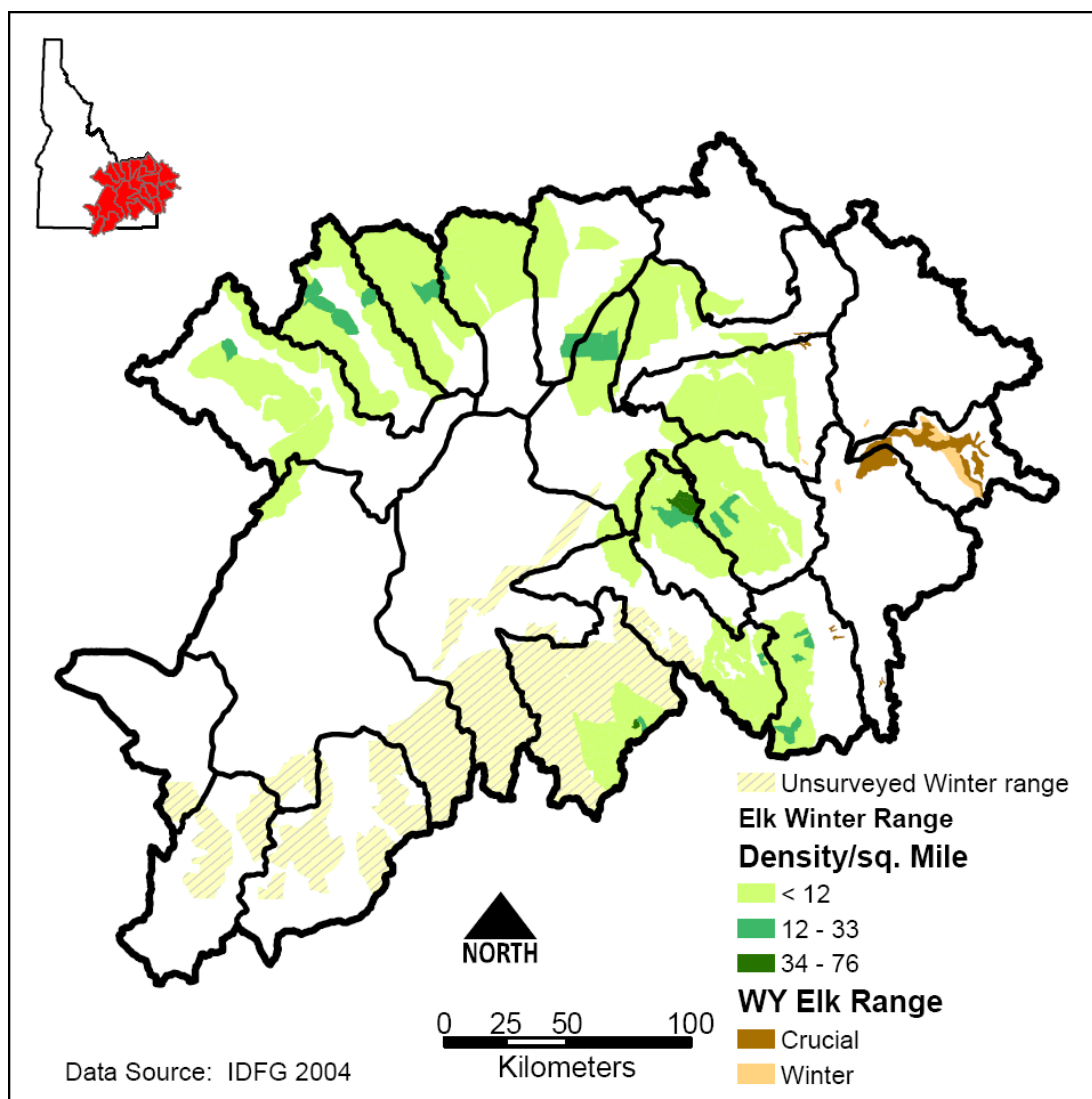


Figure 2-41. Rocky Mountain elk winter range population estimates in the Upper Snake province (IDFG 2004 unpublished aerial survey data collected during 1984-2003).

Table 2-28. Status and life history information for vertebrate focal species selected for brush habitat in the Upper Snake province. See Appendix H for detailed life history and biological information for each of the focal species.

Focal Species	Green-tailed Towhee	Mule Deer	Rocky Mountain Elk
Conservation Status	Protected nongame species in Idaho	Game species in Idaho	Game species in Idaho
Population Status	Demonstrably widespread, abundant, and secure	Demonstrably widespread, abundant, and secure	Demonstrably widespread, abundant, and secure

Focal Species	Green-tailed Towhee	Mule Deer	Rocky Mountain Elk
Age at First Reproduction	Unknown	Females usually breed at 2 years, while males may not mate until they are at least 3 or 4 years of age due to competition with older males.	Females breed at 2 years of age.
Frequency of Reproduction	Iteroparous; breeds annually	Iteroparous; breeds annually	Iteroparous; breeds annually
Number of Offspring/ Fecundity	One clutch per season. Females lay 2–5 eggs, 4 being the usual. Will replace lost clutches.	Mature females commonly have twins, while yearlings have only single fawns.	Usually a single calf, but twins are common.
Life span/ Longevity	Can live to at least 7 years and 8 months.	Females can live as long as 22 years, while males may live as long as 16 years.	Potential life span is 20 years.
Predators	Predators of adults and juveniles include the sharp-shinned hawk, Cooper's hawk, northern goshawk, peregrine falcon, American kestrel, red-tailed hawk, and long-eared owl. Nest predators include the Steller's jay, red squirrel, least chipmunk, long-tailed weasel, black-billed magpie, striped skunk, spotted skunk, and gopher snake.	Include humans, domestic dogs, coyotes, wolves, black bears, grizzly bears, mountain lions, lynx, bobcats, and golden eagles	Include humans, wolves, coyotes, black bears, grizzly bears, and mountain lions
Diet	Major food items are weed seeds and insects, including beetles, bees, wasps, butterflies, moths, grasshoppers, crickets, true bugs, and flies.	Primarily browsers, deer feed on several thousand different plant species across their range.	Some populations prefer to graze, while others rely more heavily on browse. Grasses and forbs are preferred during spring and early summer, and woody browse is preferred during winter.
Trophic Relationships	Heterotrophic consumer, primary consumer (herbivore), spermivore (seed-eater), frugivore (fruit-eater), secondary consumer; eats terrestrial invertebrates	Heterotrophic consumer, primary consumer (herbivore and foliovore), browser (leaf, stem eater), grazer (grass, forb eater), fungivore (fungus feeder)	Heterotrophic consumer, primary consumer (herbivore), browser (leaf, stem eater), grazer (grass, forb eater), fungivore (fungus feeder)

2.3.9 Threatened and Endangered Wildlife Species

The Endangered Species Act (ESA) and other federal regulations have significant implications on management of public and private lands in the Columbia River Basin. While these laws are intended to protect and recover individual species near extinction, the quantity and quality of many habitats across the U.S. are in decline and new species continue to be listed under ESA. Practices of managing wildlife and their habitat on a species-by-species basis sometimes fail to recognize the importance of biological diversity, or "biodiversity," to the health of the ecosystem (Wheeler 1996). The protection of a threatened or endangered species often results in the protection of small parcels of habitats that often benefits other non-listed species. For terrestrial assessment purposes, the technical teams opted to base the assessment and management plan upon an ecosystem-based approach with an emphasis upon focal habitats and a select number of focal species for each focal habitat. This habitat-based assessment places greater emphasis upon key habitats and their functional components, and less emphasis upon selected focal species. An artifact of this approach is the perception that threatened, endangered, candidate or sensitive (TECS) species are being overlooked or ignored. The technical teams recognized the significant role TECS species have in the ecosystem structure and function; however, the technical teams also felt that some TECS species were inappropriate choices as focal species for the following reasons:

- Some TECS species are not necessarily the best indicators of habitat type.

- TECS species are not always the best indicators of habitat quality.
- TECS species are not necessarily the best indicators of the effectiveness of management actions.
- TECS species habitat evaluation protocols at the watershed scale are non-existent.
- Sometimes very little information is available for TECS species.
- TECS species-specific recovery analysis was not the goal of the assessment.
- Many non-TECS species were more effective at meeting the focal species selection criteria (Section 2.0).

Federal management direction predicates that TECS species are addressed through the Endangered Species Act and other laws or regulation, thus, TECS species must be considered in the planning process regardless of the assessment approach. Further, the management and recovery responsibility for species listed under the Endangered Species Act fall under federal authority. The assessment addresses the significance of TECS species separately from other focal species by tabulating them and mapping known locations of pertinent species within the planning area, but does not attempt to assess their management or recovery.

2.3.9.1 *Bald Eagle (Haliaeetus leucocephalus)*

The bald eagle is a large bird of prey associated with aquatic ecosystems. The bird historically ranged throughout North America. It was first listed as endangered under the ESA on March 11, 1967 (32 FR 4001). Since that first listing, the bald eagle population has increased in number and

expanded in range. It is estimated that the species has doubled its breeding population every 6 to 7 years since the late 1970s. The improvement is a direct result of the banning of DDT and other organochlorines, habitat protection, and other recovery efforts. On July 12, 1995, the status of the bald eagle was downlisted to threatened (60 FR 35999). In the Pacific region, development-related habitat loss was identified to be a major factor limiting the abundance and distribution of bald eagles.

The bald eagle breeds from central Alaska across Canada to Labrador and Newfoundland and south to southern mainland Alaska and the Aleutian Islands (DeGraaf *et al.* 1991). It also breeds in Baja California, central Arizona, and southwestern and central New Mexico, as well as along the Gulf Coast from Texas to Florida (Donohoe 1974, DeGraaf *et al.* 1991). Bald eagles winter in most of their breeding range, from southern Alaska and Canada southward (Donohoe 1974, DeGraaf *et al.* 1991). Resident populations are found along the Atlantic, Pacific, and Gulf coasts (Johnsgard 1990).

Bald eagles are capable of breeding in their fifth year but may not start breeding until they are 6 or 7 years old (Gerrard *et al.* 1992). The breeding season extends from January through March and can vary with elevation and latitude. A breeding pair usually mates for life. Females lay a single clutch of one to three eggs. The chicks hatch after an incubation period of 35 days and fledge between 10 to 12 weeks. Bald eagles can live up to 28 years in the wild and up to 36 years in captivity (Green 1985, Johnsgard 1990).

Bald eagles prefer habitat near seacoasts, rivers, large lakes, or other large areas of open water (Peterson 1986). They prefer to nest, perch, and roost primarily in old growth and mature stands of conifers or hardwoods. Eagles usually select the oldest and tallest

trees that have good visibility and an open structure and that are near prey (Glinski *et al.* 1983, Johnsgard 1990, Kralovec *et al.* 1992, Garrett *et al.* 1993). A study in Maine showed that bald eagles preferred areas with “super-dominant” trees and avoided lakes that were surrounded by dense forest or inhabited by coldwater fishes. They used areas away from human disturbance and selected nesting sites near lakes with an abundance of warmwater fishes (Livingston *et al.* 1990). Another study showed a preference for nesting near lakes with a circumference greater than 7 miles (11 km). The smallest body of water supporting a nesting pair of bald eagles was 20 acres (8 ha) (Peterson 1986).

Eagles choose sites farther than 0.75 mile (1.2 km) from low-density human disturbance and farther than 1.2 miles (1.8 km) from medium- to high-density human disturbance (Peterson 1986). Wintering bald eagles in New Mexico and Arizona used a disproportionate amount of snags in the largest class size (no dbh given) for perching and usually perched in the top one-third of these trees. For roosting, eagles preferred the largest live trees having open structures for visibility (Grubb and Kennedy 1982).

Habitat suitability index models have been developed for wintering bald eagles in lacustrine and estuarine habitats of the central and northern states (Peterson 1986). Bald eagles need old growth or late-successional forests for nesting and roosting (Lehmkuhl and Ruggiero 1991). Nest snags must be sturdy to support nests. Tree height or species is not as important as the abundance of comparatively large trees near feeding areas (Glinski *et al.* 1983). Lakes greater than 3.8 square miles (10 km²) may be optimal for breeding bald eagles, although longer and narrower bodies of water can support breeding pairs. Nest trees should have an open form and sturdy branches in the upper one-third of the tree. Eagles nest in the

overstory. Forests used for nesting should have a canopy cover of less than 60% (may be as low as 20%) and be near water (Snyder 1993). In treeless areas, bald eagles nest on cliffs or on the ground (Peterson 1986).

Roosting sites need not be as near to water as nesting sites. It is more important that roosting sites are in dense stands of old growth that offers protection from weather. Eagles usually arrive at roost sites after dark and depart from them before dawn. It is therefore difficult to determine important roost sites by observing eagles during daylight hours (Grubb and Kennedy 1982).

Average home ranges for eight pairs of bald eagles in Oregon were 1,650 acres (660 ha), with an average distance between nest territories of 2 miles (3.2 km) and an average of 0.3 mile (0.5 km) of shoreline per pair (Johnsgard 1990). In Arizona, the estimate for home range was 24.6 square miles (64 km²), with 9.4 to 11.2 miles (15–18 km) of shoreline for each pair.

Bald eagles eat fish, reptiles, birds, mammals, invertebrates, and carrion, including livestock carrion. Some food species of eagles include bullhead fish (*Ictalurus* spp.), alewife (*Alosa pseudoharengus*), chain pickerel (*Esox niger*), sucker (*Catostomus* spp.), salmon (*Oncorhynchus* spp.), white perch (*Morone americana*), smallmouth bass (*Micropterus dolomieu*), eel (*Anguilla rostrata*), sea otter (*Enhydra lutris*), pied-billed grebe (*Podilymbus podiceps*), Canada goose (*Branta canadensis*), American coot (*Fulica americana*), mallard (*Anas platyrhynchos*), pintail (*A. acuta*), hare (*Lepus* spp.), and prairie dog (*Cynomys* spp.) (Peterson 1986, Kralovec *et al.* 1992, Livingston *et al.* 1990).

Eggs, nestlings, and fledglings are most vulnerable to predators. Reported predation of eggs in tree nests is by black-billed magpies (*Pica pica*), gulls (*Larus* spp.), ravens and

crows (*Corvus brachyrhynchos* and *C. corax*), black bears (*Ursus americanus*), bobcats *Felis rufus*), wolverines (*Gulo gulo*), and raccoons (*Procyon lotor*) (Chrest 1964, Hensel and Troyer 1964, Sprunt and Ligas 1964, McKelvey and Smith 1979, Nash *et al.* 1980). Few nonhuman species are able or likely to prey on immature or adult bald eagles (Buehler 2000), except when the bird is in the nest. Fledglings on the ground are vulnerable to mammalian predators.

Humans pose the greatest threat to bald eagles through habitat destruction, pesticide use, and poaching (Buehler *et al.* 1991). Bald eagles are flushed, in order of increasing ease, from perches, nests, and foraging areas by human disturbance (Grubb and King 1991). They are most easily disturbed by pedestrian traffic and least disturbed by aircraft. Establishing buffer zones of 148 to 296 feet (400–800 m) in Oregon and 167 to 592 feet (450–1,600 m) in the Southeast was recommended to reduce the impact of human disturbance on nesting pairs (Grubb and King 1991).

Silvicultural treatments for maintaining eagle habitat in ponderosa pine (*Pinus ponderosa*) of various age and structure, subclimax mixed conifer, Douglas-fir (*Pseudotsuga menziesii*), and oak (*Quercus lobata*; *Q. kelloggii*) stands in northeastern California have been detailed (Burke 1983).

Because forest structure (density and height class) determines avian community composition, changes in forest structure lead to changes in avian communities (Diem and Zeveloff 1980, Smith 1980). A stand-replacing fire will, therefore, likely change bald eagle use of a forest. Fires that destroy old growth forest can reduce eagle populations (Yellowstone National Park 1991). If low-intensity, litter-reducing fires are not allowed to burn in old growth forests, stand-replacing, high-intensity crown fires can result (Covington and Moore 1992).

Fires create snags, which are important perching and nesting sites for bald eagles. Snags can possibly increase potential for lightning-caused fire when standing, and when fallen, they increase fuel loading (Lyon 1977). These increased potentials may be hazardous in areas where fire control for maintaining bald eagle populations is necessary. There have been no studies to determine whether the hazards of snags outweigh their benefits to eagles. Snag attrition rates have been listed for lodgepole pine forests following fire (Lyon 1977). Old growth eastern white pine (*Pinus strobus*) forests in Ontario continually recruit snags in the absence of fire because of their uneven-aged structure (Quinby 1991). Catastrophic fires in mature and old growth forests can create even-aged conditions that may stop continuous snag recruitment (Quinby 1991).

- **Trophic Relationships**—heterotrophic consumer, secondary consumer (primary predator or primary carnivore of vertebrates), piscivorous (fish eater); ovivorous (egg eater), carrion feeder.
- **Key Ecological Role**—pirates food from other species, controls terrestrial vertebrate populations (through predation or displacement), provides primary creation of aerial structures (which are possibly used by other organisms).

2.3.9.2 *Gray Wolf (Canis lupus)*

The gray wolf (*Canis lupus*) was listed as threatened under the ESA on March 11, 1967 (32 FR 4001). On November 18 and 22, 1994, areas in Idaho, Montana, and Wyoming were designated as nonessential experimental populations in order to initiate gray wolf reintroduction projects in central Idaho and the Greater Yellowstone Area (59 FR 60252, 59 FR 60266). Special regulations for the experimental populations allow flexible management of wolves, including

authorization for private citizens to take wolves in the act of attacking livestock on private land.

The gray wolf is a social species, normally living in packs of 2 to 12 wolves. Packs tend to occupy a territory of 500 to 1,000 square kilometers and defend this area from other packs and individual wolves. Packs are primarily family groups consisting of a breeding pair, their pups from the current year, offspring from the previous year, and occasionally an unrelated wolf. Normally, only the top-ranking (alpha) male and female in each pack breed and produce pups. A pack has a single litter annually of four to six pups (range 1–11 pups). Yearling wolves often disperse from their natal packs and become nomadic, covering large areas while searching for unoccupied habitat and an individual of the opposite sex to begin their own territorial pack.

- **Trophic Relationships**—heterotrophic consumer, primary consumer (herbivore), frugivore (fruit-eater), secondary consumer (primary predator or primary carnivore of vertebrates), tertiary consumer (secondary predator or secondary carnivore).
- **Key Ecological Role**—is a primary burrow excavator (fossorial or underground burrows), creates and uses trails (possibly used by other species), controls terrestrial vertebrate populations (through predation or displacement), creates feeding opportunities for other organisms.

2.3.9.3 *Lynx (Lynx canadensis)*

On March 24, 2000, the Canada lynx was federally listed as threatened (65 FR 16051) under the ESA. Lynx populations experience volatile swings, becoming very low about every ten years (Burt and Grossenheider

1976, Fox 1978, Mech 1980, USFWS 1994). Therefore, they can be rare in any given area at these times.

Some female lynx can breed as yearlings (Snyder 1991a). Prey scarcity may suppress breeding (Lippincott 1997). The breeding season extends between January and February and sometimes into April (Nellis *et al.* 1972, Brainerd 1985). The gestation period lasts between 62 and 74 days (Snyder 1991a). Females generally give birth in March or April, but sometimes in May or June, producing one litter of three to four kittens (Snyder 1991a). The maximum life span for a lynx is between 15 and 18 years in captivity (Snyder 1991a).

Lynx occur in both dense climax forests and second growth stands. In Alaska and Canada, they prefer boreal forests, and in the Intermountain West, they prefer spruce (*Picea* spp.)–subalpine fir (*Abies lasiocarpa*) and lodgepole pine (*Pinus contorta*) forests. Lynx are associated with dense climax forests at elevations above 1,200 m (Koehler and Brittell 1990), and they also use early seral stage communities bordering dense forests. Because their populations are closely tied to snowshoe hare (*Lepus americanus*) numbers, lynx can also be found in second growth forests when hare are numerous (DeVos and Matel 1952, Heinselman 1973).

Lynx require a mix of early and late seral habitats to meet their food and cover needs. Early seral habitats provide the lynx with a prey base, while mature forests provide denning space and hiding cover (Snyder 1991a). Pockets of dense forest must be interspersed with prey habitat. Lynx den in rotten logs, beneath tree roots, and in rock crevices. Koehler (1990) reported that lynx use forests having a high density of downfall logs (more than 40 logs/46 m² lying 0.3–1.3 m above the ground).

Lynx prey primarily on snowshoe hare. Their diet also includes ducks (*Anas* spp.); upland game birds (especially grouse [*Dendragapus* spp.]); and various forest rodents, including squirrels (scurids, spermophilids). Lynx also feed on deer (*Odocoileus* spp.), moose (*Alces alces*), and caribou (*Rangifer tarandus*) carcasses. Saunders (1963) reported that lynx are able to kill these large mammals.

Predators of lynx include people, mountain lions (*Felis concolor*), bears (*Ursus* spp.), and other lynx. Because of the cyclic nature of the population, one management strategy to ensure kitten recruitment is to put a moratorium on trapping for the three years following the declining phase of lynx (USFWS 1994).

Lynx can also be managed by managing for snowshoe hare, their primary prey. Hare populations increase dramatically following disturbance; particularly fire (Snyder 1991a). For instance, fires that create snowshoe hare cover and food generally benefit lynx (Heinselman 1973, Koehler and Brittell 1990). Fire may have negative short-term effects by eliminating cover for snowshoe hare and lynx. However, as succession progresses and snowshoe hares become abundant, lynx benefit. Lynx usually do not cross openings greater than 90 m, and they use travel corridors with tree densities of 450 per hectare. Therefore, fires or logging operations that create large openings without leaving travel corridors between pockets of dense forest may be detrimental to lynx (DeVos and Matel 1952, Saunders 1963, Grange 1965, Deems and Pursley 1978).

- **Trophic Relationships**—heterotrophic consumer, secondary consumer (primary predator or primary carnivore), vertebrate eater (consumer or predator of herbivorous vertebrates).

- **Key Ecological Role**—is an apex predator, is an indicator of specific habitat elements, uses runways created by other species.

2.3.9.4 Grizzly Bear (*Ursus arctos horribilis*)

The grizzly bear (*Ursus arctos horribilis*) was first listed as endangered in the conterminous United States (lower 48 states) on March 11, 1967 (32 FR 4001). Less than a decade later on July 28, 1975, the grizzly bear was listed as threatened (40 FR 31734). Within the area covered by this listing, this species occurs in Idaho, Montana, Washington, and Wyoming. On November 17, 2000, the U.S. Fish and Wildlife Service published a final rule (65 FR 69644) to designate a grizzly bear nonessential, experimental population in the Selway-Bitterroot ecosystem. Later, the agency published a notice of intent (June 22, 2001, 66 FR 33623) to reevaluate its decision to establish an experimental population of grizzly bears in east-central Idaho and western Montana.

The grizzly bear tends to be crepuscular, with the least activity occurring at midday (Snyder 1991b). Grizzly bears hibernate, entering their dens in October and emerging in May. The total time in hibernation depends on food availability, weather conditions, and sex (Snyder 1991b). Grizzly bears may emerge from their den early if disturbed by human activity. Grizzly bears dig their own den, usually excavated in hillsides, although dens are also made in rock caves, in downfall timber, and beneath trees and stumps (Willard and Herman 1977, Servheen 1981).

Grizzly bears breed between May and July, usually in two- to four-year intervals. Implantation is delayed, and gestation lasts about 184 days (Snyder 1991b). The birthing season is in late November through February. Litter size varies from one to four cubs, with

two cubs being the most common. The cubs remain with the female for the first two winters. The age of maturity for female grizzly bears is between 5 and 8 years (Snyder 1991b). The average life span of a grizzly bear is 25 years, or more in captivity (Jonkel 1978, Servheen 1981, Craighead and Mitchell 1987).

Although timber is an important habitat component, grizzly bears prefer more open habitats. Timbered plant communities most frequented by grizzly bears include subalpine fir (*Abies lasiocarpa*)-whitebark pine (*Pinus albicaulis*), lodgepole pine (*P. contorta*)-Douglas-fir (*Pseudotsuga menziesii*), and spruce (*Picea* spp.)-western red cedar (*Thuja plicata*)-hemlock (*Tsuga* spp.) forests. Sedge (*Carex* spp.)-bluegrass (*Poa* spp.) meadows are also important, as well as shrubfields and lowland high-elevation riparian communities (Willard and Herman 1977, Blanchard 1980, McLellan and Shackleton 1988). The bears typically choose low-elevation riparian sites, wet meadows, and alluvial plains during spring (Willard and Herman 1977, Reichert 1989). During summer and fall, grizzly bears more frequently use high-elevation meadows, ridges, and open, grassy timbered sites (Servheen 1983, Reichert 1989).

Optimal grizzly bear covers are wooded areas interspersed with grassland and shrubland. Ruediger and Mealy (1978) defined hiding cover as that capable of hiding an animal of 61 m or less in an area of 12 to 20 hectares. Thermal cover was defined as coniferous trees at least 12 m tall with a 70% canopy cover in a 3- to 20-hectare area. Ruediger and Mealy (1978) recommended maintaining 30% of grizzly bear habitat as cover. Graham (1978) found that in Yellowstone National Park, grizzly bears preferred open areas that were within 50 m of cover. McLellan and Shackleton (1988) reported that the bears use areas within 100 m of roads during the day but that darkness is sufficient "cover" for road

use at night. Grizzly bear use daybeds in timbered areas that are near feeding sites (Blanchard 1980, Reichert 1989).

Grizzly bears eat primarily grasses, forbs, roots, tubers, and fruits. They also eat carrion, grubs, insects (particularly army cutworm moths [Noctuidae] and ladybird beetles [Coccinellidae]), fish, small rodents, various bird species, and garbage (Zager and Jonkel 1983). Adult males also prey on black bears and subordinate grizzly bears (Hechtel 1985). Orchards, beehives, and crops may be damaged by grizzly bears; they may also prey on livestock (Jonkel 1978, Servheen 1983). Some of the more common plant foods are russet buffaloberry (*Shepherdia canadensis*), Saskatoon serviceberry (*Amelanchier alnifolia*), Sitka mountain ash (*Sorbus sitchensis*), snowberry (*Symphoricarpos* spp.), hawthorn (*Crataegus* spp.), honeysuckle (*Lonicera* spp.), whitebark pine seeds, pine (Pinaceae) vascular cambium, willow (*Salix* spp.), dogwood (*Cornus* spp.), huckleberry and blueberry (*Vaccinium* spp.), dandelion (*Taraxacum* spp.), sweetvetch (*Hedysarum* spp.), clover (*Trifolium* spp.), cowparsnip (*Heracleum* spp.), glacier lily (*Erythronium grandiflorum*), horsetail (*Equisetum* spp.), lomatium (*Lomatium* spp.), kinnikinnick (*Arctostaphylos uva-ursi*), strawberry (*Fragaria* spp.), buckthorn (*Rhamnus* spp.), paintbrush (*Castilleja* spp.), thistle (*Cirsium* spp.), fritillary (*Fritillaria* spp.), boykinia (*Boykinia richardsonii*), and sheathed cottonsedge (*Eriophorum vaginatum*) (Graham 1978, Zager 1980, Servheen 1983, Hechtel 1985, Craighead and Mitchell 1987).

Grizzly bear predators include humans and other grizzly bears (Jonkel 1978).

Grizzly bears have a low reproductive rate and late maturation age, which make them susceptible to overharvesting (Snyder 1991b). Also, many grizzly bears are poached or hit by cars and trains. Other factors contributing

to the bear's decline are habitat use and disturbance by humans, both for commercial and recreational purposes, and fire control, which in some instances can result in reduced acres of food-rich seral shrubfields (Jonkel 1978, Knight 1980, Zager *et al.* 1983). Grizzly bears have been known to prey on livestock where their ranges overlap with areas containing livestock and to occasionally kill humans as a result of chance encounters, usually in the backcountry. Because of conflicts between grizzly bears and humans, grizzly bear habitat should be isolated from developed areas and preferably be located in areas that receive only light recreational, logging, or livestock use (Spowart and Samson 1986).

- **Trophic Relationships**—heterotrophic consumer, primary consumer (herbivore), spermivore, frugivore, root feeder, secondary consumer (primary predator or primary carnivore of terrestrial invertebrate and vertebrate species), piscivorous (fish eater), carrion feeder, cannibalistic.
- **Key Ecological Role**—is a primary burrow excavator (fossorial or underground burrows), uses trails created by other species, controls terrestrial vertebrate populations (through predation or displacement), disperses seeds/fruits (through ingestion or caching), creates feeding opportunities (other than direct prey relations).

2.4 Environmental Conditions

Natural ecosystems are enormously intricate. The complex mosaic of habitats within the Interior Columbia River basin results from the interaction of soil and vegetative characteristics, climate, wind, fire, wildlife, and human activity. All of these variables contribute to the “proper” functioning of these systems, which develop in a variety of ways

over time. The natural pathways of development in these habitats produce diverse ecosystems, which are extremely productive in terms of both biological resources and useful products for society (Carey *et al.* 1996).

Over the past century, however, humans have become an increasingly significant factor in how these systems function by disturbing and accentuating many of these ecological processes and interactions. As anthropomorphic processes modify the pathways and patterns of ecosystem development and succession, the structure of the system has become simplified (Carey *et al.* 1996). Simplification and loss of diversity has, in turn, led to the loss or potential loss of plant, animal, and fish species and reduced the ability of the land and waters to provide continued, predictable flows of resources that contribute to both traditional and current human values and demands (USFS 1996).

An ecosystem is defined as a community of plants, animals, and other living organisms and their physical environment. In many ways, the physical environment determines what the ecosystem is or can be. The geology of the Upper Snake province and the natural processes that continue to shape the subbasins of that province today are major influences on the aquatic ecosystem. The province's natural physical features change considerably over the length and breadth of the subbasins. The geology and geomorphology of the Upper Snake province are described in section 1.

The Upper Snake province is characterized at the subbasin scale by the habitats and areas summarized in Table 2-1. For assessment purposes, habitat analyses were conducted at the watershed scale in terms of the following focal habitat classifications: aquatic habitats, riparian/herbaceous wetlands, open water, shrub-steppe, pine/fir forests,

juniper/mountain mahogany, whitebark pine, aspen, and mountain brush (Figure 2-31).

2.4.1 Snake Headwaters Subbasin

2.4.1.1 Greys–Hoback (GHB)

Aquatic—Information for this section was taken from WGFD (2004).

The Greys River drainage is a natural, free-flowing system with some areas of channel entrainment due to road construction. The basin has areas of lateral channel migration and areas of large woody debris accumulation. Most of the drainage is characterized by large cobble substrate. Boulder-rubble substrates dominate in the canyon sections. The minimum stream flows needed to maintain or improve existing conditions in the Greys River at critical flows are 350 cfs between April and June and 204 cfs for the remaining months (Bradshaw and Annear 1993). The Little Greys River drainage is a stable, free-flowing system with generally stable channels. The watershed is erosive with soils containing a lot of clay. Overgrazing is notable along Greyback Ridge. There are pockets of suitable spawning gravels, with the better gravels above and including Steer Creek. Other tributaries lack good spawning or holding habitats. The area has a poor pool-to-riffle ratio (< 30% pools). Standing water is limited to shallow eutrophic catch basins.

The upper Greys–Hoback watershed is predominantly alpine tundra. Spawning for standing waters is limited and generally in outlet streams. Water exchange is usually associated only with spring runoff. The canyon sections of streams are contained largely in bedrock formations with large rubble-boulder substrate and few areas of gravel. The streambanks are steep and timbered. Meadow sections exhibit a relatively high degree of lateral migration in

alluvial floodplains with willows. Cobble-gravel-sand substrates dominate, resulting in unstable channels with poor development. The entire system is considered high gradient with poor wintering habitat and high seasonal flow variation. Tributaries are subject to heavy silt loads when there is precipitation. Such loading is the result of oil exploration/timber roading, as well as some overgrazing, and unstable lands and avalanches. Heavy silt loads are particularly common on Cliff Creek and upstream from Bondurant. Channel manipulation and dewatering is common from Deadshot Ranch to the Elkhorn Store (near the confluence of Dell Creek). Standing water in the Hoback River drainage consists of alpine lakes located in the Gros Ventre Wilderness.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Greys–Hoback watershed results from various forms of development and/or conversion within the floodplain. Ninety-one points of water diversion have been constructed in the Greys–Hoback watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. This watershed is located in the more remote areas of the Snake Headwaters subbasin, so anthropogenic influences are less pronounced. Current estimates of riparian/herbaceous wetland habitat composition in the watershed amount to nearly 3%. **Open Water**—Open water habitats are not a significant component of the landscape in the Greys–Hoback watershed. Two dams on Flat Creek and the Snake River in Teton County have created approximately 66 acres (27 ha) of open water habitat.

Shrub-Steppe—Shrub-steppe habitats currently comprise 12% of the landscape in the Greys–Hoback watershed. According to the best estimates, shrub-steppe habitats have increased nearly 2,600% from historical

conditions. Increases may be attributed to two components of an altered fire regime. Stand replacement fires have burned approximately 5% of the Greys–Hoback watershed, and when fires are suppressed, the shrub component of grassland habitat expands at the expense of native grassland habitat. Regardless, the quality of remaining shrub-steppe habitat is severely reduced from the historical condition (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (dry, mature)—Pine/fir forests are the most significant habitats in the Greys–Hoback watershed, amounting to over 50% of the vegetative composition. According to the best data available, pine/fir forests have increased 142% from historical conditions. The quality of the pine/fir forest habitat has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires.

The xeric, mature forest component of the pine/fir forest habitat was assessed in terms of Douglas-fir and lodgepole pine habitat. Historically, this habitat was mostly open and park-like, with relatively few undergrowth trees. It was the predominant landscape feature. Timber harvest activities in the watershed during the 1900s selectively harvested the mature stands, while other factors limit reestablishment of normal forest successional processes. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Greys–Hoback watershed. The western juniper component of the habitat is at the northern

periphery of its range in the Snake Headwaters subbasin; however, it continues to expand its range due in large part to an altered fire regime. The lengthened fire-return intervals give western junipers a competitive advantage over the shrub/forb vegetation. According to the best available information, the western juniper component has decreased 100% from historical conditions. The mountain mahogany component is not a significant vegetative element in the Greys–Hoback watershed.

Whitebark Pine—Whitebark pine habitats are broadly distributed across the Greys–Hoback watershed at alpine and subalpine elevations but they are not a significant vegetative element on the landscape. According to the best available information, whitebark pine habitat has declined 100% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitat is a patchily distributed resource in the Greys–Hoback watershed. This habitat is a prominent component of the landscape in the Snake Headwaters subbasin and currently comprises 5% of the landscape in the Greys–Hoback watershed. It has been estimated that aspen habitats in the Greys–Hoback watershed have decreased 92% from historical conditions due primarily to the effects of an altered fire regime.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Greys–Hoback watershed. According to the best available data, the mountain brush habitats currently comprise less than 1% of the habitat in the Greys–Hoback watershed.

2.4.1.2 Gros Ventre (GVT)

Aquatic—The Gros Ventre River is relatively stable above the town of Kelly. Downstream the river enters a floodplain area where the river channel is relatively unstable and braided, with broad channels and large cobble substrate. Results from instream flow work conducted by Annear and Bradshaw (1992) indicated that the lower stretches of the Gros Ventre River have considerably less productive potential than most trout streams in Wyoming. There are few suitable spawning substrates in the Gros Ventre River proper, with large cobble, rubble, boulder, and bedrock being the primary substrates. Silt and sand commonly choke gravel deposition areas. The land mass is generally unstable and subject to erosion during precipitation events throughout the drainage. This instability is aggravated by timber harvest and roading. There are stable banks in canyon sections. A channel with lateral migration/braiding is notable in glacial-cobble alluvium through Grand Teton National Park/National Elk Refuge. The basin is generally high gradient with poor pool-riffle ratios (< 30% pools). There are ice problems similar to those of the Hoback River drainage. Also, there are considerable diversions downstream from Lower Slide Lake. Most standing water in the Gros Ventre watershed is situated in the alpine tundra, with water exchange limited to spring runoff. The majority of lakes fail to overwinter fish. Lower Slide Lake is losing depth due to increased silt deposition in the upper reaches since the river has bypassed Upper Slide Lake.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Gros Ventre watershed results from various forms of development and/or conversion within the floodplain. Five points of water diversion have been constructed in the Gros Ventre watershed for irrigation purposes. This watershed is located in the more remote areas

of the Snake Headwaters subbasin, so anthropogenic influences are less pronounced, and the diversions are few. Current estimates of riparian/herbaceous habitat composition in the watershed amount to 3%. **Open Water**—Open water habitat encompasses less than 1% of the landscape in the Gros Ventre watershed. It is assumed that all open water habitat in the watershed is naturally occurring. **Shrub-steppe**—Shrub-steppe habitats currently comprise 6% of the landscape in the Gros Ventre watershed. According to the best estimates, shrub-steppe habitat has increased nearly 3,087% from historical conditions. Shrub-steppe habitat increases may be attributed to two components of an altered fire regime. Stand replacement fires have burned approximately 5% of the Gros Ventre watershed, and when fires are suppressed, the shrub component of grassland habitat expands at the expense of native grassland habitat. Regardless, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (dry, mature)—Pine/fir forests are the most significant habitats in the Gros Ventre watershed, amounting to one-third of the vegetative composition. Based on the best data available, this habitat has increased 58% from historical conditions. The quality of the pine/fir forest habitat has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires.

Historically, this habitat was mostly open and park-like, with relatively little undergrowth trees. Timber harvest activities in the watershed during the last century selectively harvested the mature stands, while other factors limit reestablishment of normal forest successional processes. Currently, much of

this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Gros Ventre watershed. The western juniper component of the habitat is at the northern periphery of its range in the Snake Headwaters subbasin; however, it continues to expand its range due in large part to an altered fire regime. The lengthened fire-return intervals give junipers a competitive advantage over the shrub/forb vegetation. According to the best available information, the western juniper component has decreased 100% from historical conditions. The mountain mahogany component is not a significant vegetative element in the Gros Ventre watershed.

Whitebark Pine—Whitebark pine habitats are broadly distributed across the Gros Ventre watershed at alpine and subalpine elevations but it is not a significant vegetative element on the landscape. According to the best available information, whitebark pine habitat has declined 100% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitat is a patchily distributed resource in the Gros Ventre watershed but a prominent component of the landscape in portions of the Snake Headwaters subbasin where it comprises 1% of the vegetative composition. It has been estimated that aspen habitats in the Gros Ventre watershed have decreased 94% from historical conditions primarily due to the effects of an altered fire regime.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Gros Ventre watershed. According to the best

available data, the mountain brush habitats currently comprise less than 1% of the habitat in the Gros Ventre watershed.

2.4.1.3 Palisades (PAL)

Aquatic— The Palisades watershed contains the South Fork of the Snake River downstream from Palisades Dam, Palisades Reservoir and tributaries to the River and Reservoir. Flows in the South Fork Snake are controlled by flows from the dam. Altered flows appear to favor reproduction of rainbow trout, which have been increasing in numbers in recent years. A collaborative effort is underway to change winter and spring flow management in an attempt to reduce habitat suitability for rainbow trout spawning and early rearing. Palisades Dam has no fish passage which blocked fish access to spawning tributaries above the dam. Some culverts under Highway 26 can become impassable to fish depending on reservoir levels. Most tributary habitat in the watershed is in good shape.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Palisades watershed results from various forms of development and/or conversion within the floodplain. Three hundred fifty-one points of water diversion have been constructed in the Palisades watershed for irrigation purposes. The most significant of the diversions is Palisades Dam, whose regulated flows have significant ramifications for hydrologic processes, maintenance of cottonwood riparian habitats within the historic floodplain, and wetland structure and function in the watershed. Current estimates of riparian/herbaceous habitat composition in the watershed amount to nearly 3%. Inundation of the Snake River by the construction of Palisades dam resulted in significant losses of riparian habitats and species.

Open Water—Open water habitat comprises 2% of the landscape in the Palisades watershed. Most of this habitat was created when Palisades Dam created over 16,000 acres (6,475 ha) of open water habitat when it was completed in 1958. This is an increase of 2,100% from historical conditions. An additional 10 acres (4 ha) of open water habitat was created when the Antelope Creek dam was completed in 1991. Water level manipulations affect aquatic habitat quantity and quality in the Palisades watershed by altering upstream and downstream hydrologic processes.

Shrub-steppe—Shrub-steppe habitats currently comprise 14% of the landscape in the Palisades watershed. According to the best estimates, shrub-steppe habitat has increased nearly 1,929% from historical conditions. Shrub-steppe habitat increases may be attributed to two components of an altered fire regime. Stand replacement fires have burned approximately 3% of the Palisades watershed, and when fires are suppressed, the shrub component of grassland habitat expands at the expense of native grassland habitat. Regardless, the quality of remaining shrub-steppe habitat is severely reduced from historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (dry, mature)—Pine/fir forests are significant habitats in the Palisades watershed, amounting to 20% of the vegetative composition. Based on the best data available, this habitat has decreased 35% from historical conditions. Historically, this habitat was mostly open and park-like, with relatively little undergrowth trees. Timber harvest activities in the watershed during the last century selectively harvested the mature stands, while other factors limit reestablishment of normal forest successional processes. Currently, much of this habitat has a younger tree cohort of more shade-tolerant

species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Palisades watershed. The western juniper component of the habitat is at the northern periphery of its range in the Snake Headwaters subbasin; however, it continues to expand its range due in large part to an altered fire regime. The lengthened fire-return intervals give junipers a competitive advantage over the shrub/forb vegetation. The mountain mahogany component is not a significant vegetative element in the Palisades watershed.

Whitebark Pine—Whitebark pine habitats are broadly distributed across the Palisades watershed at alpine and subalpine elevations. Whitebark pine habitat is not a significant vegetative element on the landscape. Less than 1% of the watershed contains whitebark pine habitat. According to the best available information, whitebark pine habitat has declined 81% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitats are broadly distributed resources in the Palisades watershed. Aspen habitat is a prominent vegetative component and currently comprises 20% of the vegetative landscape. It has been estimated that aspen habitats in the Palisades watershed have decreased 38% from historical conditions primarily due to the effects of an altered fire regime.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape, and they are not a significant vegetative component of that landscape in the Palisades watershed. According to the best available data, the mountain brush habitats currently comprise less than 1% of the habitat in the Palisades watershed and have increased 589% from historical conditions.

2.4.1.4 Salt (SAL)

Aquatic—This information was taken from WGFD (2004).

The Lower Salt River Basin covers 334 square miles (865 km²) and includes the Salt River drainage below Fairview, Wyoming. The Salt River is dewatered for approximately 4 miles near Fairview due to diversions. Headwaters originate on the west slope of the Salt River Range in the Bridger-Teton National Forest. The practice of willow removal in the past has resulted in degraded streambanks. Revetments have helped to stabilize the streambanks; however, the area is still subject to slumping due largely to agricultural and grazing practices. The Salt River tends to cut laterally and fill pools rather than form good point and lateral bars. There are some large woody debris piles for overhead cover. There is a general lack of bedform variability for a stream of this size. An abundance of fines has resulted in few clean gravel beds. Reservoirs comprise the majority of standing waters, with a few alpine lakes that lack adequate spawning. The headwater streams are fairly stable but tend to be intermittent or small, with a low carrying capacity.

The Upper Salt River Basin is a natural, free-flowing system above Highway 89. The area has fairly stable banks and channel development. Large woody debris piles and undercut banks are adequate for the existing population. There is fairly large rubble/boulder substrate in the canyon reaches and fair to good gravels in the meadow reaches.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Salt watershed results from various forms of development and/or conversion within the floodplain. Two hundred ninety-eight points of water diversion have been constructed in

the Salt watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Nineteen miles of riparian habitat were destroyed by mechanical and chemical means during the middle part of the 1900s. Current estimates of riparian/herbaceous wetland habitat composition in the watershed amount to 2% of the landscape. **Open Water**—Open water habitat encompasses less than 1% of the landscape in the Salt watershed. Collectively, 6 dams in the Salt watershed created approximately 575 acres (233 ha) of open water habitat. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation. Water level manipulations affect aquatic habitat quantity and quality in the Salt watershed by altering upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise 8% of the landscape in the Salt watershed. According to the best estimates, shrub-steppe habitat has increased nearly 2,359% from historical conditions. Shrub-steppe habitat increases may be attributed to altered fire regimes. Stand replacement fires have burned approximately 1% of the Salt watershed, and when fires are suppressed, the shrub component of grassland habitat expands at the expense of native grassland habitat. Regardless, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (dry, mature)—Pine/fir forests are the most significant habitats in the Salt watershed, amounting to 17% of the vegetative composition. Based on the best data available, this habitat has decreased 31% from historical conditions. The quality of the pine/fir forest habitat has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower

diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Salt watershed. **Whitebark Pine**—Whitebark pine habitats are broadly distributed across the Salt watershed at alpine and subalpine elevations. Whitebark pine habitat is not a significant vegetative element on the landscape. Less than 1% of the watershed contains whitebark pine habitat. According to the best available information, whitebark pine habitat has declined 100% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitats are broadly distributed resources in the Salt watershed. Aspen habitat is a prominent landscape component and currently comprises 12% of the watershed. It has been estimated that aspen habitats in the Salt watershed have decreased 48% from historical conditions primarily due to the effects of an altered fire regime.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Salt watershed. Mountain brush habitats currently comprise less than 1% of the habitat in the Salt watershed.

2.4.1.5 Snake Headwaters (SHW)

Aquatic—The upper Snake River basin (above Jackson Lake Dam) is a natural, free-flowing stream system. The area is subject to

periodic mass wasting triggered by heavy precipitation or earthquakes. Large woody debris is common but not excessive. The stream exhibits natural meandering with a healthy riparian area. The glacial/alluvial floodplain exhibits large gravel-cobble substrate with a fair amount of suitable spawning gravel, sand, and fines. Spawning primarily occurs within the mainstem. There is adequate, but somewhat limited, spawning success resulting in a less dense population. There is virtually no standing water other than sterile alpine lakes in Grand Teton National Park along the crest of the Teton Range. Flow in the Snake River proper is regulated by Jackson Lake Dam, while all tributaries within the lower Snake River basin are free flowing. Dikes have been constructed between Moose and South Park for flood protection. The diking has resulted in channeling and loss of instream structure. The channel is continuing to deteriorate with age within the diked reach. Natural banks are relatively stable with a healthy riparian area for an alluvial/glacial floodplain. The substrate is approximately 50% cobble in the mainstem of the Snake River. The majority of suitable spawning areas occur on deeded lands in Spring Creek tributaries between the Hoback River and Cottonwood Creek. Diversions are of little effect. Tributaries within the canyon reach (Hoback River to Palisades Reservoir) are high gradient with limited potential. Most standing water is located within Grand Teton National Park.

Riparian/Herbaceous Wetlands—Twenty-six points of water diversion have been constructed in the Snake Headwaters watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current estimates of riparian/herbaceous habitat composition in the watershed amount to 3%. This watershed is located in the more remote areas of the Snake Headwaters subbasin and

contains both Yellowstone and Grand Teton National Parks, so anthropogenic influences are less pronounced.

Open Water—Open water habitat encompasses approximately 6% of the landscape in the Snake Headwaters watershed. Proportionally, the Snake Headwaters watershed has the greatest amount of open water habitat of Upper Snake province watersheds. Most of this habitat was created when Jackson Lake Dam was completed in 1911, creating over 25,000 acres (10,117 ha) of open water habitat. An additional 1,380 acres (558 ha) were created by the construction of dams on Randolph Creek, Wallace Creek, Spread Creek, and Leidy Creek. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation, affecting aquatic habitat quantity and quality by altering upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise 4% of the landscape in the Snake Headwaters watershed. According to the best estimates, shrub-steppe habitat has increased nearly 1,143% from historical conditions. Shrub-steppe habitat increases may be attributed to two components of an altered fire regime. Stand replacement fires have burned approximately 5% of the Snake Headwaters watershed, and when fires are suppressed, the shrub component of grassland habitat expands at the expense of native grassland habitat. The quality of remaining shrub-steppe habitat is severely reduced from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (dry, mature)—Pine/fir forests are the most significant habitats in the Snake Headwaters watershed, amounting to 65% of the vegetative composition. Based on the best data available, this habitat has increased 68% from historical conditions.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Snake Headwaters watershed. The western juniper component of the habitat is at the northern periphery of its range in the Snake Headwaters subbasin; however, it continues to expand its range due in large part to an altered fire regime. **Whitebark Pine**—Whitebark pine habitats are broadly distributed across the Snake Headwaters watershed at alpine and subalpine elevations. The Snake Headwaters watershed contains the greatest proportion (3%) of whitebark pine habitat of all Upper Snake province watersheds. Whitebark pine habitat has declined 91% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitats are a patchily distributed resource in the Snake Headwaters watershed and are not a significant component in the watershed. **Mountain Brush**—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Snake Headwaters watershed.

2.4.2 Upper Snake Subbasin

2.4.2.1 American Falls (AMF)

Aquatic—American Falls Reservoir covers 58,078 surface acres and has a usable storage of 1,671,300 acre-feet. The Snake River from the backwaters of American Falls Reservoir upstream to Tilden Bridge, a distance of approximately 20 miles (32 km), is considered an excellent trout stream. Numerous springs arise on the Fort Hall Bottoms, located near the upper end of American Falls Reservoir and between the Portneuf River on the south and the Snake River on the north. These springs produce approximately 1,800,000 acre-feet of water annually, more than enough to fill American Falls Reservoir. The two largest of

the reservation springs are Clear Creek (7 miles [11 km] long) and Spring Creek (11 miles [18 km] long). These creeks are considered high-quality spawning and rearing streams and managed by the Shoshone-Bannock Tribes. The Snake River flows 37 river miles (60 km) from Tilden Bridge to the Gem State Power Dam and runs through a mixed cottonwood riparian community. Water is diverted from the river at numerous points in this reach. During the irrigation season and early fall, river flows vary depending on amount released from upriver storage and amount diverted at each canal.

Riparian/Herbaceous Wetlands—Five hundred points of water diversion have been constructed in the American Falls watershed for irrigation purposes. The most significant diversion is American Falls Dam. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current estimates of riparian/herbaceous wetland habitat composition in the watershed amount to 3%.

Open Water—Open water habitat comprises 2% of the landscape in the American Falls watershed. Collectively, 6 dams in the watershed created approximately 387 acres (157 ha) of open water habitat. **Shrub-Steppe**—Shrub-steppe habitats currently comprise nearly 45% of the landscape in the American Falls watershed. According to the best estimates, shrub-steppe habitat has decreased nearly 52% from historical conditions. Shrub-steppe habitat decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture, inundation from American Falls Reservoir, and significant losses from rangeland fires during the previous century. Furthermore, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions, mostly by livestock

grazing and noxious weeds (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are not a significant vegetative component in the American Falls watershed, amounting to just 1% of the landscape.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the American Falls watershed. Approximately 1% of the current landscape is characterized by these habitat elements. **Whitebark Pine**—Whitebark pine is not an identified vegetative element either historically or currently in the American Falls watershed.

Aspen—Aspen habitat is a patchily distributed resource associated with riparian habitats in the American Falls watershed. Current estimates of aspen habitat composition in the watershed amount to slightly more than 1%. **Mountain Brush**—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the American Falls watershed. According to the best available data, the mountain brush habitats currently comprise less than 1% of the habitat in the American Falls watershed. Mountain brush habitat gains have been estimated to be 165% from historical conditions.

2.4.2.2 Blackfoot (BFT)

Aquatic—The Blackfoot River and tributaries total 346 miles (557 km), covering 734 surface acres. Blackfoot Reservoir covers 19,000 surface acres and contains 350,000 acre-feet of water at full capacity. The Blackfoot River is the reservoir's major tributary and has a mean annual flow of 168 cfs. The river upstream from the reservoir extends 35 miles (56 km) to its origin at the confluence of Lane and Diamond creeks. Habitat conditions are generally fair in the upper river and tributaries,

with a few exceptions due to livestock grazing and irrigation diversions. One of the largest phosphate ore reserves in the United States is located in this drainage. Environmental problems associated with phosphate mining have been minimal to date. However, there is an ongoing investigation into effects of selenium from mines on the fish and wildlife in the upper Blackfoot River drainage.

Riparian/Herbaceous Wetlands—Five hundred fifty points of water diversion have been constructed in the Blackfoot watershed for irrigation purposes. The most significant diversion is Blackfoot Dam. Current estimates of riparian/herbaceous habitat composition in the watershed amount to 3%. **Open Water**—Open water habitat comprises 2% of the landscape in the Blackfoot watershed. Most of this habitat was created when Blackfoot dam was completed in 1925, creating approximately 36,000 acres (14,569 ha) of open water habitat with the formation of Blackfoot Reservoir. An additional 742 acres (300 ha) of open water habitat was created when dams were completed on the Bear River, Cutoff Canyon Creek, Chicken Creek, Angus Creek, and the Blackfoot River.

Shrub-Steppe—Shrub-steppe habitats currently comprise nearly 61% of the landscape in the Blackfoot watershed. According to the best estimates, shrub-steppe habitat has decreased nearly 3% from historical conditions. Decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture, inundation from Blackfoot Reservoir, and losses to rangeland fires during the previous century. Furthermore, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions by livestock grazing (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are not a significant vegetative

component in the Blackfoot watershed, amounting to less than 5% of the landscape. However, based on the best available data, this habitat has increased 16% from historical conditions. The habitat increase may be a result of an altered fire regime that has allowed localized patches of forest to expand at the expense of shrub-steppe or grassland habitats. The quality of the pine/fir forest habitat has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Blackfoot watershed. Less than 1% of the current landscape is characterized by these habitat elements. Based on the best available data, juniper/mountain mahogany habitat has decreased 73% from historical conditions.

Whitebark Pine—Whitebark pine is not an identified vegetative element either historically or currently in the Blackfoot watershed.

Aspen—Aspen habitat is a prominent, although patchily distributed, resource in the Blackfoot watershed. Current estimates of landscape composition amount to 11% in the watershed. It has been estimated that aspen habitats in the Blackfoot watershed have decreased 62% from historical conditions primarily due to the effects of an altered fire regime.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Blackfoot watershed.

2.4.2.3 *Goose (GSE)*

Aquatic—Goose Creek begins in Idaho, flows southward into Nevada, turns and flows northward back into Idaho, and then flows northward through high desert until it empties into Lower Goose Creek (Oakley) Reservoir. This reservoir stores water for irrigation and flood control and supports a fishery of stocked rainbow trout and some cutthroat trout. Goose Creek is the major stream in the watershed. Historically, Goose Creek connected to the Snake River; currently, Goose Creek ends at Oakley Reservoir. There is minimal stream habitat remaining downstream of Oakley Reservoir. Headwater tributaries are thought to be in good condition. Big Cottonwood and Dry creeks are tributaries to the Snake River in the Goose watershed that were isolated by Murtaugh Reservoir.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Goose watershed results from various forms of development and/or conversion within the floodplain. Eleven hundred points of water diversion have been constructed in the Goose watershed for irrigation purposes. Current estimates of riparian/herbaceous habitat composition in the watershed amount to less than 1%. Data limitations prevent an accurate or precise quantification of the direct and indirect losses of riparian/herbaceous wetland habitat in the Goose watershed (Appendix 2-1).

Open Water—Open water habitat encompasses less than 1% of the landscape in the Goose watershed.

Goose Creek Reservoir provides the only significant source of open water habitat in the watershed. Approximately 1,350 acres (546 ha) of habitat were created when Goose Creek Dam was completed in 1916. Lake levels may be stabilized or manipulated at any

time of the year for recreation, power, and irrigation. Water level manipulations affect aquatic habitat quantity and quality in the watershed by altering upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise nearly 65% of the landscape in the Goose watershed. According to the best estimates, shrub-steppe habitat has decreased nearly 27% from historical conditions. Decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses from rangeland fires during the previous century. Furthermore, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are not a significant vegetative component in the Goose watershed, amounting to less than 2% of the landscape. However, based on the best available data, this habitat has increased 341% from historical conditions. These habitat increases may be a result of an altered fire regime that has allowed localized patches of forest to expand at the expense of shrub-steppe or grassland habitats. Historically, this habitat was mostly open and park-like, with relatively little undergrowth. Timber harvest activities in the watershed during the last century selectively harvested the mature stands, while other factors limit reestablishment of normal forest successional processes. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat becomes increasingly significant in terms of vegetative composition in the southern portions of the Upper Snake province. In the Goose watershed, juniper/mountain

mahogany vegetative composition is estimated to be greater than 7%. Based on the best available data, juniper/mountain mahogany habitat has increased 15% from historical conditions. Juniper/mountain mahogany expansion is largely attributed to an altered fire regime that no longer inhibits the expansion of this habitat, an expansion at the expense of the shrub-steppe and native grassland habitats.

Whitebark Pine—Whitebark pine is not an identified vegetative element either historically or currently in the Goose watershed.

Aspen—Aspen habitats are a patchily distributed resource in the Goose watershed. Aspen habitat is not a significant component in the watershed and currently comprises 1% of the landscape. It has been estimated that aspen habitats in the Goose watershed have decreased 58% from historical conditions primarily due to the effects of an altered fire regime.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Goose watershed.

2.4.2.4 Idaho Falls (IFA)

Aquatic—The mainstem Snake River and the South Fork Snake River downstream from Heise are in this watershed. Three low-head power dams that do not have fish passage fragment the mainstem Snake River. Habitat is degraded by sediment impacts from the Teton Dam collapse. The South Fork Snake River in this watershed is subject to substantial water withdrawals during irrigation season.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the

Idaho Falls watershed results from various forms of development and/or conversion within the floodplain. Twelve hundred fifty points of water diversion have been constructed in the Idaho Falls watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. **Open Water**—Open water habitat encompasses less than 1% of the landscape in the Idaho Falls watershed. Collectively, 5 dams in the watershed created approximately 856 acres (346 ha) of open water habitat. **Shrub-Steppe**—Shrub-steppe habitats currently comprise nearly 22% of the landscape in the Idaho Falls watershed. According to the best estimates, shrub-steppe habitat has decreased nearly 76% from historical conditions. Decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses from rangeland fires during the previous century. Also, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are not a significant vegetative component in the Idaho Falls watershed, amounting to less than 1% of the landscape. Based on the best available data, this habitat has decreased 92% from historical conditions. **Juniper/Mountain Mahogany**—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Idaho Falls watershed. Less than 1% of the current landscape is characterized by these habitat elements. **Whitebark Pine**—Whitebark pine is not an identified vegetative element either historically or currently in the Idaho Falls watershed.

Aspen—Aspen habitat is a patchily distributed resource associated with riparian habitats in the Idaho Falls watershed. Current

estimates of aspen habitat composition in the watershed amount to slightly more than 1%.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and are significant vegetative components of the landscape in the Idaho Falls watershed. According to the best available data, the mountain brush habitats currently comprise 3.5% of the habitat in the Idaho Falls watershed. Mountain brush habitat gains are estimated to be 1,207% from historical conditions.

2.4.2.5 Lower Henrys (LHF)

The Lower Henrys watershed includes the mainstem Henrys Fork downstream of the Ashton Dam to the confluence with the South Fork and including the Falls River drainage. The lower 4 miles of the Falls River is dewatered seasonally, while the remainder of the drainage is in good shape.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Lower Henrys watershed results from various forms of development and/or conversion within the floodplain. Five hundred fifty points of water diversion have been constructed in the Lower Henrys watershed for irrigation purposes. Current estimates of riparian/herbaceous habitat composition in the watershed amount to 3%. **Open Water**—Open water habitat encompasses less than 1% of the landscape in the Lower Henrys watershed. Collectively, 11 dams on Blue Creek, Spring Creek, Sand Creek, and the Henrys Fork have created approximately 750 acres (305 ha) of open water habitat. The most significant amount of habitat was created when Ashton Dam was completed in 1913. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation. Water level manipulations affect aquatic habitat quantity and quality in the watershed by altering

upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise nearly 22% of the landscape in the Lower Henrys watershed. According to the best estimates, shrub-steppe habitat has decreased nearly 75% from historical conditions. The decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses from rangeland fires during the previous century. Furthermore, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are a significant vegetative component in the Lower Henrys watershed, amounting to 10% of the landscape. Based on the best available data, these habitats have increased 143% from historical conditions. However, data limitations pertaining to historical acreages of forested habitats prevent the precise quantification of habitat gains (Appendix 2-1). The quality of the pine/fir forest habitat has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Lower Henrys watershed. Less than 1% of the current landscape is characterized by these habitat elements. Based on the best available data, juniper/mountain mahogany habitat has decreased 97% from historical conditions. Frequent fires and conversion to dryland and

irrigated agriculture have inhibited the expansion of the western juniper component that is common to this region. **Whitebark Pine**—Whitebark pine habitats are broadly distributed across the Lower Henrys watershed at alpine and subalpine elevations. Whitebark pine habitat is not a significant vegetative element on the landscape. Less than 1.5% of the watershed contains whitebark pine habitat. According to the best available information, whitebark pine habitat has declined 92% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitat is a patchily distributed resource associated with riparian habitats in the Lower Henrys watershed. Current estimates of aspen habitat composition in the watershed amount to slightly more than 8%. Aspen habitat losses from historical conditions are estimated at 63%. These losses may be attributed primarily to reduced structure and function resulting from altered hydrologic regimes.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and are significant vegetative components of the landscape in the Lower Henrys watershed. According to the best available data, the mountain brush habitats currently comprise 15% of the habitat in the Lower Henrys watershed. Mountain brush habitat gains are estimated to be 9,218% from historical conditions.

2.4.2.6 Portneuf (PTF)

Aquatic—The Portneuf River and tributaries total 297 miles (478 km) of stream and drain nearly 1,300 square miles (3,367 km²). There are four irrigation storage reservoirs in the watershed covering 1,704 acres (690 ha). The Portneuf River flows into American Falls Reservoir. From this confluence upriver to Siphon Road, the Portneuf River is on the Fort Hall Indian Reservation. The Shoshone-

Bannock Tribes manage reaches of the river and reservoir on this reservation. From American Falls Reservoir upstream to Pocatello, the river receives considerable spring water and has desirable water temperatures for trout. The reach from Pocatello upstream to Marsh Creek contains very few trout, receives very little fishing pressure, and is severely impacted by sediment, irrigation withdrawals, damaged streambanks, and high water temperatures. The Portneuf River, where it flows through Pocatello, was channelized and directed through a flat-bottom, vertical-sided cement flume that is a barrier to upstream movement. From the confluence of Marsh Creek upstream to the Portneuf/Marsh Valley Canal diversion, silt is less of a problem, but low flows caused by irrigation diversions adversely affect the populations of feral brown trout, the main game species in this area. Much of the sediment in the lower Portneuf River comes from Marsh Creek.

Conditions improve upriver from the Portneuf/Marsh Valley diversion since very little water is diverted upriver from here. Also, during summer, water is added to this reach from Chesterfield Reservoir for diversion approximately 20 miles (32 km) downriver at the Portneuf/Marsh Valley Canal. From the Portneuf/Marsh Valley Canal upstream to Lava Hot Springs, a distance of approximately 4 miles, the main problem for fish is severe bank erosion caused by livestock and exacerbated by full flows during the summer growing season. This area contains a mixture of hatchery and natural rainbow trout, brown trout, and cutthroat trout. The 16 miles (26 km) from Lava Hot Springs upstream to Kelly-Toponce Road Bridge once supported an excellent feral rainbow trout population and was a very popular fishery. The Portneuf River above Lava Hot Springs was at one time considered a “blue ribbon” trout stream (Mende 1989). Harvest of wild trout on the river declined in

the late 1980s to a few hundred fish annually and was so low that restrictive regulations would not have been effective. The Idaho Department of Fish and Game, angler groups, the Natural Resource Conservation Service, and landowners began a cooperative effort to correct sediment problems in the Portneuf-Marsh Valley Canal Company’s “outlet canal,” the channelized reach below Chesterfield Reservoir. This reach was identified as contributing most heavily to sediment in the river below. This 10-mile reach upstream from the Kelly-Toponce Road bridge to Chesterfield Reservoir had been extensively damaged by stream channel alterations and contains few trout. From Chesterfield Reservoir upstream, the river has a base flow of less than 10 cfs and significant beaver activity.

Riparian/Herbaceous Wetlands—Thirty-one hundred points of water diversion have been constructed in the Portneuf watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current estimates of riparian/herbaceous habitat composition in the watershed amount to less than 1%. **Open Water**—Open water habitat encompasses less than 1% of the landscape in the Portneuf watershed.

Approximately 1,700 acres (687 ha) of habitat were created by the construction of 7 dams on Yago Creek, Twentyfourmile Creek, Hawkins Creek, Wiregrass Creek, Deer Creek, and the Portneuf River. Most of the open water habitat was created (1,593 acres [645 ha]) when the Portneuf Dam was completed in 1912. All of the larger lakes and many of the smaller lakes in Idaho have dams that maintain lake levels. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation. Water level manipulations affect aquatic habitat quantity and quality in the watershed

by altering upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise nearly 46% of the landscape in the Portneuf watershed. Based on the best estimates, this habitat has decreased nearly 51% from historical conditions. Shrub-steppe habitat decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses from rangeland fires during the previous century. Furthermore, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are not a significant vegetative component in the Portneuf watershed, amounting to less than 1% of the landscape.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Portneuf watershed. Less than 1% of the current landscape is characterized by these habitat elements. Based on the best available data, juniper/mountain mahogany habitat has decreased 14% from historical conditions. Frequent fires and conversion to dryland and irrigated agriculture have inhibited the expansion of the western juniper component that is common to this region. **Whitebark Pine**—Whitebark pine is not a significant vegetative element either historically or currently in the Portneuf watershed.

Aspen—Aspen habitats are a patchily distributed resource in the Portneuf watershed. Aspen habitat is not a significant component in the watershed and currently comprises less than 1% of the landscape. It has been estimated that aspen habitats in the Portneuf watershed have decreased 69% from historical conditions primarily due to the effects of an altered fire regime.

Mountain Brush—Mountain brush habitats are irregularly distributed and are not a significant vegetative component of that landscape in the Portneuf watershed. According to the best available data, the mountain brush habitats currently comprise less than 1% of the habitat in the Portneuf watershed.

2.4.2.7 Raft (RFT)

Aquatic—The Raft River originates in Utah, courses northward near City of Rocks, and then flows out onto the Raft River plain. As it flows northward through the high desert, it is continually dewatered. The drainage is naturally very dry (containing few perennial streams) and also subject to irrigation withdrawals. Water does not reach the river mouth; the river becomes completely dry. Sedimentation is a problem, and it is likely that temperature is also a problem because there is little riparian vegetation. There are Yellowstone cutthroat trout in the upper reaches of the drainage. Although there is little information on the Raft River system in the literature, Bell (1979) has some data on Raft River tributaries. Sublett Reservoir, a small reservoir used for water storage, has excellent rainbow and brown trout reproduction in tributary streams. Below the reservoir, river water is dissipated by withdrawals until the river is completely dewatered. Eightmile Creek and Sixmile Creek are known to support trout.

Riparian/Herbaceous Wetlands—Twenty-one hundred points of water diversion have been constructed in the Raft watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Other forms of development and/or land conversion within the 50- and 100-year floodplains impact wetland habitat quantity and quality. Current estimates of

riparian/herbaceous habitat composition in the watershed amount to more than 1%.

Open Water—Open water habitat encompasses less than 1% of the landscape in the Raft watershed. Collectively, 4 dams in the watershed have created approximately 110 acres (45 ha) of habitat. Sublett Reservoir provides 89% of the open water habitat in the watershed. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation. Water level manipulations affect aquatic habitat quantity and quality in the watershed by altering upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise nearly 60% of the landscape in the Raft watershed. According to the best estimates, this habitat has decreased nearly 45% from historical conditions. Shrub-steppe habitat decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses from rangeland fires during the previous century. The quality of remaining shrub-steppe habitat is severely reduced from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are not a significant vegetative component in the Raft watershed, amounting to 6.3% of the landscape. However, based on the best available data, these habitats have increased 4.7% from historical conditions. These habitat increases may be a result of an altered fire regime that has allowed localized patches of forest to expand at the expense of shrub-steppe or grassland habitats. The pine/fir forest habitat has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires.

Historically, this habitat was mostly open and park-like, with relatively little undergrowth trees. Timber harvest activities in the watershed during the last century selectively harvested the mature stands, while other factors limit reestablishment of normal forest successional processes. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Raft watershed. Currently, 1% of the landscape is characterized by these habitat elements. Based on the best available data, juniper/mountain mahogany habitat has decreased 37% from historical conditions. Frequent fires and conversion to dryland and irrigated agriculture have inhibited the expansion of the western juniper component that is common to this region. The mountain mahogany component is even less significant as a vegetative element in the Raft watershed.

Whitebark Pine—Whitebark pine is not a significant vegetative element either historically or currently in the Raft watershed.

Aspen—Aspen habitats are a patchily distributed resource in the Raft watershed. Aspen habitat currently comprises nearly 7% of the landscape. It has been estimated that aspen habitats in the Raft watershed have decreased 29% from historical conditions primarily due to the effects of an altered fire regime.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and are not a significant vegetative component of that landscape in the Raft watershed. According to the best available data, the mountain brush habitats currently comprise 1.5% of the habitat in the Raft watershed.

2.4.2.8 Teton (TET)

Aquatic—The Teton River originates on the west slope of the Teton Mountains and drains around 800 square miles (2,072 km²) in Idaho and an additional 327 square miles (847 km²) in Wyoming. From the headwaters to its confluence with the Henrys Fork near Rexburg, the mainstem Teton River is about 64 miles (103 km) long. Upstream from the confluence approximately 16 miles (26 km), the Teton River splits into two forks (North Fork and South Fork). The flow into the respective forks is regulated for irrigation purposes.

The Teton River has been subject to a variety of serious environmental constraints. The most serious and devastating of these was the construction and collapse of the Teton Dam on June 5, 1976. On the day of the collapse, the evacuation of the nearly full reservoir resulted in a discharge of nearly 1.7 million cfs below the dam site. These flows not only altered the river below the dam site, but the evacuation of water resulted in a series of massive landslides that transformed the Teton Canyon from a riffle-pool environment into a series of deep, slow pools with short, high-gradient drops. In addition to the habitat alteration caused by the Teton Dam disaster, water table declines, loss of instream flows to irrigation diversions, cattle grazing, and development have restricted the quantity and quality of Teton River aquatic habitat.

In 1998, the Teton River Fishery Enhancement Program began to improve fishing by restoring habitat lost by the flood and the cumulative effects of gradual changes in land-use practices. Cooperative fencing, pasture management, and livestock non-use agreements with landowners are being used to protect and improve riparian habitat in tributaries and river sections. In addition, revegetation and tree revetments are being

used to speed recovery and reduce sediment, while fish passage problems at culverts and canal diversions are being resolved.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Teton watershed results from various forms of development and/or conversion within the floodplain. Twenty-one hundred sixty points of water diversion have been constructed in the Teton watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current estimates of riparian/herbaceous habitat composition in the watershed amount to 1%. Data limitations prevent an accurate or precise quantification of the direct and indirect losses of riparian/herbaceous wetland habitat in the Teton watershed (Appendix 2-1).

Open Water—Open water habitat is nearly nonexistent in the Teton watershed. The construction of Teton Dam in 1975 would have created approximately 2,100 acres (850 ha) of open water habitat, but the collapse of the dam in 1976 resulted in the loss of that habitat. The dam has never been rebuilt. Two additional dams, on Tygee Creek and Spring Creek, have created 12 acres (5 ha) of habitat in the watershed. All of the larger lakes and many of the smaller lakes in Idaho have dams that maintain lake levels. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation. Water level manipulations affect aquatic habitat quantity and quality in the watershed by altering upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise nearly 44% of the landscape in the Teton watershed. Based on the best estimates, this habitat has decreased 89% from historical conditions. Shrub-steppe habitat decreases in this watershed are likely a

result of habitat conversion to dryland and irrigated agriculture and losses from rangeland fires during the previous century. Furthermore, the quality of remaining shrub-steppe habitat is likely severely reduced from the historical conditions through livestock grazing (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are not a significant vegetative component in the Teton watershed, amounting to 2% of the landscape. However, based on the best available data, these habitats have increased 122% from historical conditions. These habitat increases may be a result of an altered fire regime that has allowed localized patches of forest to expand at the expense of shrub-steppe or grassland habitats. The quality of the pine/fir forest habitat has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that increases the likelihood of stand-replacing fires.

The xeric, mature forest component of the pine/fir forest habitat was assessed in terms of Douglas-fir and lodgepole pine habitat. Historically, this habitat was mostly open and park-like, with relatively little undergrowth trees. It was the predominant landscape feature. Timber harvest activities in the watershed during the last century selectively harvested the mature stands, while other factors limit reestablishment of normal forest successional processes. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a significant vegetative element in the Teton watershed. Currently, 8% of the landscape is characterized by these habitat elements. However, data limitations prevent

the accurate or precise quantification of direct and indirect losses or gains of these habitat elements in the watershed.

Whitebark Pine—Whitebark pine is not a significant vegetative element either historically or currently in the Teton watershed.

Aspen—Aspen habitat is a patchily distributed resource associated primarily with riparian habitat in the Teton watershed. Aspen habitat currently comprises 2% of the landscape. It has been estimated that aspen habitats in the Teton watershed have decreased 31% from historical conditions. These losses may be primarily attributed to reduced structure and function that result from altered hydrologic regimes and to altered fire regimes that no longer inhibit conifer encroachment.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and are not a significant vegetative component of that landscape in the Teton watershed. According to the best available data, the mountain brush habitats currently comprise less than 1% of the habitat in the Teton watershed. Mountain brush habitat losses are estimated to be 94% from historical conditions due to altered fire regime characteristics that no longer inhibit the encroachment of dominant conifer species.

2.4.2.9 Upper Henrys (UHF)

Aquatic—The Upper Henrys watershed includes the headwaters of the Henrys Fork of the Snake River, its tributaries, Henrys Lake, and Warm River. The Henrys Fork originates in the Island Park Caldera, with over half of the total discharge above Ashton coming from a series of springs on the east side of the caldera (Benjamin 2000). The largest of these springs, Big Springs, has a discharge of over 5 m³ per second and is considered to be the

headwaters of the Henrys Fork. Henrys Lake is a natural lake that was dammed to increase the storage capacity in 1923. The dam increased the lake level by about 5 meters (16.4 feet). The lake is approximately 6,500 acres (2,630 ha), with a storage capacity of around 90,000 acre-feet. The dam inundated historic tributary spawning habitat. Tributaries to Henrys Lake have been subject to habitat improvement projects in an attempt to increase natural recruitment. Irrigation ditches have also been screened in an attempt to reduce fish losses. Island Park Dam regulates flow on the Henrys Fork and is also a complete fish passage barrier. The river is dominated by rainbow trout, and past silt releases from the dam may still impact habitat immediately downstream from the dam. A small dam on the Buffalo River (tributary to the Henrys Fork just downstream of Island Park Dam) recently had fish passage installed. Mesa Falls on the Henrys Fork was a natural barrier to fish movement.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Upper Henrys watershed results from various forms of development and/or conversion within the floodplain. Seven hundred fifty points of water diversion have been constructed in the Upper Henrys watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Other forms of development and/or land conversion within the 50- and 100-year floodplains impact wetland habitat quantity and quality. Current estimates of riparian/herbaceous habitat composition in the watershed amount to 3%. Data limitations prevent an accurate or precise quantification of the direct and indirect losses of riparian/herbaceous wetland habitat in the Upper Henrys watershed (Appendix 2-1).

Open Water—Open water habitat encompasses less than 1% of the landscape in the Upper Henrys watershed.

Collectively, 15 dams in the watershed have created approximately 14,675 acres (5,939 ha) of habitat. Island Park Reservoir and Henrys Lake provide 95% of the open water habitat in the watershed. Smaller structures have been constructed on Spring, Icehouse, Strong, Thurmon, Sheep, Blue, Sheridan, and Dry creeks and the Henrys Fork. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation. Water level manipulations affect aquatic habitat quantity and quality in the watershed by altering upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise 4.5% of the landscape in the Upper Henrys watershed. According to the best estimates, this habitat has increased nearly 602% from historical conditions. Shrub-steppe habitat increases may be attributed to a component of an altered fire regime whereby the shrub component of grassland habitat expands at the expense of native grassland habitat. Regardless, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are a significant vegetative component in the Upper Henrys watershed, amounting to 22% of the landscape. Based on the best available data, these habitats have increased 67% from historical conditions. However, data limitations pertaining to historical acreages of forested habitats prevent the precise quantification of habitat gains (Appendix 2-1). The quality of the pine/fir forest habitats has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire

suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires.

The xeric, mature forest component of the pine/fir forest habitat was assessed in terms of Douglas-fir and lodgepole pine habitat. Historically, this habitat was mostly open and park-like, with relatively little undergrowth trees. It was the predominant landscape feature. Timber harvest activities in the watershed during the last century selectively harvested the mature stands, while other factors limit reestablishment of normal forest successional processes. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Upper Henrys watershed. Currently, less than 1% of the landscape is characterized by these habitat elements. Based on the best available data, juniper/mountain mahogany habitat has decreased 99% from historical conditions. Frequent fires and conversion to dryland and irrigated agriculture have inhibited the expansion of the western juniper component that is common to this region. The mountain mahogany component is even less significant as a vegetative element in the Upper Henrys watershed.

Whitebark Pine—Whitebark pine habitats are broadly distributed across the Upper Henrys watershed at alpine and subalpine elevations although it comprises less than 1% of the watershed. According to the best available information, whitebark pine habitat has declined 99% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitats are broadly distributed resources in the Upper Henrys watershed. Aspen habitat is a prominent

vegetative component and currently comprises 17% of the vegetative landscape. It has been estimated that aspen habitats in the Upper Henrys watershed have decreased 64% from historical conditions due primarily to the effects of an altered fire regime that promotes conifer encroachment.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Upper Henrys watershed. According to the best available data, the mountain brush habitats currently comprise less than 1% of the habitat in the Upper Henrys watershed. Mountain brush habitat losses are estimated to be less than 1% from historical conditions due to an altered fire regime that no longer inhibits the encroachment of dominant conifer species.

2.4.2.10 Upper Snake–Rock (USR)

Aquatic—The Snake River in the Upper Snake–Rock watershed is heavily impacted by flow regulation and temperature alterations from upstream reservoirs. Murtaugh Dam is an impassable barrier to fish migration, Vinyard and Deer Creeks, which are accessible to fish from the Snake River, may provide limited spawning habitat for trout in this watershed.

Riparian/Herbaceous Wetlands—Riparian/herbaceous wetlands are a significant habitat element of the landscape in the Upper Snake–Rock watershed. The most quantifiable impact to wetland habitats in this watershed results from various forms of development and/or conversion within the floodplain. Two thousand seven hundred seventy-five points of water diversion have been constructed in the Upper Snake–Rock watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current

estimates of riparian/herbaceous habitat composition in the watershed amount to 7%. Data limitations prevent an accurate or precise quantification of the direct and indirect losses of riparian/herbaceous wetland habitat in the Upper Snake–Rock watershed (Appendix 2-1).

Open Water—Open water habitat encompasses slightly more than 1% of the landscape in the Upper Snake–Rock watershed. Most of the 4,000 acres of open water habitat was created when Milner Dam was completed in 1905. An additional 727 acres (294 ha) of open water habitat was created when the Auger Falls, Twin Falls, Wilson Lake, and Shoshone Falls dams were built. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation. Water level manipulations affect aquatic habitat quantity and quality in the Upper Snake–Rock watershed by altering upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise nearly 12% of the landscape in the Upper Snake–Rock watershed. Based on the best estimates, this habitat has decreased 81% from historical conditions. Shrub-steppe habitat decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses from rangeland fires during the previous century. Furthermore, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions by livestock grazing (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are a significant vegetative component in the Upper Snake–Rock watershed, amounting to 45% of the landscape. The quality of the pine/fir forest habitats has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem

density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires.

The xeric, mature forest component of the pine/fir forest habitat in this watershed is primarily characterized by lodgepole pine with aspen habitat “stringers.” The majority of forested stands are overly mature and decadent. There are only limited amounts of Douglas-fir in the watershed in localized areas. Some portions of the watershed that have either been burned or had timber removed within the last century have a younger tree cohort that gives the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a comparatively minor vegetative element in the Upper Snake–Rock watershed. Currently, less than 1% of this watershed’s landscape is characterized by these habitat elements. Based on the best available data, juniper/mountain mahogany habitat has decreased 7% from historical conditions. At mid elevations where this habitat occurs, frequent fires have reduced the extent of the habitat and prevented the expansion of western juniper commonly observed in other parts of its range. The mountain mahogany component is even less significant as a vegetative element in the Upper Snake–Rock watershed.

Whitebark Pine—Whitebark pine habitat is not a significant vegetative element in the Upper Snake–Rock watershed. Less than 1% of the watershed contains whitebark pine habitat.

Aspen—Aspen habitats are broadly, though patchily, distributed in the Upper Snake–Rock watershed. Aspen habitat is a prominent vegetative component and currently comprises 14% of the vegetative landscape.

The habitat is closely associated with pine/fir forest habitats and wet/spring riparian areas at mid to high elevations. The effects of altered hydrologic processes in this watershed most likely limit aspen habitat. In some areas of the watershed, decreased fire frequency undoubtedly allows conifers to encroach and dominate aspen.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and are significant vegetative components of that landscape in the Upper Snake–Rock watershed. According to the best available data, the mountain brush habitats currently comprise less than 1% of the habitat in the Upper Snake–Rock watershed. Mountain brush habitat gains are estimated to be 368% from historical conditions.

2.4.2.11 Lake Walcott (LWT)

Aquatic—The Snake River in this watershed is heavily impacted by flow regulation and temperature alterations from reservoirs within the watershed and upstream. Flows in the mainstem Snake River are controlled by American Falls, Minidoka, and Milner dams. Minidoka Dam forms Lake Walcott in this watershed. There is a legal minimum flow of 0 cfs in the Snake River below Milner Dam and downstream of Minidoka Dam. Most tributaries in the watershed are disconnected. Rock Creek in the Lake Walcott watershed contains very few perennial streams.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Lake Walcott watershed results from various forms of development and/or conversion within the floodplain. One thousand fifty points of water diversion have been constructed in the Lake Walcott watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current estimates of

riparian/herbaceous habitat composition in the watershed amount to less than 1%.

Open Water—Open water habitat encompasses less than 1% of the landscape in the Lake Walcott watershed. Most of the 56,000 acres (22,662 ha) of open water habitat was created when American Falls Dam was completed in 1978. An additional 11,850 acres (4,796 ha) of habitat was created by the construction of Minidoka Dam 1906. Together, these two waterbodies provide the most significant open water habitat in terms of quantity and quality for numerous fish and wildlife species in the Upper Snake province. Eight additional structures create a total of 160 acres (65 ha) of habitat in the watershed. Lake levels may be stabilized or manipulated at any time of the year for recreation, power, and irrigation. Water level manipulations affect aquatic habitat quantity and quality in the American Falls watershed by altering upstream and downstream hydrologic processes.

Shrub-Steppe—Shrub-steppe habitats currently comprise nearly 18% of the landscape in the Lake Walcott watershed. Based on the best estimates, this habitat has decreased 51% from historical conditions. Shrub-steppe habitat decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses due to frequent rangeland fires during the previous century. Furthermore, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions by livestock grazing (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are not a significant vegetative component in the Lake Walcott watershed, amounting to less than 1% of the landscape. Pine/fir forests were likely never a significant vegetative element in the watershed. Based on the best available data, this habitat has

increased 402% from historical conditions. Habitat gains may be attributable to an altered fire regime that has allowed localized patches of forest to expand at the expense of shrub-steppe or grassland habitats. The quality of the pine/fir forest habitat has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a comparatively minor vegetative element in the Lake Walcott watershed. Currently, less than 1% of the landscape is characterized by these habitat elements. Based on the best available data, juniper/mountain mahogany habitat has decreased 65% from historical conditions. At mid elevations where this habitat occurs, frequent fires have reduced the extent of the habitat and prevented the expansion of western juniper commonly observed in other parts of its range. The mountain mahogany component is an even less significant vegetative element in the Lake Walcott watershed.

Whitebark Pine—Whitebark pine is not an identified vegetative element either historically or currently in the Lake Walcott watershed.

Aspen—Aspen habitat is a patchily distributed resource associated primarily with riparian habitat in the Lake Walcott watershed. Aspen habitat currently comprises less than 1% of the landscape. It has been estimated that this habitat in the Lake Walcott watershed has decreased 67% from historical conditions. These losses may be attributed primarily to reduced structure and function resulting from altered hydrologic regimes.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative

component of that landscape in the Lake Walcott watershed. According to the best available data, the mountain brush habitats currently comprise less than 1% of the habitat in the Lake Walcott watershed. Mountain brush habitat losses are estimated to be 55% from historical conditions.

2.4.2.12 Willow (WIL)

Aquatic—The Willow Creek drainage includes over 95 miles (153 km) of streams above Ririe Reservoir. Most of these streams are in narrow canyons and contain important wild cutthroat populations. Since 1924, up to 20,000 acre-feet of water a year has been diverted from the Willow Creek drainage to Blackfoot Reservoir through Clark's Cut Canal. Intense agricultural practices have contributed to poor riparian habitat conditions in the upper watershed. Water quantity and quality have suffered as a result. The Natural Resource Conservation Service has identified the Willow Creek drainage as one of the 10 worst soil erosion areas in the United States. A water quality program has been initiated to reduce loss of topsoils and improve the water quality of Willow Creek above Ririe Dam. Riparian habitat improvement through improved grazing management is a high priority on both state and private lands.

Riparian/Herbaceous Wetlands—Riparian/herbaceous wetlands are a significant habitat element of the landscape in the Willow watershed. The most quantifiable impact to wetland habitats in the Willow watershed results from various forms of development and/or conversion within the floodplain. Three hundred points of water diversion have been constructed in the Willow watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current estimates of riparian/herbaceous habitat

composition in the watershed amount to 11%.

Open Water—Open water habitat encompasses less than 1% of the landscape in the Willow watershed. The Grays Lake structure created approximately 22,000 acres of intermittent open water habitat in the center of the Willow watershed. Ririe Dam, which was built in 1976, created an additional 1,560 acres (631 ha) of habitat. Eight smaller dams created the remaining 300 acres of open water habitat across the watershed.

Shrub-Steppe—Shrub-steppe habitats currently comprise nearly 36% of the landscape in the Willow watershed. Based on the best estimates, this habitat has increased 41% from historical conditions. However, the quality of shrub-steppe habitat in the watershed is severely reduced from the historical conditions by livestock grazing (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are not a significant vegetative component in the Willow watershed, amounting to 2% of the landscape. Based on the best available data, this habitat has decreased 82% from historical conditions. The quality of pine/fir forest habitat in the watershed has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a comparatively minor vegetative element in the Willow watershed. Currently, less than 1% of the landscape is characterized by these habitat elements.

Whitebark Pine—Whitebark pine habitat is not a significant vegetative element in the Willow watershed. Less than 0.1% of the watershed contains whitebark pine habitat. Based on the best available data, whitebark pine habitat has decreased 41% from historical conditions.

Aspen—Aspen habitats are broadly distributed resources in the Willow watershed. Aspen habitat is a prominent vegetative component and currently comprises nearly 25% of the vegetative landscape. It has been estimated that this habitat in the Willow watershed has decreased 42% from historical conditions due primarily to the effects of an altered fire regime promotes conifer encroachment.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Willow watershed.

2.4.3 Closed Basin Subbasin

2.4.3.1 Beaver–Camas (BCM)

Aquatic—Beaver and Camas Creeks are small streams that drain the southern edge of the Centennial Mountains and flow south ending in Mud Lake. Most of the headwater streams are in forested lands. The lower end flows through agricultural/pasture land and has some sediment and riparian issues resulting from land use.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Beaver–Camas watershed results from various forms of development and/or conversion within the floodplain. Nine hundred points of water diversion have been constructed in the Beaver–Camas watershed for irrigation purposes. The diversions have significant ramifications for hydrologic

processes and wetland structure and function in the watershed. Current estimates of riparian/herbaceous habitat composition in the watershed amount to less than 1%.

Open Water—Open water habitat is nearly nonexistent in the Beaver–Camas watershed. Fourteen acres (5.6 ha) of habitat were created when the Hagenbarth and Paul dams were constructed on Crooked Creek and East Modoc Creek, respectively.

Shrub-Steppe—Shrub-steppe is the most encompassing habitat in the Beaver–Camas watershed. This habitat currently comprises nearly 53% of the landscape in the Beaver–Camas watershed. Based on the best estimates, this habitat has increased 2% from historical conditions. Shrub-steppe habitat increases in the watershed may largely be attributed to the altered fire regime that allows the shrub component of grassland habitats to expand at the expense of native grasslands. The quality of shrub-steppe habitat in the watershed is severely reduced from the historical conditions by livestock grazing (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are an important vegetative component in the Beaver–Camas watershed, amounting to 13% of the landscape. Based on the best available data, these habitats have increased 43% from historical conditions. The quality of the pine/fir forest habitats has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires.

The xeric, mature forest component of the pine/fir forest habitat was assessed in terms of Douglas-fir and lodgepole pine habitat. Historically, this habitat was mostly open and park-like, with relatively little undergrowth

trees. It was the predominant landscape feature. Timber harvest activities in the watershed during the last century selectively harvested the mature stands, while other factors limit reestablishment of normal forest successional processes. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Beaver–Camas watershed, amounting to less than 1% of the current habitat. The western juniper component of the habitat is at the northern periphery of its range in this portion of the Upper Snake province; however, it continues to expand its range due in large part to an altered fire regime. The lengthened fire-return intervals give conifers a competitive advantage over the shrub/forb vegetation. The mountain mahogany component of the habitat has declined across the Beaver–Camas watershed because of the altered fire regime. Although mountain mahogany is not a significant component of the landscape, the habitat is of critical importance to overwintering wildlife species (Hickman 1975, Dittberner and Olson 1983, Miller and Tausch 2001).

Whitebark Pine—Whitebark pine habitat is not a significant vegetative element in the Beaver–Camas watershed. Less than 1% of the watershed contains this habitat. Based on the best available data, whitebark pine habitat has decreased 97% from historical conditions.

Aspen—Aspen habitats are broadly distributed resources in the Beaver–Camas watershed. Aspen habitat is an important vegetative component and currently comprises nearly 3% of the vegetative landscape. It has been estimated that aspen habitats in the Beaver–Camas watershed have decreased 50% from historical conditions due

primarily to the effects of an altered fire regime that no longer inhibits conifer encroachment.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Beaver–Camas watershed. According to the best available data, the mountain brush habitats currently comprise 3% of the habitat in the Beaver–Camas watershed.

2.4.3.2 *Birch (BCK)*

Aquatic— Birch Creek contains the smallest amount of stream habitat of any of the sinks drainages. Most of the drainage is considered to be good habitat but the lower section is completely diverted.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Birch Creek watershed results from various forms of development and/or conversion within the floodplain. One hundred points of water diversion have been constructed in the Birch Creek watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current estimates of riparian/herbaceous habitat composition in the watershed amount to less than 1%. **Open Water**—Open water habitat is not identified as occurring in the Birch Creek watershed.

Shrub-Steppe—Shrub-steppe is the most encompassing habitat in the Birch Creek watershed. Shrub-steppe habitats currently comprise nearly 64% of the landscape in this watershed. Based on the best estimates, this habitat has decreased 6% from historical conditions. Shrub-steppe habitat losses in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses due to frequent

rangeland fires during the previous century. Furthermore, the quality of remaining shrub-steppe habitat is severely reduced from the historical conditions by livestock grazing (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are an important vegetative component in the Birch Creek watershed, amounting to nearly 10% of the landscape. Based on the best available data, these habitats have decreased 10% from historical conditions. The quality of the pine/fir forest habitats has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires.

The xeric, mature forest component of the pine/fir forest habitat was assessed in terms of Douglas-fir and lodgepole pine habitat. Historically, this habitat was mostly open and park-like, with relatively little undergrowth trees. It was the predominant landscape feature. Timber harvest activities in the watershed during the last century selectively harvested the mature stands, while other factors limit reestablishment of normal forest successional processes. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Birch Creek watershed, amounting to less than 1% of the current habitat. The western juniper component of the habitat is at the northern periphery of its range in this portion of the Upper Snake province; however, it continues to expand its range due in large part to an altered fire regime. The lengthened fire-return intervals give conifers a competitive advantage over the shrub/forb vegetation.

Based on the best available data, the western juniper component has increased 706% from historical conditions. The mountain mahogany component of the habitat has declined across the Birch Creek watershed because of the altered fire regime. Although mountain mahogany is not a significant component of the landscape, the habitat is of critical importance to overwintering wildlife species (Hickman 1975, Dittberner and Olson 1983, Miller and Tausch 2001).

Whitebark Pine—Whitebark pine habitats are broadly distributed across the Birch Creek watershed at alpine and subalpine elevations. Whitebark pine habitat is probably most pristine in the watersheds of the Closed Basin subbasin. Current estimates indicate that whitebark pine habitat comprises 8% of the landscape in the Birch Creek watershed. Whitebark pine habitat has increased in the Birch Creek watershed an estimated 12% from historical conditions.

Aspen—Aspen habitats are patchily distributed and a minor habitat element in the Birch Creek watershed. Although rarely occurring in the Birch Creek watershed, aspen habitat is an important vegetative component and currently comprises less than 1% of the vegetative landscape. It has been estimated that aspen habitats in this watershed have decreased 82% from historical conditions due primarily to the effects of an altered fire regime that no longer inhibits conifer encroachment.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Birch Creek watershed. According to the best available data, the mountain brush habitats currently comprise nearly 2% of the habitat in the Birch Creek watershed. Mountain brush habitat gains are estimated to be 5,529% from historical conditions.

2.4.3.3 Big Lost (BLR)

Aquatic—The Big Lost River is the largest of the Closed Basin watersheds. Streamflow in the lower section of the Big Lost River is regulated by Mackay Dam, which was built in 1916 as an irrigation supply reservoir. Downstream from the dam substantial irrigation withdrawal occurs dewatering the lower section and sections of the river have been channelized for flood control purposes. Above the reservoir sections of the Big Lost River are dewatered during irrigation season. Tributary streams are considered productive trout habitat. Historically, the Big Lost River flowed into the Snake River Plain Aquifer.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Big Lost River watershed results from various forms of development and/or conversion within the floodplain. Thirty-eight hundred points of water diversion have been constructed in the Big Lost River watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current estimates of riparian/herbaceous habitat composition in the watershed amount to 2.7%. **Open Water**—Open water habitat encompasses less than 1% of the landscape in the Big Lost River watershed. Mackay Dam on the Big Lost River created 1,392 acres (563 ha) of intermittent open water habitat when it was constructed in 1918.

Shrub-Steppe—Shrub-steppe is the most encompassing habitat in the Big Lost River watershed. This habitat currently comprises nearly 58% of the landscape in the Big Lost River watershed. Based on the best estimates, this habitat has decreased 4.6% from historical conditions. Shrub-steppe habitat decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses due to frequent

rangeland fires during the previous century. The quality of remaining shrub-steppe habitat is severely reduced from the historical conditions by livestock grazing (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are an important vegetative component in the Big Lost River watershed, amounting to nearly 10.3% of the landscape. Based on the best available data, these habitats have decreased 50% from historical conditions. The quality of the pine/fir forest habitats has shifted from a mix of seral stages to a young seral-dominated habitat with higher stem density and lower diversity and cover of understory species. Fire suppression has led to a buildup of fuels that in turn increases the likelihood of stand-replacing fires.

Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Big Lost River watershed, amounting to less than 1% of the current habitat. The western juniper component of the habitat is at the northern periphery of its range in this portion of the Upper Snake province; however, it continues to expand its range due in large part to an altered fire regime. The lengthened fire-return intervals give conifers a competitive advantage over the shrub/forb vegetation. The mountain mahogany component of the habitat has likely declined across the Big Lost River watershed because of the altered fire regime. According to the best estimates, mountain mahogany habitat has declined 97%. Although not a significant component of the landscape, this habitat is of critical importance to overwintering wildlife species (Hickman 1975, Dittberner and Olson 1983, Miller and Tausch 2001).

Whitebark Pine—Whitebark pine habitats are broadly distributed across the Big Lost River watershed at alpine and subalpine elevations. Whitebark pine habitat is probably most pristine in the watersheds of the Closed Basin subbasin. Current estimates indicate that whitebark pine habitat comprises 8% of the landscape in this watershed. According to the best available information, whitebark pine habitat has declined 4.6% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitats are patchily distributed and a minor habitat element in the Big Lost River watershed. Although rarely occurring in the Big Lost River watershed, at 1% of the vegetative landscape, aspen habitat is an important ecological component. It has been estimated that aspen habitats in the Big Lost River watershed have decreased 26% from historical conditions due primarily to the effects of an altered fire regime that no longer inhibits conifer encroachment.

Mountain Brush—According to the best available data, the mountain brush habitats currently comprise nearly 1% of the habitat in the Big Lost River watershed. Mountain brush habitat gains are estimated to be 6,569% from historical conditions.

2.4.3.4 Little Lost (LLR)

Aquatic—The Little Lost River flows southwesterly between the Lost River and Lemhi mountains until the river sinks into the Snake River Plain Aquifer. Portions of the lower Little Lost River are dried up during the year by irrigation diversions. Habitat restoration activities have been improving habitat in the watershed with positive results. The flow in the Little Lost River is a typical snowmelt dominated hydrograph. Impacts to riparian habitat are likely contributing to increased water temperatures in some tributaries in the watershed.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Little Lost River watershed results from various forms of development and/or conversion within the floodplain. Six hundred fifty points of water diversion have been constructed in the Little Lost River watershed for irrigation purposes. The diversions have significant ramifications for hydrologic processes and wetland structure and function in the watershed. Current estimates of riparian/herbaceous habitat composition in the watershed amount to 1.4%.

Open Water—Open water habitat is nearly nonexistent in the Little Lost River watershed. One hundred acres (40.5 ha) of habitat were created when Summit Dam was constructed in 1921 on Pass and Big Gulch creeks.

Shrub-Steppe—Shrub-steppe is the most encompassing habitat in the Little Lost River watershed. Shrub-steppe habitats currently comprise nearly 53% of the landscape in the Little Lost River watershed. Based on the best estimates, this habitat has decreased 18% from historical conditions. Shrub-steppe habitat decreases in this watershed are likely a result of habitat conversion to dryland and irrigated agriculture and losses due to frequent rangeland fires during the previous century. The quality of remaining shrub-steppe habitat is severely reduced from the historical conditions by livestock grazing (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are an important vegetative component in the Little Lost River watershed, amounting to nearly 13% of the landscape. Based on the best available data, these habitats have decreased 2% from historical conditions. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Little Lost River watershed, amounting to less than 1% of the current habitat. The mountain mahogany component of the habitat has declined across the Little Lost River watershed because of the altered fire regime. According to the best estimates, mountain mahogany habitat has declined 87%. Although mountain mahogany is not a significant component of the landscape, the habitat is of critical importance to overwintering wildlife species (Hickman 1975, Dittberner and Olson 1983, Miller and Tausch 2001).

Whitebark Pine—Whitebark pine habitats are broadly distributed across the Little Lost River watershed at alpine and subalpine elevations. Whitebark pine habitat is probably most pristine in the Closed Basin subbasin watersheds. Current estimates indicate that whitebark pine habitat comprises 8% of the landscape in the Little Lost River watershed. According to the best available information, whitebark pine habitat has declined 4.6% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitats are patchily distributed and a minor habitat element in the Little Lost River watershed. Although rarely occurring in the Little Lost River watershed, at 1% of the vegetative landscape, aspen habitat is an important ecological component. It has been estimated that aspen habitats in this watershed have decreased 26% from historical conditions due primarily to the effects of an altered fire regime that no longer inhibits conifer encroachment.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Little Lost River watershed. According to the best

available data, the mountain brush habitats currently comprise 3% of the habitat in the Little Lost River watershed. Mountain brush habitat gains are estimated to be 3,770% from historical conditions.

2.4.3.5 Medicine Lodge (MDL)

Aquatic—Medicine Lodge Creek is the largest stream in the Medicine Lodge Watershed. Medicine Lodge Creek flows in a southerly direction until it reaches the desert where the waters sink into the Snake River Plain Aquifer. The watershed is small with only 98 named streams and approximately 600 km of stream habitat with most streams on public land. Stream habitat is considered good throughout much of the watershed.

Riparian/Herbaceous Wetlands—The most quantifiable impact to wetland habitats in the Medicine Lodge watershed results from various forms of development and/or conversion within the floodplain. Five hundred points of water diversion have been constructed in the Medicine Lodge watershed for irrigation purposes. Current estimates of riparian/herbaceous habitat composition in the watershed amount to less than 1%. **Open Water**—Open water habitat encompasses less than 1% of the landscape in the Medicine Lodge watershed. It is assumed that all open water habitat in the watershed is naturally occurring. **Shrub-Steppe**—Shrub-steppe is the most predominant focal habitat in the Medicine Lodge watershed. Shrub-steppe habitats currently comprise nearly 54% of the landscape in the Medicine Lodge watershed. This habitat has increased 38% from historical conditions. Shrub-steppe habitat increases in the watershed may be attributed to an altered fire regime that allows the shrub component of grassland habitats to expand at the expense of native grasslands. Livestock grazing reduces the quality of remaining shrub-steppe habitat from the historical conditions (Dobler *et al.* 1996, West 1999).

Pine/Fir Forests (Dry, Mature)—Pine/fir forests are an important vegetative component in the Medicine Lodge watershed, amounting to nearly 8% of the landscape. Based on the best available data, these habitats have decreased 52% from historical conditions. Historically, this habitat was mostly open and park-like, with relatively little undergrowth trees. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy.

Juniper/Mountain Mahogany—The juniper/mountain mahogany woodland habitat is a minor vegetative element in the Medicine Lodge watershed, amounting to less than 1% of the current habitat. The mountain mahogany component of the habitat has declined across the Medicine Lodge watershed because of the altered fire regime. According to the best estimates, mountain mahogany habitat has declined 99%.

Whitebark Pine—Whitebark pine habitat is not a significant vegetative element in the Medicine Lodge watershed. Less than 1% of the watershed contains this habitat. Based on the best available data, whitebark pine habitat has decreased 65% from historical conditions due to blister rust and an altered fire regime.

Aspen—Aspen habitats are patchily distributed and a minor habitat element in the Medicine Lodge watershed. Although rarely occurring in this watershed, at 1% of the vegetative landscape, aspen habitat is an important ecological component. It has been estimated that aspen habitats in the Medicine Lodge watershed have decreased 98% from historical conditions primarily due to the effects of an altered fire regime that no longer inhibits conifer encroachment.

Mountain Brush—Mountain brush habitats are irregularly distributed across the landscape and not a significant vegetative component of that landscape in the Medicine

Lodge watershed. The mountain brush habitat currently comprises 1% of the habitat in the Medicine Lodge watershed. Mountain brush habitat gains are estimated to be 378% from historical conditions.

3 Biological Resources Limiting Factors

Abundance, productivity, and diversity of organisms are integrally linked to the characteristics of their ecosystem. We assume a naturally functioning ecosystem provides the basis for sustainable populations of organisms native to that system. Ecosystems, their habitats, and fish and wildlife populations are expected to fluctuate and are more dynamic than stable. These variations demonstrate and rely on the resilience of ecosystems and their components. Resilience is generally greater in systems retaining all or the majority of their components.

Human activities may affect ecosystems in ways similar to natural occurrences, but human impacts tend to be chronic, directional, and long term rather than episodic. Therefore, human effects on ecosystem function tend to alter the system beyond the range of natural variation to which native organisms are adapted, resulting in decreases or limits in habitats, components, or processes that maintain native species.

The Interior Columbia Basin Ecosystem Management Project (ICBEMP) assessment concluded that development of the Interior Columbia River Basin over the last 150 years has greatly altered ecological processes to the detriment of many native fish and wildlife species (ICBEMP 1997). Information collected for the ICBEMP assessment was considered in the preparation of the terrestrial portion of this assessment. ICBEMP data presented here were intended for use at the broad scale, generally at a watershed level or larger scale. Watershed anthropogenic effects contributing to these detrimental changes include unrestricted or little-restricted livestock grazing, road construction, timber harvest and fire management, intensive agricultural practices, placer and dredge

mining, dam construction, and stream channelization. The ICBEMP assessment broadly concluded that anthropogenic disturbances such as these cause risks to ecological integrity by reducing biodiversity and threatening riparian-associated species across broad geographic areas.

We suggest that reduction of habitat quality and quantity and habitat fragmentation are impacting focal fish and wildlife species in the Upper Snake province. The causes and effects of the reductions in habitat quantity and quality are presented in Figure 3-1. In section 3.1, we discuss watershed-specific impacts to aquatic habitats in terms of the degree to which altered ecosystem components impact habitat quality or quantity for focal fish species in the subbasins. The technical teams relied on existing information and professional judgment to make these assessments. Watershed level assessments of terrestrial focal habitats are presented largely in terms of how habitat quality and quantity has been affected by identified causes.

Figure 3-1. Expression of limiting factors and their causes for each focal habitat type in the Upper Snake province. This table is representative rather than comprehensive. The classification of exogenous material in this assessment generally refers to nonnatural physical barriers to migration or sediment, chemical impacts, and introduction of nonnative plants or animals (aquatic habitat information modified from Gregory and Bisson [1997]).

Focal Habitat	Limiting Factor	Cause of Limiting Factor	Expression of Limiting Factor
Aquatic	Habitat quality	Alteration of channel structure	<u>Loss of floodplain access</u> alters hydrology by preventing energy dissipation of high flows, reduces organic matter input from riparian interaction <u>Change in pool to riffle ratio</u> reduces rearing/overwinter habitat <u>Loss or reduction in large woody debris</u> reduces cover for fish, alters sediment storage and pool formation, reduces production of macroinvertebrates, changes salmon carcass transport rates <u>Changed substrate</u> reduces salmonid egg survival and causes loss of interstitial space for rearing, reduces macroinvertebrate production <u>Changes in interaction with groundwater/hyporheic zone</u> reduces nutrient exchange, reduces potential for recolonizing disturbed substrates
		Alteration of hydrology	Changes timing of discharge-related lifecycle, changes food availability, alters sediment and organic matter transport, may reduce biodiversity, leads to juvenile crowding, reduces primary/secondary productivity, increases predation, changes sediment transport by reducing stream power, may result in stranding, increases water temperature
		Increased sedimentation	Reduces salmonid egg survival, affects macroinvertebrate production, reduces rearing area, reduces pool volumes
		Change in water temperature	Alters migration patterns, changes emergence timing, may result in behavioral avoidance, increases susceptibility to disease/parasites, changes mortality in macroinvertebrate community
		Altered riparian areas	

Focal Habitat	Limiting Factor	Cause of Limiting Factor	Expression of Limiting Factor
Aquatic			Reduce cover, reduce large woody debris recruitment thereby changing channel structure, reduce production of macroinvertebrates, reduce access to terrestrial invertebrates for food, reduce growth, decrease shading, increase water temperature (see ecosystem effects to riparian/herbaceous wetlands below)
		Exogenous materials	<u>Chemical pollution</u> reduces invertebrate production, can kill fish <u>Exotics</u> increase competition, displacement, introgression of population, predation, disease risk; alter nutrient cycles
Riparian/herbaceous wetlands	Habitat quantity	Exogenous materials	
			<u>Barriers</u> reduce access to suitable habitat either completely or seasonally, affect behavior by preventing migration and colonization, lead to loss of thermal refuge, result in population fragmentation for resident fish species <u>Chemical pollution</u> makes habitat uninhabitable
	Habitat quality	Altered fire regime	
		Grazing/browsing	Reduces food, cover, shading, and sediment filtering
			Changes soil condition, results in introduction of nonnative vegetation and loss of native vegetation, reduces species diversity and vegetative density, increases water temperature, results in excessive sedimentation due to bank and upland instability, results in high coliform bacterium counts, alters channels, reduces water table, alters aquatic nutrient cycling
		Altered hydrology	Increases water temperature, degrades water quality, alters sediment movement, results in streambank erosion and blockage of material and organisms, reduces habitat complexity, results in stream channelization, results in wetland drainage or filling, leads to inundation, reduces amount of mature riparian vegetation, reduces number of beavers, increases overland flow, reduces filtration capability, increases effects due to pollution

Focal Habitat	Limiting Factor	Cause of Limiting Factor	Expression of Limiting Factor
Riparian/herbaceous wetlands		Timber harvest	
			Results in bed scour and streambank erosion; alters sediment movement and aggregation; destabilizes streambanks; reduces instream woody debris; alters snow depth and timing and rate of runoff; leads to wetter soils, resulting in later summer runoff; accelerates runoff on roads, trails, and landings; degrades water quality
		Land use/conversion/development	
			Seasonal recreation and tourism increase disturbance from road and trail networks
Riparian/herbaceous wetlands	Habitat quantity	Exotic invasive species	
			Reduce biodiversity, productivity and foragability, while physically fragmenting habitats
		Altered hydrology	
			Reduces amount of habitat due to channel alteration and lowered water table
Riparian/herbaceous wetlands	Fragmentation/connectivity	Land use/conversion/development	
			Results in conversion of habitat to agriculture or “urban” areas
		Altered hydrology	
			Reduces amount of habitat due to channel alteration and lowered water table
Shrub-steppe	Habitat quality	Land use/conversion/development	
			Results in loss of linkage and corridor habitats, increases patch and edge habitats, creates linear barriers related to road/trail development

Focal Habitat	Limiting Factor	Cause of Limiting Factor	Expression of Limiting Factor
		Altered fire regime	
			Results in vegetative uniformity and loss of perennial herbaceous understory, increases susceptibility to noxious weed spread, leads to unmanageable fuel loading, results in conversion to annual grassland habitat
		Grazing/browsing	
			Alters vegetative community, ecosystem structure and function, and species composition; leads to trampling of vegetation and soil; alters fire regime; decreases soil organic matter aggregates, decreases infiltration capacity; increases overland flow; results in localized habitat fragmentation due to “trailing”
		Altered hydrology	
			Decreases infiltration capacity, increases overland flow, increases potential for nonpoint source pollution
Shrub-steppe	Habitat quantity	Land use/conversion/development	
			Results in habitat fragmentation from conversion and road networks, increases disturbance from road and trail networks, negative impacts to winter range
		Exotic invasive species	
			Displace native species, alter predator–prey relationships, decrease ecosystem resiliency, reduce biodiversity, reduce soil productivity, reduce aesthetic quality, reduce forage
		Altered fire regime	
			Results in habitat loss due to stand-converting fire
		Land use/conversion/development	
			Results in conversion of habitat to dryland or irrigated agriculture or to development, leads to exclusion due to increased human–wildlife conflict at the wildland interface

Focal Habitat	Limiting Factor	Cause of Limiting Factor	Expression of Limiting Factor
Shrub-steppe	Fragmentation/ connectivity	Altered fire regime	
			Fragments habitat due to stand-converting fire
		Land use/conversion/development	
			Results in loss of linkage and corridor habitats, increases patch and edge habitats, creates linear barriers related to road/trail development
Pine/fir forest	Habitat quality	Altered fire regime	
			Reduces landscape complexity and habitat diversity, alters nutrient flow and other ecosystem processes, alters successional stages and associated plants and animals, elevates insect and disease risk
		Grazing/browsing	
			Alters fire regime and forest structure, reduces herbaceous understory, alters understory cover and composition, results in introduction of noxious weeds, reduces plant litter, alters nutrient cycling, compacts soils, reduces infiltration, increases soil erosion, results in dietary conflicts between wildlife and domestic ungulates
		Timber harvest	
			Reduces productivity, results in loss of nutrients, compacts soil, increases soil erosion, disrupts microorganism processes, results in fragmentation
		Land use/conversion/development	
			Increases disturbance from road and trail networks
Pine/fir forest	Habitat quantity	Exotic invasive species	
			Outcompete native plant species, reduce native plant and animal biodiversity, decrease forage production, increase soil erosion, increase sedimentation

Focal Habitat	Limiting Factor	Cause of Limiting Factor	Expression of Limiting Factor
Pine/fir forest	Fragmentation/ connectivity	Timber harvest	Results in loss of habitat such as old growth, alters habitat structural components due to harvest regimes
		Altered fire regime	Fragments habitat due to stand-altering fire
		Land use/conversion/development	Results in loss of linkage and corridor habitats, increases patch and edge habitats, creates linear barriers related to road/trail development
Native grasslands	Habitat quality	Altered fire regime	Results in shrub/conifer encroachment, alters nutrient cycling, leads to vegetative uniformity, increases susceptibility to noxious weed invasion, results in conversion to annual grassland habitat
		Grazing/browsing	Alters vegetative community, ecosystem structure and function, and species composition; leads to trampling of vegetation and soil; alters fire regime; decreases soil organic matter aggregates; decreases infiltration capacity; increases overland flow; results in localized habitat fragmentation due to "trailing"
		Timber harvest	Results in localized erosion, soil compaction, and fragmentation; leads to introduction of noxious weeds
		Land use/conversion/development	Results in habitat fragmentation from conversion and road networks
		Exotic invasive species	

Focal Habitat	Limiting Factor	Cause of Limiting Factor	Expression of Limiting Factor
Native grasslands	Habitat quantity		Displace native species, alter predator–prey relationships, decrease ecosystem resiliency, reduce biodiversity, reduce soil productivity, reduce aesthetic quality, reduce forage
		Altered fire regime	
		Land use/conversion/development	Results in habitat losses due to conversion to shrub/conifer types
Native grasslands	Fragmentation/connectivity		Results in conversion of habitat to dryland or irrigated agriculture or to development, leads to loss due to road/trail development and disturbance
		Land use/conversion/development	
Aspen	Habitat quality		Results in loss of linkage and corridor habitats, increases patch and edge habitats, creates linear barriers related to road/trail development
		Altered fire regime	
			Reduces post-fire regeneration, reduces fine fuels to carry fire, results in conifer encroachment/change in successional processes
		Grazing/browsing	
		Altered hydrology	Reduces aspen habitat due to excessive grazing of regenerative stands
		Timber harvest	Results in localized habitat degradation due to water table reduction
Aspen	Habitat quantity		Reduces size and structure of stands

Focal Habitat	Limiting Factor	Cause of Limiting Factor	Expression of Limiting Factor
Juniper/mountain mahogany		Altered fire regime	
			Reduces aspen habitat due to successional processes
		Grazing/browsing	
			Reduces aspen habitat due to excessive grazing of regenerative stands
		Altered hydrology	
			Reduce aspen habitat due to dysfunctional hydrology
Juniper/mountain mahogany	Habitat quality	Altered fire regime	
			Results in conifer encroachment/change in successional processes; leads to landscape dominated by overly mature, decadent stands and high fuel loading, resulting in “hot” fires with slow regenerative ability
		Grazing/browsing	
			Results in high palatability and nutrition, resulting in overbrowsing; increases water runoff and erosion; reduces regeneration
		Exotic invasive species	
			Displace native species, decrease ecosystem resiliency, reduce biodiversity, reduce soil productivity, reduce forage
Juniper/mountain mahogany	Habitat quantity	Altered fire regime	
			Results in habitat losses due to conifer encroachment
		Grazing/browsing	
			Inhibits regeneration
Whitebark pine	Habitat quality	Altered fire regime	
			Results in interspecific site competition/successional processes; leads to landscape dominated by overly mature, decadent stands

Focal Habitat	Limiting Factor	Cause of Limiting Factor	Expression of Limiting Factor
Whitebark pine		Exotic invasive species	Result in direct mortality due to blister rust
	Habitat quantity	Altered fire regime	Reduces habitat due to lack of regeneration
		Exotic invasive species	
			Result in landscape habitat losses due to blister rust

3.1 Limiting Factors by Watershed

Aquatic habitats are created and maintained by natural processes within the watersheds that surround them: watershed size, vegetation, slope, geology, and climate combine to form the aquatic habitat (Doppelt *et al.* 1993). In addition to reflecting the nature of their watersheds, flowing waters shape watersheds over time by cutting channels, terracing floodplains, depositing sediment, and transporting materials from highlands to lowlands (Stanford 1996). Ward (1989) describes the nature of stream networks, indicating that any point along a stream has four dimensions (longitudinal, lateral, vertical, and temporal) that combine to form that particular location. The longitudinal dimension is related to the location of the point in the profile of the stream (from headwaters to mouth). The lateral dimension encompasses the transition of the stream into the terrestrial environment. The movement of water as subsurface or interstitial flow within the river and its floodplain is the vertical link, and the naturally associated changes in the system over time of all the above components is the temporal dimension.

The distribution and abundance of aquatic animals and invertebrates are determined by their distinct preferences and tolerances for specific habitat conditions. As discussed above, the conditions of a stream at any point along the stream are determined by the conditions upstream of that point; therefore, the distribution and abundance of aquatic species must be examined in the context of the stream and associated watershed.

The functional components of aquatic ecosystems are made up of several ecosystem

“features” that are interrelated and interdependent. These features can generally be classified into the following categories: channel structure, hydrology, sediment, and water quality. In addition to the natural variation present in the processes that form ecosystems, human actions have altered the ecosystem components. The degree of alteration can range from minor to severe, with varying lengths of effects.

However, it is not always easy to clearly quantify or qualify the effects of the causes of limiting factors on focal habitats or species. Difficulties encountered in the analysis of the limiting factors for each habitat type and by watershed are due, in part, to either information gaps or differences in information-collection methods and/or interpretation or to data limitations (Appendix 2-1). Therefore, this assessment relies on expert opinion as much as information and data.

For example, experts evaluated the impacts of limiting factor causes to terrestrial focal habitats for each watershed in the Upper Snake province (Table 3-1). Results from these deliberations suggest that, in general, altered fire regime has resulted in the greatest impacts across all watersheds within the Province, followed by introduced invasive/exotic species, grazing and browsing by domestic animals, land-use conversion, and timber harvest. More specifically, at the watershed level, the Birch Creek and Big Lost River watersheds are impacted the most through six causes of habitat limiting factors but this assessment is based on watershed level data combined with site-specific knowledge.

Table 3-1. Rankings of the impacts of limiting factor causes for terrestrial resources in each watershed in the Upper Snake province (rankings by the technical team: 0 = none to insignificant, 1 = low, 2 = moderate, and 3 = high).

Watershed	Altered Fire Regime	Grazing/Browsing	Altered Hydrologic Regime	Timber Harvest	Land-Use Conversion	Invasive/Exotics
Snake Headwaters subbasin						
Greys–Hoback (GHB)	3	?	1	1	2	?
Gros Ventre (GVT)	3	1	1	1	2	?
Palisades (PAL)	3	2	3	2	3	3
Salt (SAL)	3	2	1	?	3	3
Snake Headwaters (SHW)	3	2	3	2	3	3
Upper Snake subbasin						
American Falls (AMF)	1	3	3	0	2	3
Blackfoot (BFT)	2	3	3	2	3	3
Goose (GSE)	3	3	3	0	3	3
Idaho Falls (IFA)	3	3	3	0	3	3
Lower Henrys Fork (LHF)	3	3	3	0	3	3
Portneuf (PTF)	3	3	3	1	3	3
Raft (RFT)	2	3	3	0	3	3
Teton (TET)	3	2	2	2	3	3
Upper Henrys Fork (UHF)	3	2	3	3	3	2
Upper Snake–Rock (USR)	3	3	2	2	2	3
Lake Walcott (LWT)	1	3	3	0	3	3
Willow (WIL)	3	3	3	2	2	3
Closed Basin subbasin						
Beaver–Camas (BCM)	3	2	2	2	2	3
Birch (BCK)	3	2	2	0	2	2
Big Lost (BLR)	3	2	3	2	2	3
Little Lost (LLR)	3	2	2	1	2	3
Medicine Lodge (MDL)	3	2	2	0	2	3

3.1.1 Snake Headwaters Subbasin

Information for waters in Wyoming is provided by Wyoming Game and Fish Department Staff and Jackson Fish Management. Subbasin Management Plans (WG&F 2004) provided information on the aquatic habitat conditions and limiting factors in this section. For purposes of this

discussion, the boundaries established and used by the Wyoming Game and Fish Department have been preserved.

Table 3-2 ranks the impacts of altered ecosystems for fish in the Snake Headwaters subbasin. While some altered components are not detrimental to fish populations at the watershed level, specific problems do inhibit

fish populations. Watersheds in good condition are most probably a function of a large amount of protected lands (e.g., U.S. Forest Service Roadless Areas, Yellowstone National Park, Grand Teton National Park) (Figure 1-16) combined with many organizations assisting in maintaining the natural state of the region.

Causes of terrestrial limiting factors by watershed (Table 3-3, Table 3-4, Table 3-5, Table 3-6, and Table 3-7) illustrate negative impacts to aquatic focal habitats at the watershed level. Dominant concerns in the

Upper Snake Headwaters basin (Snake Headwaters subbasin) include altered fire regime and land-use conversion. Analysis for altered fire regime in this subbasin was restricted to Idaho, so the watersheds that cross state boundaries are assessed only for the Idaho portion. Where data exist, altered fire regime is characteristically moderate to high, primarily due to over 100 years of intense fire suppression that created a greater potential for large, stand replacement fires. Population density in this subbasin is largely recreational and tourism based, although some agriculture exists.

Table 3-2. Ranked impacts of altered ecosystem features impacting habitat quality and quantity for focal fish species in tributaries to the 5 watersheds of the Snake Headwaters subbasin. Degree of impact on habitat quality or quantity ranked as P (component is functioning properly, needs protection), 1 (least influence), 2 (moderate influence), and 3 (greatest influence, highest priority).

Ecosystem Feature	Altered Component	Palisades	Salt River	Greys–Hoback	Gros Ventre	Snake Headwaters
Channel structure	Floodplain	P	P	P	P	3
	Pool/riffle ratio	P	P	P	P	3
	Large woody debris	P	P	P	P	P
Hydrology	Discharge	3	P	P	P	3
	Low flow/dewatering	3	3	1	1	3
Sediment	Increased fines	P	P	P	P	P
Water quality	Temperature	P	P	P	P	P
Riparian	Shade	P	3	P	P	P
	Streambank stability	P	3	P	P	P
Exogenous	Reservoir operations	3	P	P	P	3
	Barriers	3	2	1	1	3
	Exotics	3	3	P	P	1

3.1.1.1 Greys–Hoback (GHB)

In the Greys River drainage, sediment loading from timbering/grazing practices, as well as natural soil movements from periodic heavy precipitation, limits aquatic habitat quality

(Table 3-2). The area has a high gradient, with ice problems in the winter. The Greys River proper has a poor pool to riffle ratio (< 30% pools). High runoff and low late summer flows result in high stream flow variation. There are limited spawning sites

and nursery areas. Tributaries are generally high gradient and have substrate that is too large for spawning to occur. We identified 5 points of water diversion¹ in the watershed.

In the Hoback River drainage, lack of wintering habitat (anchor and frazil ice problems) is the primary limiting factor in the basin. There is also poor pool development (< 30%) and a general lack of spawning areas in the mainstem and tributaries alike. Heavy runoff during the spawning season limits recruitment. Unstable channels in meadow sections without pool development also limit fish populations. In addition, there is a lack of large woody debris and considerable silt/sediment loading with precipitation or avalanche events.

The terrestrial causes of limiting factors in the Greys–Hoback watershed are dominated by human population density and timber harvest, followed by grazing and browsing by domestic animals. Population in the watershed is concentrated near the resort area of Jackson, Wyoming, and strongly influenced by tourism during summer and winter. Of the area grazed by livestock, cattle graze about 55%; sheep, 41% (Appendix 3-1). While 56% of the area is not harvested for timber (Table 3-3), most of the area that is harvested has at least a moderate impact to focal habitats. One effect has been the fragmentation of aspen stands and the replacement of spruce-fir habitats with lodgepole pine, an early seral species (Figure

3-2 and Appendix 3-1). Species composition changes affect both habitat quantity and quality and result from timber harvest activities and altered fire processes. Data were not available to assess the state of fire regime alteration in this watershed.

¹ The points of water diversion (PODs) summed are actually water rights with surface water irrigation PODs associated with them. The total consists of the Snake River Basin Adjudication recommended rights, the claims they are or will be processing, and any other licensed and permitted rights currently recognized. There can be more than one POD associated with a water right and vice versa, so the count is an estimate. Also, because the amount of water that can be diverted at any one time depends on available water and many other factors, no diversion rates or volumes have been given. Models are being developed to estimate diversion rates or volumes, but the findings can only be verified and used in areas where there is a substantial effort at gauging the flow.

Table 3-3. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Greys–Hoback watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 17	($10 < x > 60$) 58	($60 < x < 100$) 15	($100 < x > 300$) 10
Habitat fragmentation		78	22	<1%	
Altered fire regime	?	?	?	?	?
Timber harvest (56% no harvest)		7	33	5	
Grazing/browsing (27% no grazing or unknown status)		24	48	1	

^a For information about ICBEMP data limitations, see Appendix 2-1.

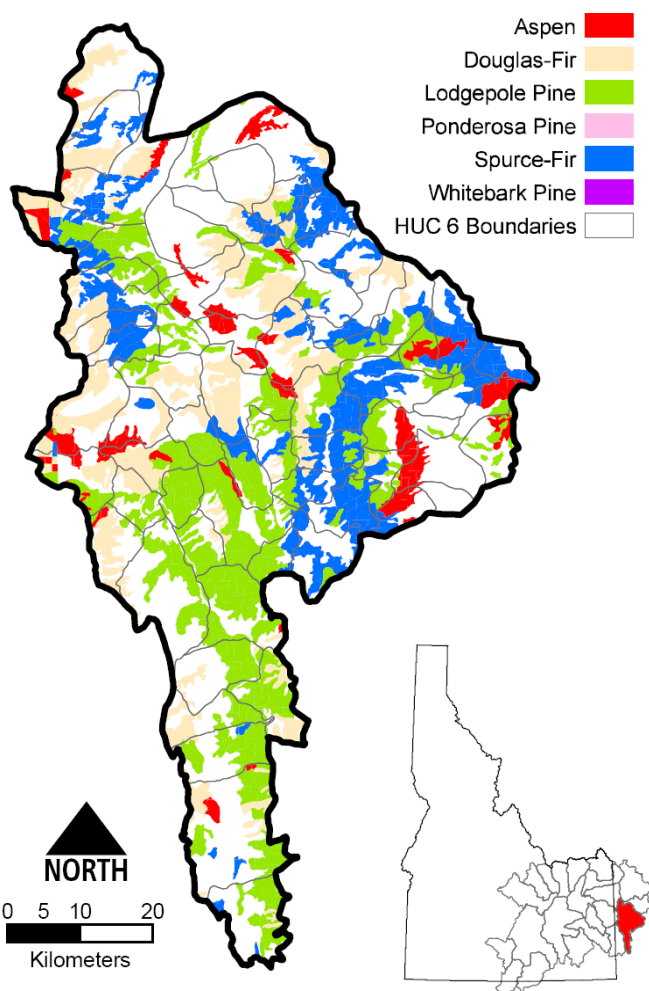


Figure 3-2. Current distribution of forest species compositions in the Greys–Hoback watershed, Snake Headwaters subbasin, Wyoming (GAP II, Scott *et al.* 2002).

3.1.1.2 Gros Ventre (GVT)

In the Gros Ventre watershed, there is a general lack of pools and suitable spawning sites due mostly to high gradient and variation in stream flow. Heavy silt/sediment loading associated with precipitation events also limits populations (Table 3-2). There is poor bank cover and limited riparian system development. Dewatering occurs lower in the system from 26 known water diversions, but the system may have also have been subject to periodic dewatering based on the geology of the area.

The major cause of terrestrial limiting factors in the Gros Ventre watershed is population density. While there are no major population centers in this watershed, it is

near Jackson, Grand Teton National Park, and Yellowstone National Park. Most of the population distribution in this area consists of small developments of recreational and seasonal-use homes mixed with small local population centers. Although human population is high, habitat fragmentation, timber harvest, and grazing all have had a relatively low effect on ecosystems in this area. And although 81% of the watershed is grazed, grazing allotments are primarily for cattle, and the projected impact of this grazing is minimal (Table 3-4 and Appendix 3-1). Data were not available to assess the state of alteration to the fire regime in this watershed.

Table 3-4. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Gros Ventre watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 9	($10 < x > 60$) 66	($60 < x < 100$) 23	($100 < x > 300$) 3
Habitat fragmentation		93	7		
Altered fire regime	?	?	?	?	?
Timber harvest (65% no harvest)			31	4	
Grazing/browsing (19% no grazing or unknown status)		64	17		

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.1.3 Palisades (PAL)

The South Fork Snake River is one of the last remaining strongholds for Yellowstone cutthroat trout, though naturalized rainbow trout are seen as a major threat to the long-term persistence of this population. Altered flow timing/magnitude are thought to contribute to the increasing rainbow trout population, which had been present at low levels for many years. Most tributary

habitats are in good shape and provide the primary spawning habitat for Yellowstone cutthroat trout. Rainey Creek (one of the spawning tributaries) is periodically dewatered. There are 351 points of water diversion (Figure 3-3) in the watershed. Palisades Dam alters the magnitude and timing of flows in the mainstem South Fork Snake River and forms an upstream passage barrier to fish (Table 3-2).

Terrestrial limiting factors in the Palisades watershed are dominated by riparian limitations imposed by regulated flows from Palisades dam. Forested riparian areas below Palisades dam depend on seasonal flooding to renew and rejuvenate cottonwood regeneration, nutrient enrichment, and disturbance. Since the construction of Palisades dam, this highly important forested riparian area has been subject to ongoing decline through water flow management and flood control at Palisades dam. A moderate degree of population, timber harvest, and grazing occurs within the watershed (Table 3-5). As with the Gros Ventre watershed, there are no major population centers in the Palisades watershed, but there are many small rural

populations and a moderate degree of seasonal and recreation-oriented population. Low to moderate grazing occurs over most of the watershed, but it is dominantly sheep grazing, and does not appear to produce an extreme effect on ecosystems (Appendix 3-1). However, a combination of land-use conversion, timber harvest, altered fire regime practices, and grazing by domestic animals has led to some changes in forest species composition. Aspen habitats appear extremely fragmented, and lodgepole pine has replaced spruce-fir habitat (Appendix 3-1). These changes in habitat quality and quantity have increased the probability that the watershed will experience a fire event in the near future (Figure 3-4).

Table 3-5. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Palisades watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$)	($1 < x > 10$) 17	($10 < x > 60$) 74	($60 < x < 100$) 8	($100 < x > 300$) 1	($x > 300$) <1%
Habitat fragmentation		53	41	6	<1%	
Altered fire regime		22	31	33		
Timber harvest (36% no harvest)		24	36	4		
Grazing/browsing (22% no grazing or unknown status)		22	55	1		

^a For information about ICBEMP data limitations, see Appendix 2-1.

Idaho Irrigation Points of Diversion - Surface Water

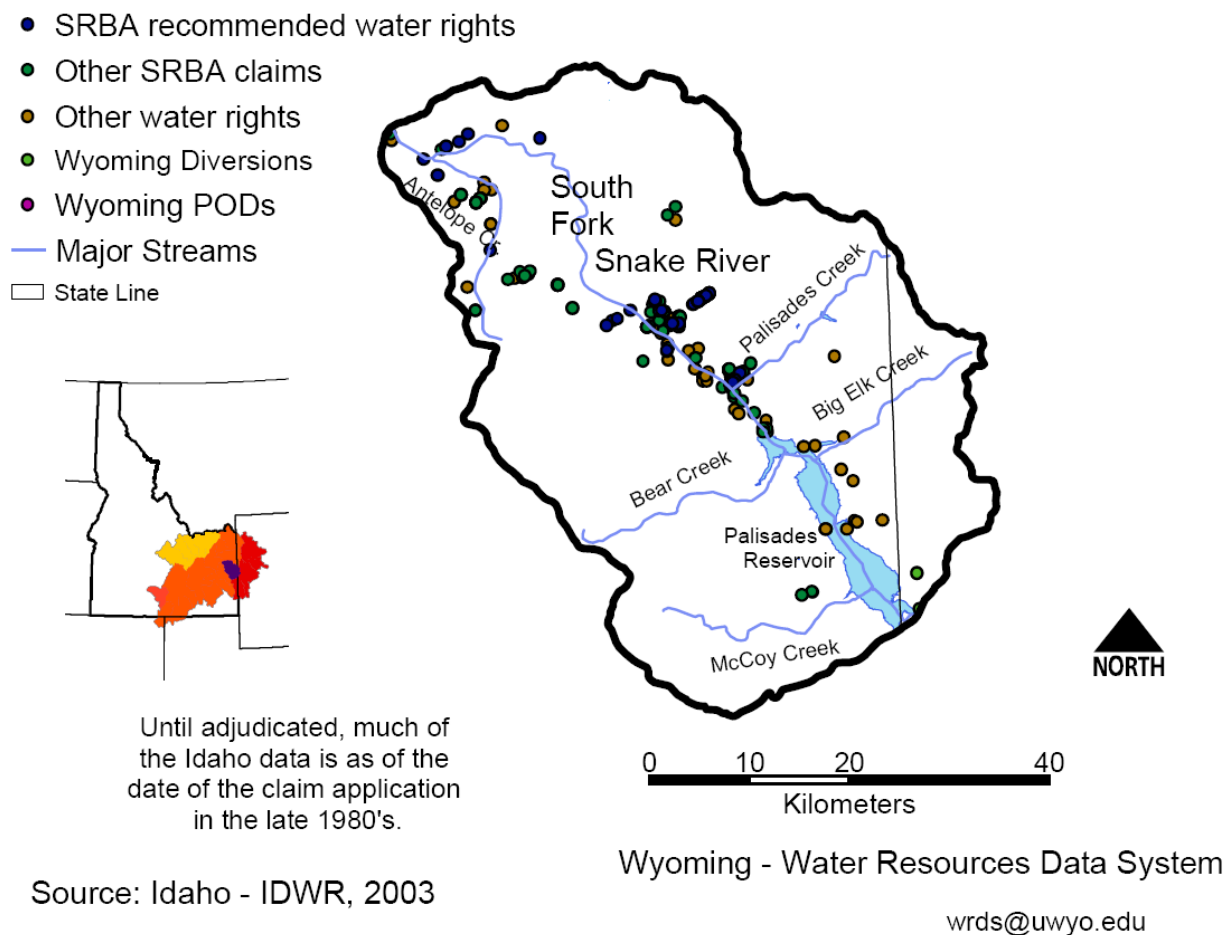


Figure 3-3. Idaho Department of Water Resources points of water diversions in the Palisades watershed, Snake Headwaters subbasin.

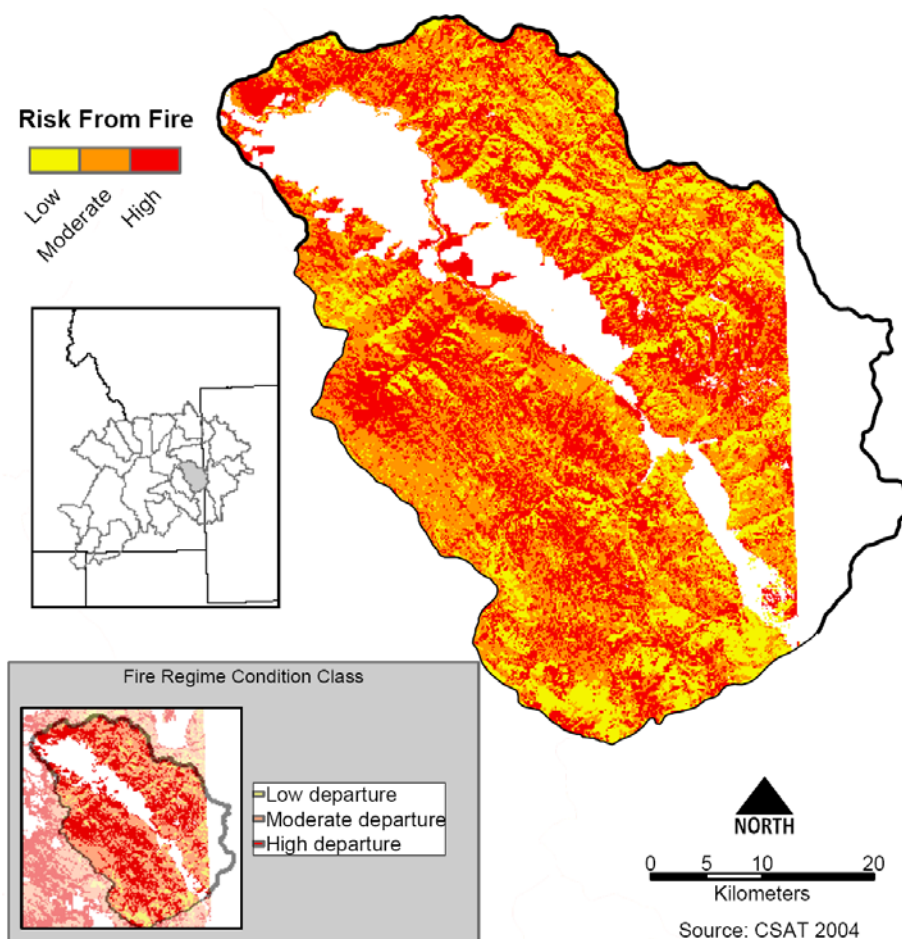


Figure 3-4. Predicted areas within the Palisades watershed, Snake Headwaters subbasin, most likely to be at risk for severe fire effects, taking into account fire regime condition class, ignition probability, and fire weather hazard. Ecosystems-at-risk integrates ignition probability, fire weather hazard, rate-of-spread, and fire regime condition class (the probability of severe fire effects). Source: Northern Regional National Fire Plan Cohesive Strategy Assessment Team, Flathead National Forest (CSAT 2004).

3.1.1.4 Salt (SAL)

Bank damage caused by periodic flooding is a limiting factor in the Lower Salt River Basin (Salt watershed) (Table 3-2). As a result, there is limited bank cover in the form of stable undercuts or streamside shrubs/trees. There are limited spawning areas for Snake River cutthroat trout. Some stream dewatering occurs due to about 298 known diversions that occur during the irrigation season. These effects are lessening due to conversion to

sprinkler irrigation systems. The tributary streams are high gradient and have high variation in stream flow. Water temperatures in Swift Creek above the reservoirs are naturally cold, and the creek below the reservoirs is dewatered. Nonnative species are a concern in the Salt River drainage as brown trout make up most of the biomass in the river's mainstem. Rainbow trout spawning occurs in a spring located on private land on the lower Salt River. Efforts to negotiate removal of rainbow trout from this area have

been unsuccessful. These trout are confined primarily to the lower end of the river.

The Salt watershed contains the population center of Afton, Wyoming and surrounding communities, an important cause of terrestrial limiting factors in the watershed. Associated activities have resulted in a moderate degree

of habitat fragmentation and timber harvest (Table 3-6). Most of the intense timber harvest activities have occurred near waterways in the watershed (Figure 3-5). In the Salt watershed, about 70% of the area is grazed, predominantly by sheep (Appendix 3-1).

Table 3-6. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Salt watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$)	($1 < x > 10$) 13	($10 < x > 60$) 55	($60 < x < 100$) 21	($100 < x > 300$) 11	($x > 300$)
Habitat fragmentation		28	72			
Altered fire regime		22	34	36		
Timber harvest (5% no harvest)		49	32	14		
Grazing/browsing (28% no grazing or unknown status)		35	37			

^a For information about ICBEMP data limitations, see Appendix 2-1.

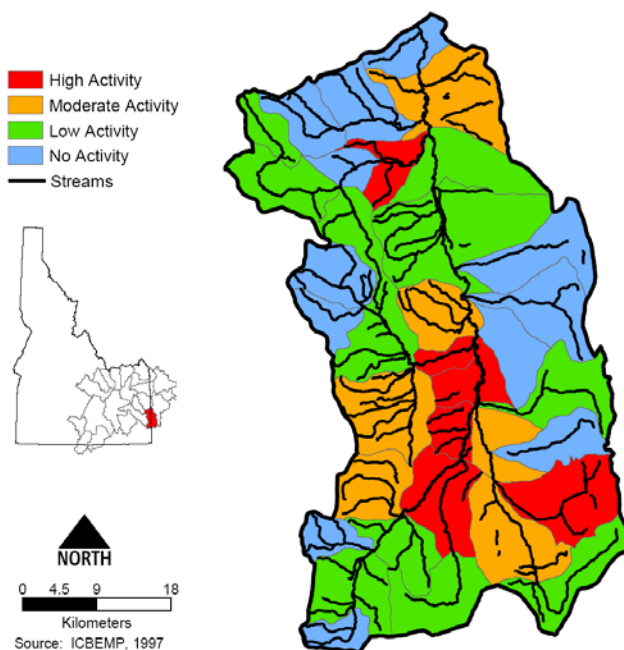


Figure 3-5. Status of timber harvest activity in the Salt watershed, Snake Headwaters subbasin, Idaho and Wyoming (ICBEMP 1997).

3.1.1.5 Snake Headwaters (SHW)

The Snake Headwaters watershed includes the mainstem Snake River from Jackson Lake downstream to the slack water in Palisades Reservoir, excluding major tributaries. This area is part of the area that the Wyoming Game and Fish Department terms the Lower Snake Basin. The primary limiting factors in the Lower Snake Basin are winter flows, loss of instream habitat, and loss of spawning areas (Table 3-2). Reduced winter flow below Jackson Lake Dam limits the amount of available wintering habitat. Dikes encourage aggradation and loss of instream structure and prevent cottonwood regeneration within the riparian areas. Spawning habitat is degraded where livestock and wildlife winter along spring creeks. Also, flooding and gravel rejuvenation in tributary spring creeks have been eliminated by dike construction, resulting in continuing loss of spawning areas.

The Wyoming Game and Fish Department refers to the Snake Headwaters watershed from Jackson Lake Dam upstream to the boundary with Yellowstone National Park as the Upper Snake Basin. A high degree of annual stream flow variation, limited spawning areas, and poor pool development (< 30%) for winter habitat are the primary limiting factors within the Upper Snake River Basin. There is limited access to the upper Snake River. The use of Jackson Lake water for irrigation will continue to alter lake elevations on an irregular basis.

The Snake Headwaters watershed within the boundary of the Teton Wilderness is termed the Wilderness Waters of the Snake Basin by the Wyoming Game and Fish Department. Human impacts in this area are considered minor.

The Buffalo Fork drainage within the Snake Headwaters watershed has high annual stream

flow variation and overall high gradient that limits trout populations. Heavy silt loads from precipitation events limit trout populations in the lower reaches of the basin. Blackrock Creek is diverted above the Blackrock Ranger Station to irrigate the Hatchet Ranch area. Insufficient winter flows limit trout populations above North Fork Falls, while low year-round water temperatures are limiting in Joy Creek. Soda Fork and North Fork Meadows are subject to overexploitation during summer/fall seasons, but trout can be found in the canyon reaches.

Mass movement and erosion are limiting factors in the Cub Creek drainage. Also, a high annual streamflow variation, high gradient, and poor pool to riffle ratio (< 30% pools) limit the trout population. Spawning is limited in long reaches of the mainstem of Cub Creek since the predominant substrate is rubble-boulder. Tributaries provide spawning that favors brook trout, and Snake River cutthroat trout have essentially been displaced. However, there probably never was a strong population of cutthroat trout due to natural limiting factors.

The Snake Headwaters watershed contains portions of Yellowstone and Grand Teton National Parks and does not contain any large population centers. This area is well protected by various state and federal agencies and has very low impacts from most causes of terrestrial limiting factors (Table 3-7). Still, considerable change has occurred in the distribution and composition of forest species within the watershed (Appendix 3-1). Large aspen forests have disappeared from the central areas of the watershed, and lodgepole pine dominates in areas that were once spruce-fir forests (Figure 3-6). Data were not available to assess the state of alteration to the fire regime in this watershed.

Table 3-7. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Snake Headwaters watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$) <1%	($1 < x > 10$)	($10 < x > 60$) 20	($60 < x < 100$) 76	($100 < x > 300$) 4	($x > 300$) <1%
Habitat fragmentation		95	5	<1%		
Altered fire regime		?	?	?	?	?
Timber harvest (81% no harvest)			12	7		
Grazing/browsing (84% no grazing or unknown status)		6	10			

^a For information about ICBEMP data limitations, see Appendix 2-1.

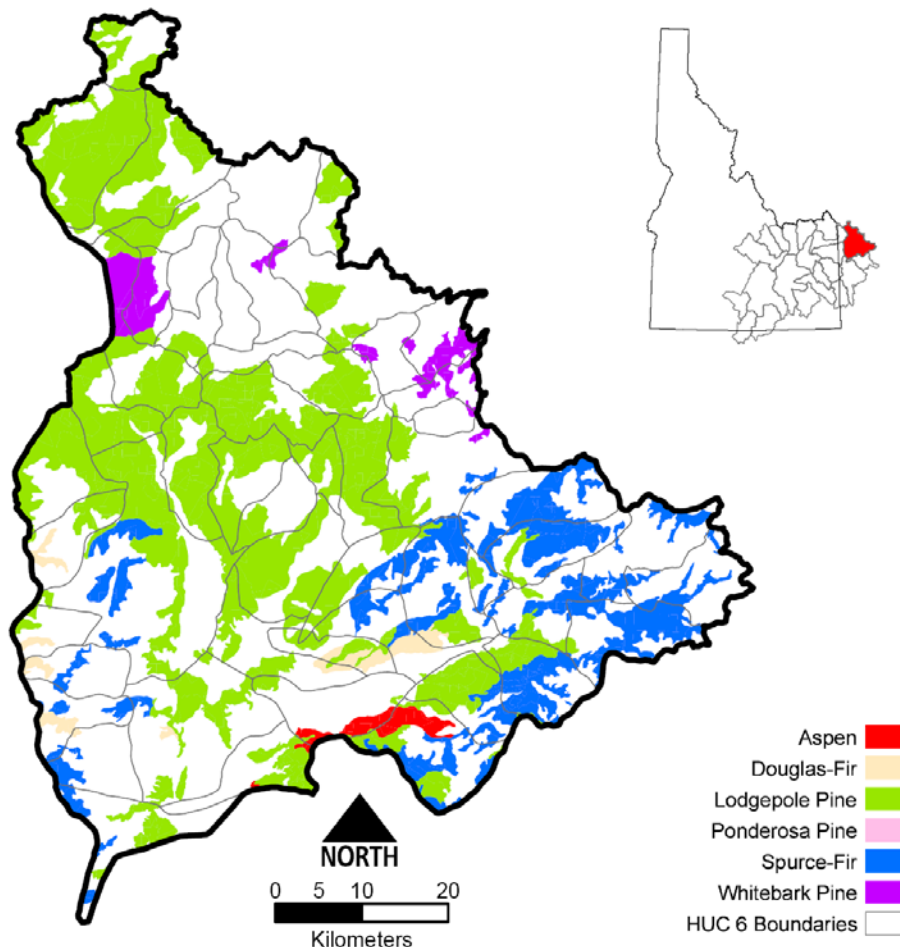


Figure 3-6. Current distribution of forest species compositions in the Snake Headwaters watershed, Snake Headwaters subbasin, Wyoming (GAP II, Scott *et al.* 2002).

3.1.2 Upper Snake Subbasin

High desert ecosystem types characterize the Upper Snake subbasin, with some transition into forested and alpine regions to the east and south. The environment is typically dry, with hot summers and cold, windy winters. Riparian resources within the subbasin vary by watershed, but there are consistent problems with low flow waters, water temperatures, and sediment contamination (Table 3-8). We discuss watersheds individually in context with both riparian and terrestrial causes for limiting factors.

Shrub-steppe habitat is the most significant habitat component in the Upper Snake subbasin. Significant reductions in shrub-steppe habitat quantity and quality has occurred due to the compounding affects of grazing and browsing, altered fire regimes, conversion to other land uses and invasive exotic weeds.

Anthropogenic impacts to the subbasins began with the exploration and settlement of the province during the mid 19th century. By the end of the 1800's grazing and browsing activities had fundamentally altered the structure and function of shrub-steppe habitats across the province (Crawford et al. 2004). Subsequent to human settlement, irrigation technological advances, transformed the subbasins from desert to some of the most agriculturally productive lands in the West. Expansive tracts of land were converted to cropland resulting in increased fragmentation in all but the most remote areas of the province.

At the same time that irrigation was transforming the province, fire suppressive policies and methodology began to lay the foundation for the next stage of shrub-steppe altering influences (Appendix 3.1). Since 1980, nearly 29,000 km² of shrub-steppe habitat has been burned in the Upper Snake

Province. Of that total, nearly 19,000 km² has burned in the Upper Snake subbasin alone. Nearly 1/3 of the remaining shrub-steppe habitat in the Upper Snake subbasin is characterized as either moderately or at high risk of severe fire.

As the population in the province began to grow, associated urban and rural development began to have greater impact upon the natural resources within the subbasins. Approximately 749 hectares of shrub-steppe habitat was converted to urban/rural uses during the last 2 decades. The invasion and spread of exotic invasive weeds further exacerbates the factors limiting shrub-steppe habitat quality and quantity.

Causes of terrestrial limiting factors by watershed (Table 3-9, Table 3-10, Table 3-11, Table 3-12, Table 3-13, Table 3-14, Table 3-15, Table 3-16, Table 3-17, Table 3-18, Table 3-19, and Table 3-20) illustrate negative deviations from the natural state at the watershed level. Dominant concerns in the Upper Snake subbasin include altered fire regime and habitat fragmentation. Analysis of altered fire regime in this subbasin was restricted to Idaho, so the watersheds that cross state boundaries are assessed only for the Idaho portion. Where data exist, altered fire regime is characteristically moderate to high, primarily due to over 100 years of intense fire suppression that created a greater potential for large, devastating fires. Currently, on the high desert, seasonal wildfires that are sparked by humans or dry lightning burn large tracts of primarily shrub steppe habitats each year. This disturbed land is of primary concern for invasion of noxious and exotic weeds, such as cheatgrass. Cheatgrass is highly flammable in summer months and thrives with frequent burns, while other native vegetation is inhibited. Habitat fragmentation in this watershed is largely a function of agriculture, with the Snake River and interstate corridors being highly

developed. Water supply concerns are at heightened levels in recent years, mainly due to many sequential years of below-average precipitation in combination with consistent increases in water consumption due to agricultural development (including an increased dependence on environmentally inefficient irrigation techniques such as sprinkler irrigation). Water rights users sometimes demand an increase in water diversions for consumptive use, and such increases dewater rivers, degrading the quantity and extent of pre-existing terrestrial habitats.

Table 3-8. Ranked impacts of altered ecosystem features impacting habitat quality and quantity for focal fish species in tributaries of the 12 watersheds in the Upper Snake subbasin. Degree of impact on habitat quality or quantity ranked as P (component is functioning properly, needs protection), 1 (least influence), 2 (moderate influence), or 3 (greatest influence, highest priority).

Ecosystem Feature	Altered Component	Upper Snake–Rock	Goose Creek	Raft River	Lake Walcott	Willow Creek	Idaho Falls	Teton	Lower Henrys Fork	Upper Henrys Fork	American Falls	Portneuf	Blackfoot
Channel Structure	Floodplain	P	P	P	P	3	P	P	P	P	P	P	3
	Pool/riffle ratio	P	P	P	P	3	P	3	P	3	3	P	3
	Large woody debris	P	P	P	P	P	P	P	P	P	P	P	
Hydrology	Discharge	3	P	P	3	2	3	P	2	3	P	3	3
	Low flow/dewatering	3	3	3	P	P	3	3	P	P	P	3	3
	Peak	P	P	P	P	P	P	P	P	P	P	P	P
Sediment	Increased fines	P	3	3	2	3	P	3	P	3	3	3	3
Water Quality	Temperature Dissolved oxygen	3	P	P	3	P	P	P	P	P	P	P	P
Riparian	Shade	P	3	3	2	3	P	3	P	3	3	3	3
	Streambank stability	P	3	3	3	3	P	3	P	3	3	3	3
Exogenous	Reservoir operations	3	P	P	3	2	3	3	P	3	3	3	3
	Exotics	3	3	3	3	P	P	3	3	3	3	1	3

3.1.2.1 American Falls (AMF)

The American Falls watershed includes tributaries to American Falls Reservoir and the Snake River from American Falls Dam upstream to a point approximately halfway between the Shelley Diversion Dam and the falls at Idaho Falls, including most streams on the Fort Hall Reservation. Streams in this watershed have altered riparian habitat from land use and conversion. There are an estimated 500 points of water diversion in the watershed. Rapid flooding and drafting of American Falls Reservoir negatively impacts bank stability on the lower reaches of streams in the area where reservoir water inundates the lower ends of the streams. Several

Yellowstone cutthroat trout populations exist in the watershed, but naturalized rainbow trout and hybrid rainbow cutthroat populations are common (Table 3-8).

The American Falls watershed contains several larger agricultural-based communities along the interstate corridor, including the cities of American Falls, Aberdeen, and Shelley and rural areas outside of Blackfoot and Idaho Falls. The elevated population in this area combined with large areas of high-intensity agricultural use elevates anthropogenic causes of limiting factors. About 70% of the area is ungrazed (Table 3-9 and Appendix 3-1).

Table 3-9. Comparison of the relative percentages of area impacted by the causes of limiting factors in the American Falls watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$) <1%	($1 < x > 10$) <1%	($10 < x > 60$) 73	($60 < x < 100$) 8	($100 < x > 300$) 17	($x > 300$) 1
Habitat fragmentation		<1%	39	45	16	
Altered fire regime		2	25	31		
Timber harvest (92% no harvest)		2	5	2		
Grazing/browsing (70% no grazing or unknown status)		29	1			

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.2.2 Blackfoot (BFT)

The upper Blackfoot River from headwaters to tributaries is subject to riparian habitat alteration from land use, resulting in channel alterations, decreased depths, and increased fine sediments (Table 3-8). There are an estimated 550 points of water diversion in the watershed. Blackfoot Reservoir has no minimum pool; total volume is 350,000 acre-feet and the reservoir can be drawn down to approximately 1,400 acre-feet. Downstream

of Blackfoot Reservoir, flows are run at bank-full discharge through much of the summer as irrigation water is transferred downstream, which impact riparian focal habitat. Drought conditions have reduced winter outflows in the river to nearly 10 cfs, while releases of 300 cfs in winter occurred during water years when storage was ample. Riparian areas in the lower Blackfoot River and tributaries are impacted by land use, resulting in reduced cover and increased sedimentation. The lower

section of the Blackfoot River has been channelized, which reduced the habitat complexity and suitability for Yellowstone cutthroat trout.

The Blackfoot watershed contains the city of Blackfoot and several smaller, agriculturally based areas. Population as a cause of limiting factors in this watershed is not a significant concern, but habitat fragmentation resulting from well-developed agriculture and road infrastructure in the area has significantly

changed the habitat in the watershed from historical conditions (Table 3-10). The southern portion of this watershed in Caribou County is heavily forested, while the northern portion of the watershed is not. High timber harvest activity, however, does occur in scattered areas throughout the watershed (Figure 3-7), and this activity near waterways may cause increases in fine sediments. Over half of the Blackfoot watershed is allotted for grazing, which is done mainly by cattle and sheep (Appendix 3-1).

Table 3-10. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Blackfoot watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$)	($1 < x > 10$) 3	($10 < x > 60$) 70	($60 < x < 100$) 19	($100 < x > 300$) 9	($x > 300$) <1%
Habitat fragmentation		2	48	39	12	
Altered fire regime		8	31	39		
Timber harvest (35% no harvest)		19	22	24		
Grazing/browsing (43% not grazed or unknown status)		41	16			

^a For information about ICBEMP data limitations, see Appendix 2-1.

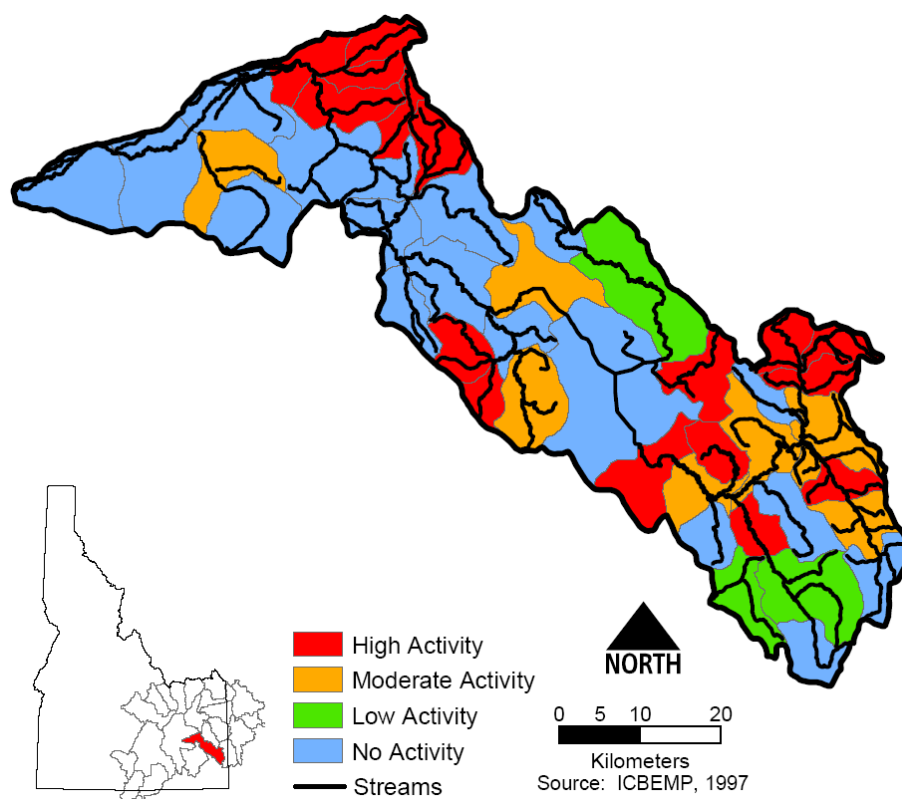


Figure 3-7. Status of timber harvest activity in the Blackfoot watershed, Upper Snake subbasin, Idaho (ICBEMP 1997).

3.1.2.3 *Goose (GSE)*

The mainstem of Goose Creek still maintains some areas of intact riparian habitat. However, impacts to riparian habitat from land use are noted on both the mainstem and tributaries, and increased fine sediments are apparent (Table 3-8). Downstream of Oakley Reservoir, Goose Creek was officially declared by Idaho law to no longer be a stream.

There are about 1,100 points of water diversion (Figure 3-8) in the Goose watershed. We only identified 10 road culverts in the Goose watershed that block fish passage, and one that allows adult fish passage (Appendix 3-1), however, many culverts have not been surveyed so these numbers are incomplete.

Populations of cutthroat in the headwater areas are isolated for most of the year by water diversion or dewatering. Nonnative salmonids (brook trout and rainbow trout) are present in the drainage and considered a threat to the long-term persistence of Yellowstone cutthroat trout populations.

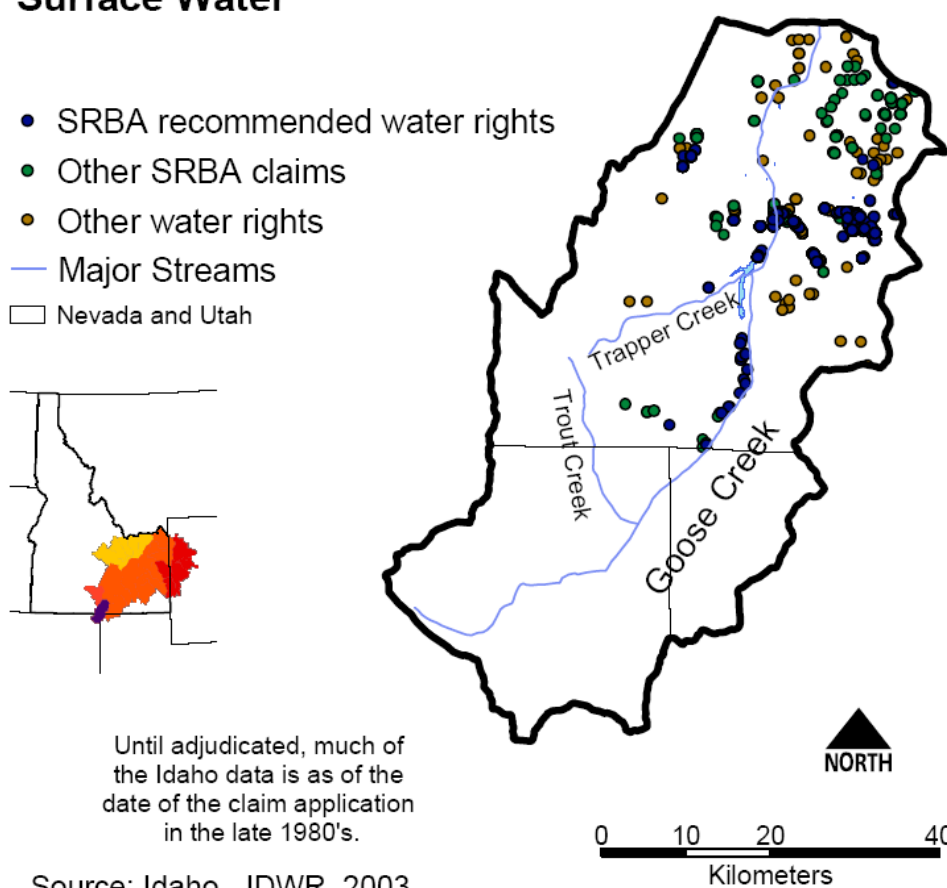
The Goose watershed contains the population center of Oakley, as well as several small agricultural areas. Agricultural development in this watershed has resulted in a high degree of habitat fragmentation and loss (Table 3-11), and timber harvest in the hills on the outskirts of the Snake River Plain has a moderate effect on existing ecosystems. Even though most of the area is grazed by cattle (Figure 3-9), the exact impact of grazing is unknown (Appendix 3-1).

Table 3-11. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Goose watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$) <1%	($1 < x > 10$) <1%	($10 < x > 60$) 74	($60 < x < 100$) 12	($100 < x > 300$) 14
Habitat fragmentation		28	49	10	13
Altered fire regime		7	25	44	
Timber harvest (40% no harvest)		2	56	2	
Grazing/browsing (21% no grazing or unknown status)		78	1		

^a For information about ICBEMP data limitations, see Appendix 2-1.

Idaho Irrigation Points of Diversion - Surface Water

**Figure 3-8. Idaho Department of Water Resources points of water diversions in the Goose watershed, Upper Snake subbasin.**

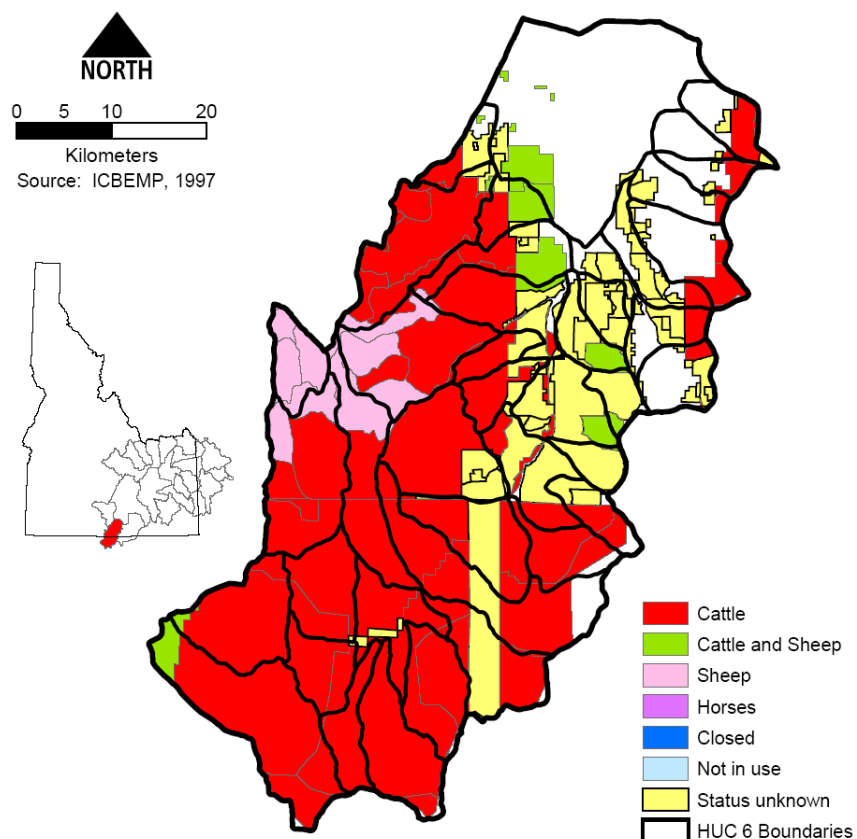


Figure 3-9. Status of grazing and browsing by domestic animals in the Goose watershed, Upper Snake subbasin, Idaho, Utah, and Nevada (ICBEMP 1997).

3.1.2.4 Idaho Falls (IFA)

This watershed includes the South Fork Snake River from the Heise Cable downstream to a point approximately halfway between the Shelley Diversion Dam and the falls at Idaho Falls. Primary impacts to focal aquatic habitats in this area include the impassable dam on the falls at Idaho Falls and dewatering of the “dry bed,” a natural channel that has had a headgate installed on the upper end and now serves as an irrigation water delivery canal (Table 3-8). Substantial irrigation withdrawals occur in this watershed, and none of the diversions are screened for fish passage. There are an estimated 1,250 points of water diversion in the Idaho Falls

watershed. Palisades Dam controls flows in this section. Five low-head dams exist, and no fish passage is provided. The Idaho Falls watershed contains the agricultural areas of Idaho Falls, Rigby, and Ammon, as well as several other small agricultural and industrial population centers. Thus, human population density and agriculture use is a cause of terrestrial limiting factors and correlates strongly to an increase in habitat fragmentation (Table 3-12). There is no significant timber harvest in this region and the dominant (65%) portion of the watershed is not grazed (Table 3-12 and Appendix 3-1).

Table 3-12. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Idaho Falls watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$)	($1 < x > 10$) 2	($10 < x > 60$) 37	($60 < x < 100$) 19	($100 < x > 300$) 36	($x > 300$) 7
Habitat fragmentation			4	60	36	
Altered fire regime			29	10		
Timber harvest (85% no harvest)			12	3		
Grazing/browsing (65% no grazing or unknown status)		34	1			

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.2.5 Lower Henrys Fork (LHF)

The Falls River is the largest tributary in the Lower Henrys Fork watershed. Falls River is impacted by irrigation diversions and one hydropower plant. The upper end of the drainage is within the boundary of Yellowstone National Park. Rainbow trout are the dominant trout in the drainage. About 550 unscreened irrigation diversions exist throughout the Lower Henrys Fork watershed. Riparian condition has been impacted through conversion from development. Ashton and Chester dams do not have fish passage, and fish passage is not a high priority in this area due to lack of cutthroat trout. Downstream from the mouth of the Teton River to the

mouth of the Henrys Fork, there are major sediment impacts from the collapse of Teton Dam (Table 3-8).

The Lower Henrys Fork watershed contains several agriculturally based population centers, including Ashton, St. Anthony, and Sugar City. The presence of these population centers elevates the concern for population density as a cause for limiting factors, and a large percentage of habitats in the watershed are fragmented, mainly from agricultural development (Table 3-13). Grazing in this watershed is not a significant concern, primarily due to a lack of persistent forbs for domestic animals to eat in the watershed (Table 3-13 and Appendix 3-1).

Table 3-13. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Lower Henrys Fork watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$)	($1 < x > 10$)) 37	($10 < x > 60$) 29	($60 < x < 100$) 18	($100 < x > 300$) 16	($x > 300$) <1%
Habitat fragmentation		28	37	35	<1%	
Altered fire regime		9	25	36		

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Timber harvest (52% no harvest)		7	39	3		
Grazing/browsing (67% no grazing or unknown status)		25	7	1		

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.2.6 Portneuf (PTF)

The Portneuf watershed contains numerous pure populations of Yellowstone cutthroat trout that are mostly located in tributary streams. Most tributary streams to the Portneuf River are disconnected, isolating these populations from the mainstem and other populations. Most of the restoration potential for Yellowstone cutthroat trout in the Portneuf watershed is in the tributary streams. The upper mainstem Portneuf River contains a naturally reproducing rainbow trout population that is competing with the native Yellowstone cutthroat trout population. Approximately 10 miles (16 km) of the upper Portneuf River is channelized and dewatered for a portion of the year, severely reducing the quality of the area's focal aquatic habitat.

The middle section of the Portneuf River is subject to approximately 3,100 diversions that allow water to warm considerably during summer (Figure 3-10), and Yellowstone cutthroat trout are mostly absent from this section. The lower section of the Portneuf runs through a concrete flume for 6 miles (10 km), with absolutely no fish habitat and no fish passage during low flows (and passage is unlikely at most flows). Below the concrete

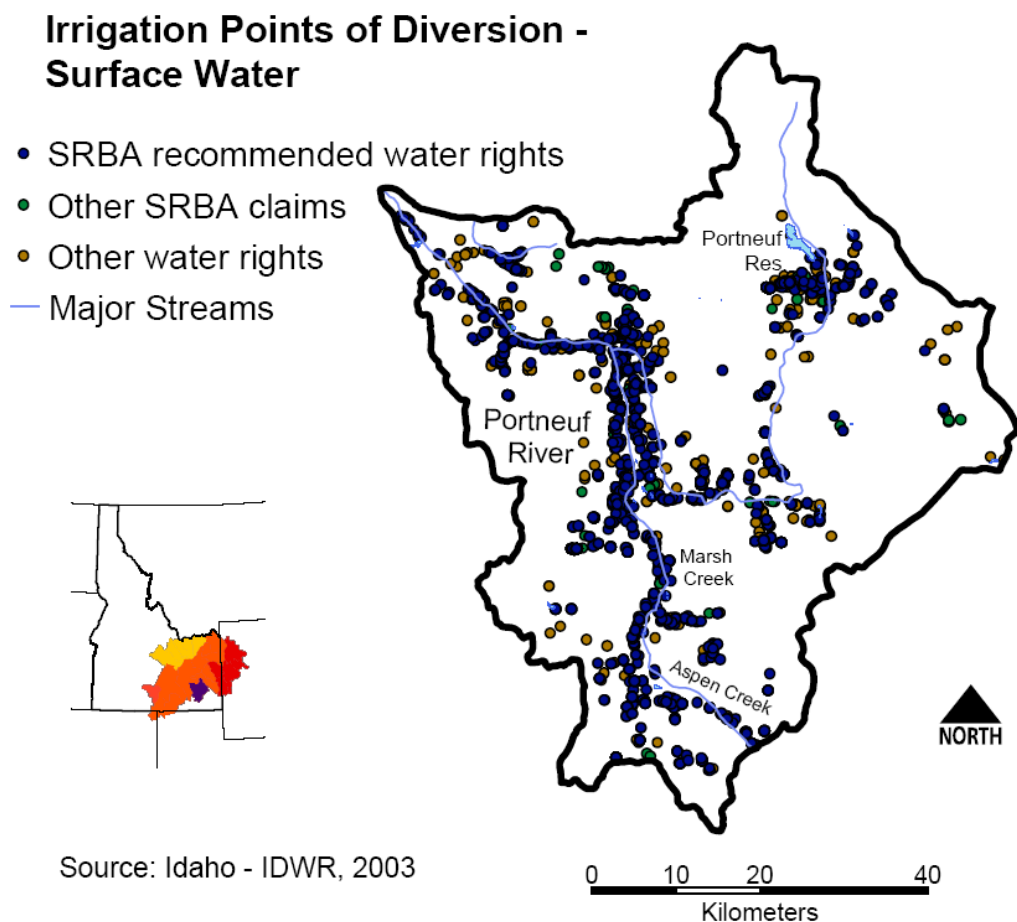
flume section, the river begins to cool when springs enter the system. Considerable inputs of phosphorous to this lower section result in substantial aquatic macrophyte growth. Many of the tributaries have impacted riparian habitat from land use or conversion (Table 3-8).

The Portneuf watershed contains the major population centers of Pocatello and Chubbuck and the second largest population center in Idaho. Aside from the Pocatello area, where industry and agriculture dominate the labor force, there are also many smaller agricultural communities in the watershed. Combined, these population centers give rise to large concern over population density as a cause of terrestrial limiting factors (Table 3-14). In addition, the intensive agriculture in the region has heavily fragmented natural systems. There is some timber harvest in the foothills on the southern end of the watershed. Much of the watershed is not grazed, and grazing is not projected to be a large cause for limiting factors in the watershed (Table 3-14 and Appendix 3-1). However, due to heavily fragmented and altered habitats, the Portneuf watershed is at risk of a fire event in the near future (Figure 3-11).

Table 3-14. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Portneuf watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$) <1%	($1 < x > 10$) <1%	($10 < x > 60$)) 52	($60 < x < 100$) 19	($100 < x > 300$) 21	($x > 300$) 7
Habitat fragmentation		6	13	72	9	
Altered fire regime		5	20	47		
Timber harvest (37% no harvest)		21	32	10		
Grazing/browsing (61% no grazing or status unknown)		32	7			

^a For information about ICBEMP data limitations, see Appendix 2-1.

**Figure 3-10. Idaho Department of Water Resources points of water diversions in the Portneuf watershed, Upper Snake subbasin.**

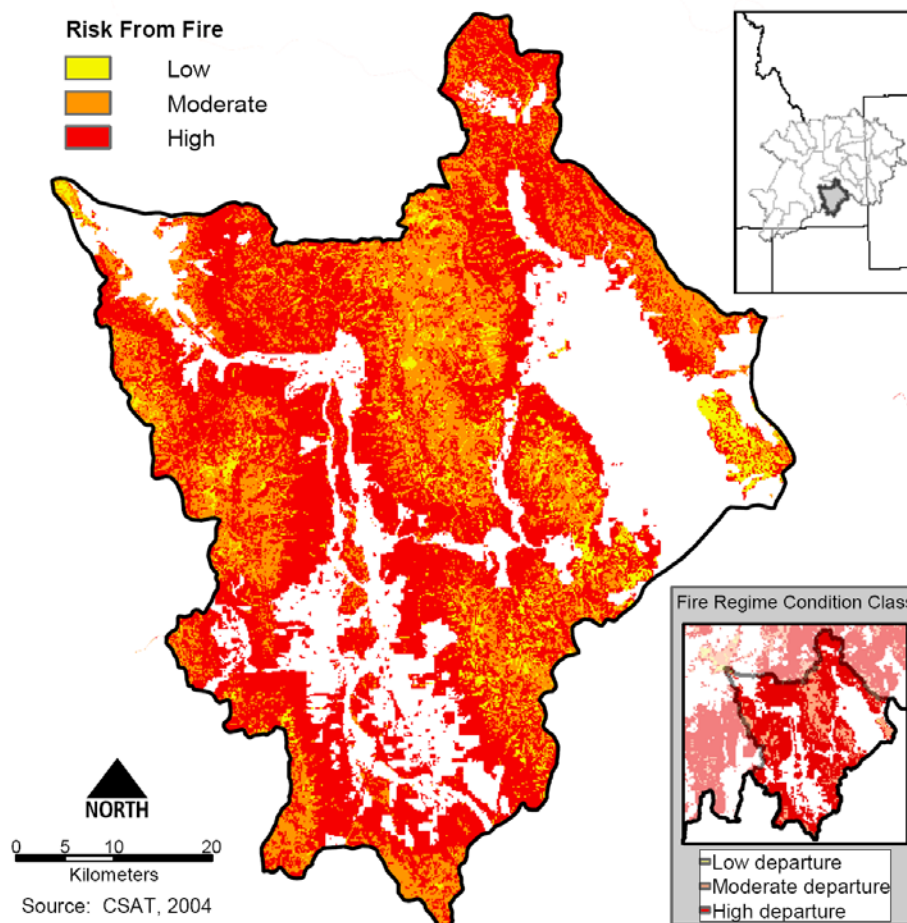


Figure 3-11. Predicted areas within the Portneuf watershed, Upper Snake subbasin, most likely to be at risk for severe fire effects, taking into account fire regime condition class, ignition probability, and fire weather hazard. Ecosystems-at-risk integrates ignition probability, fire weather hazard, rate-of-spread, and fire regime condition class (the probability of severe fire effects). Source: Northern Regional National Fire Plan Cohesive Strategy Assessment Team, Flathead National Forest (CSAT 2004).

3.1.2.7 Raft (RFT)

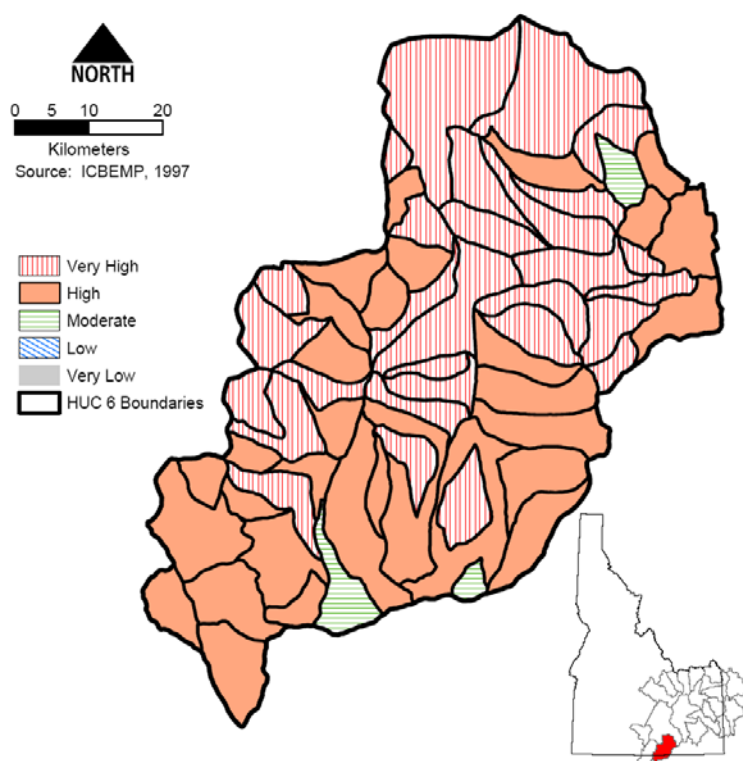
The Raft watershed connects to the mainstem Snake River only during periods of high flow in the spring and is subject to reduced flows or dewatering from 2,100 water diversions. Yellowstone cutthroat trout populations are isolated from the mainstem by dewatering (Table 3-8).

A characteristically dry area, the Raft watershed has only a few streams that may be diverted for irrigation. There is grazing over much (61%) of the area (Table 3-15 and Appendix 3-1). It is estimated that much of the habitat in the watershed is vulnerable to the effects of grazing and browsing by domestic animals because much of the rangeland is in good (high and very high) condition (Figure 3-12).

Table 3-15. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Raft watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 6	($10 < x > 60$) 65	($60 < x < 100$) 14	($100 < x > 300$) 15
Habitat fragmentation		1	63	36	
Altered fire regime		6	25	47	
Timber harvest (66% no harvest)		11	19	5	
Grazing/browsing (39% no grazing or status unknown)		53	8		

^a For information about ICBEMP data limitations, see Appendix 2-1.

**Figure 3-12. Rangeland condition in the Raft watershed, Upper Snake subbasin, Idaho and Utah (ICBEMP 1997).**

3.1.2.8 Teton (TET)

The Teton watershed has been impacted by land use, development, riparian alterations, loss of connectivity, and increased fine

sediments. The Teton River is generally divided into three sections. The lower river section runs from the river mouth to the Teton Dam site. Dewatering from 2,160 irrigation diversions impacts this lower section (Figure

3-13). Two channels are located here and used alternately for water delivery, which can directly impact fish populations in the area that are subject to stranding and dewatering. The canyon section of the Teton River runs from the Teton Dam site upstream to the top of the canyon. This section was severely impacted when the Teton Dam collapsed. Most riparian vegetation in the section was removed, and the extreme water velocity caused changes to the habitat. Riparian vegetation is slowly returning to the area, but there are large amounts of undesirable species (e.g., cheatgrass). Rainbow trout have recently become more common than Yellowstone cutthroat trout in the main Teton River. In the upper river section of the Teton River, numerous tributaries are dewatered from irrigation diversions (Table 3-8). When the Teton Dam collapsed, all banks were supersaturated and then sloughed, damming

the system and creating pools separated by high-gradient, high-velocity areas. The cottonwood riparian area was completely eliminated.

The Teton watershed contains several population centers, including the towns of Driggs, Victor, Madison, and Rexburg, along with several smaller, developed areas along the interstate and highway corridors. These population centers account for increased concern for population as a cause for limiting factors (Table 3-16). There is also a high degree of habitat fragmentation, due to agricultural development in this area. A moderate degree of timber harvest activity occurs in the higher elevations of this watershed, but there is very little grazing, and grazing is not projected to be a significant cause for limiting factors in the watershed (Appendix 3-1).

Irrigation Points of Diversion - Surface Water

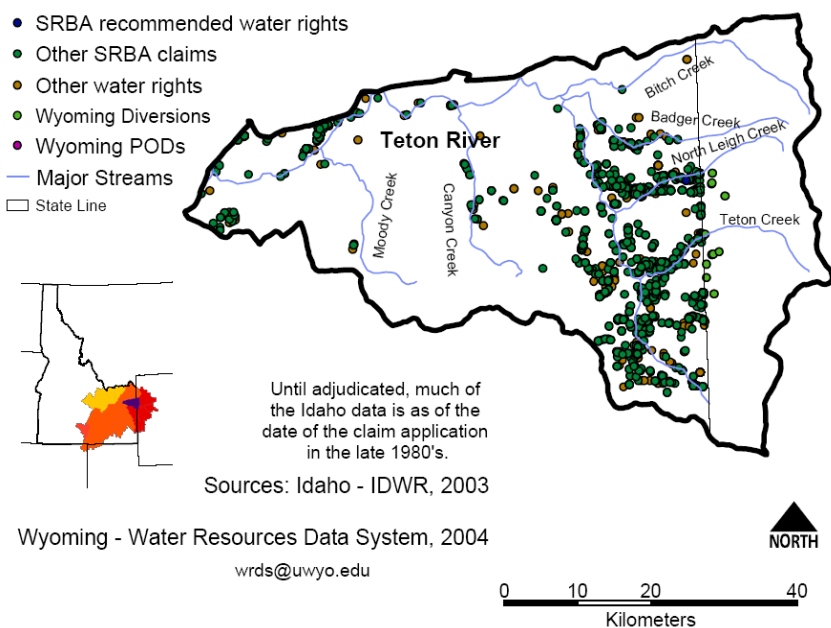


Figure 3-13. Idaho Department of Water Resources points of water diversions in the Teton watershed, Upper Snake subbasin.

Table 3-16. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Teton watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$)	($1 < x > 10$) 4	($10 < x > 60$) 57	($60 < x < 100$) 19	($100 < x > 300$) 15	($x > 300$) 5
Habitat fragmentation		11	23	45	21	
Altered fire regime		15	13	11		
Timber harvest (30% no harvest)		16	40	14		
Grazing/browsing (59% no grazing or status unknown)		1	29	11		

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.2.9 Upper Henrys Fork (UHF)

The upper end of the Henrys Fork watershed includes Henrys Lake, Henrys Lake Outlet, and tributaries to both. This watershed has altered riparian areas from land use, increased fine sediments, and channel alterations (Table 3-8). There are an estimated 750 points of water diversion in the Upper Henrys Fork watershed. The Big Springs area is highly unproductive from nutrient standpoint, and this situation may limit recruitment in the area. Island Park Dam controls discharge in the Box Canyon section of the Henrys Fork and forms an upstream fish passage barrier. Fine sediment that was flushed out of the reservoir into the Box Canyon section in 1992 is still thought to be a problem. Tributaries to Henrys Lake still support natural spawning by Yellowstone cutthroat trout, and Yellowstone cutthroat trout are spawned at the Henrys Lake Fish Hatchery and released back to the

lake (along with intentionally produced hybrids). Although rainbow trout are dominant downstream of Island Park Dam, Yellowstone cutthroat trout are still found in the drainage. Tributaries to Island Park Reservoir are in relatively good condition.

The Upper Henrys Fork watershed contains the relatively small and remote population centers of Island Park and Warm River. There is a moderate degree of habitat fragmentation in the area (Figure 3-14), primarily due to agricultural development and grazing (Table 3-17). This watershed is also heavily used for agriculture and seasonal recreation, which may further contribute to habitat fragmentation. There is a moderate degree of timber harvest in this watershed, which contains abundant ponderosa and lodgepole pine forests. Grazing in this watershed is common, with allotments evenly distributed between cattle and sheep (Appendix 3-1).

Table 3-17. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Upper Henrys Fork watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 78	($10 < x > 60$) 22	($60 < x < 100$) <1%	($100 < x > 300$) <1%
Habitat fragmentation		4	91	5	
Altered fire regime		45	17	33	
Timber harvest (11% no harvest)		32	42	15	
Grazing/browsing (27% no grazing or status is unknown)			65	8	

^a For information about ICBEMP data limitations, see Appendix 2-1.

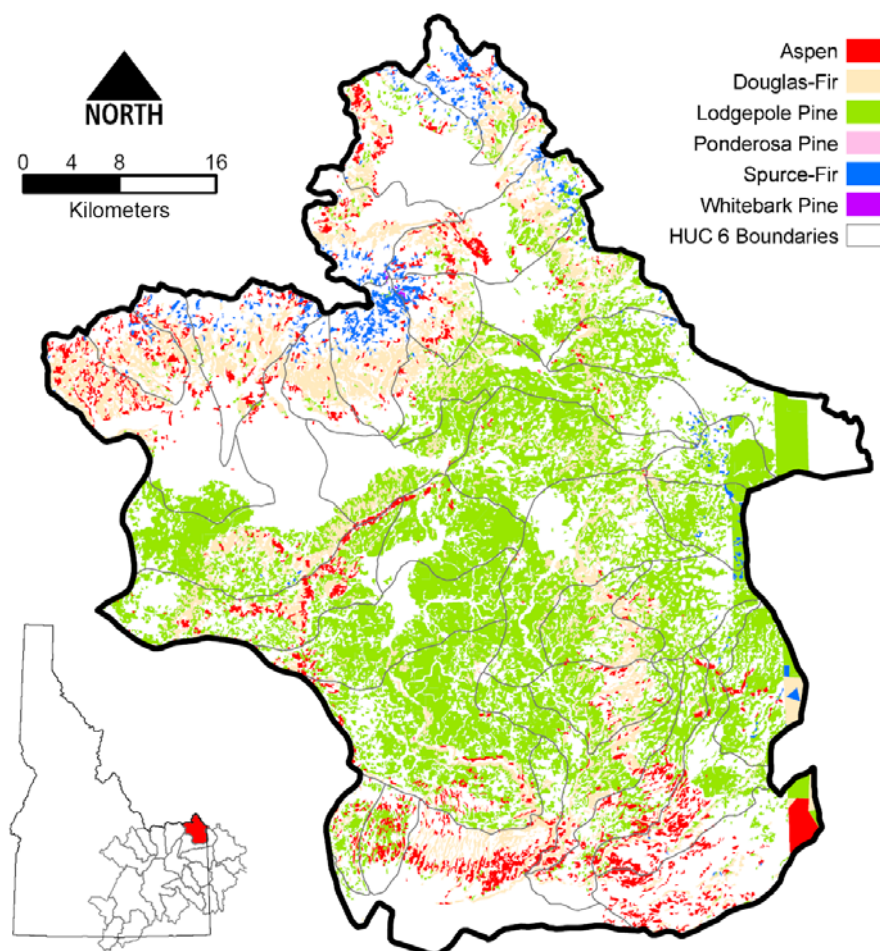


Figure 3-14. Current distribution of forest species compositions in the Upper Henrys Fork watershed, Upper Snake subbasin, Idaho and Wyoming (GAP II 2003, Scott *et al.* 2002).

3.1.2.10 Upper Snake–Rock (USR)

For the purposes of this assessment, the Upper Snake–Rock watershed includes only the area upstream of Shoshone Falls.

There are 350 points of water diversion and an unknown number of road culverts in the Snake–Rock watershed. It is also unknown whether the road culverts allow adult fish passage.

The mainstem Snake River has very few Yellowstone cutthroat trout due to water temperature and water quality (Table 3-8). Vinyard Creek and Dry Creek contain Yellowstone cutthroat trout populations and likely once supported fluvial populations. Dry Creek is dewatered, and no longer connects to

the Snake River. Vinyard Creek is still connected to the Snake River. Rainbow trout are present in the watershed.

The western extent of the Upper Snake–Rock watershed sits just east of Twin Falls, Idaho. Urban sprawl from Twin Falls eastward along the interstate corridor generates an elevated concern for population as a cause for limiting factors. While some residents of this area rely on commerce and industry related to Twin Falls and the interstate corridor, the area is also heavily used for agriculture, and this use is reflected by a high degree of habitat fragmentation (Appendix 3-1). While most of this watershed is allocated for grazing, most allocations are not in use, and the effect of grazing is considered minimal (Table 3-18 and Appendix 3-1).

Table 3-18. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Upper Snake–Rock watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) <1%	($10 < x > 60$) 63	($60 < x < 100$) 24	($100 < x > 300$) 13
Habitat fragmentation		4	5	65	26
Altered fire regime		1	14	40	
Timber harvest (almost 100% no harvest)		<1		<1	
Grazing/browsing		94	6		

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.2.11 Lake Walcott (LWT)

The Lake Walcott watershed is dominated by reservoirs created by Minidoka and Milner dams, and flows in the mainstem Snake River upstream are controlled by American Falls Dam. Water quality between Lake Walcott and Milner dam has been impaired enough at times to kill mountain whitefish. Yellowstone cutthroat trout are rare but present in Lake Walcott and the mainstem Snake River upstream. Rock Creek, the largest tributary in the watershed, contains a highly introgressed population of Yellowstone cutthroat trout in its East Fork (Table 3-8). Tributaries in this drainage are impacted by altered riparian habitat from land use and conversion and increased sedimentation. There is also an

estimated 1,050 points of water diversion in the watershed.

The Lake Walcott watershed contains several population centers, including the towns of Burley, Rupert, and Minidoka. Although these areas are large population centers, the Lake Walcott population center is not large, and so population is not a significant cause for limiting factors at the watershed level. There is, however, a large amount of agriculture in the area, resulting in a significant amount of habitat fragmentation (Table 3-19). In addition, over half of the watershed is grazed; however, the information gathered is not complete enough for judgment to be made on the typology of grazing (Appendix 3-1).

Table 3-19. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Lake Walcott watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 42	($10 < x > 60$) 40	($60 < x < 100$) 9	($100 < x > 300$) 9
Habitat fragmentation		16	48	22	14
Altered fire regime		1	19	40	
Timber harvest (95% no harvest)		2	3	<1	
Grazing/browsing (34% no grazing or status unknown)		66			

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.2.12 Willow (WIL)

Willow Creek is listed by the Natural Resources Conservation Service as one of the most serious soil erosion areas in the United States (NRCS 2001). Nearly every segment of the stream is on Idaho's 303(d) list. The Willow Creek drainage has significant impacts to riparian areas, increased fine sediment loads and channel alterations, and increased width to depth ratios because of

bank instability and the fine sediment load (Table 3-8). There are about 300 points of water diversion in the Willow watershed. The headwaters are on public land, but the majority of the drainage is privately owned. The drainage still supports core populations of Yellowstone cutthroat trout. Willow Creek downstream of Ririe Reservoir is dewatered during winter, a condition that prevents the occurrence of stable populations of Yellowstone cutthroat trout.

The Willow watershed lies just east of Idaho Falls and has a population flux resulting from the sprawl of that nearby area. This watershed is heavily used for agriculture, resulting in habitat fragmentation being a higher cause for limiting factors than population is (Table 3-20). Some timber is harvested in the watershed, and effects may be significant at

the watershed level, especially where timber harvest activity occurs adjacent to waterways. Grazing is not a large concern as a cause of limiting factors because most of the watershed is not grazed, and the grazing that occurs seems to have a low impact (Table 3-20 and Appendix 3-1).

Table 3-20. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Willow watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 28	($10 < x > 60$) 53	($60 < x < 100$) 17	($100 < x > 300$) 1
Habitat fragmentation		<1%	77	17	6
Altered fire regime		5	33	34	
Timber harvest (22% no harvest)		48	5	25	
Grazing/browsing (67% no grazing or status unknown)		20	12	1	

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.3 Closed Basin Subbasin

The Closed Basin subbasin is characterized by high desert ecosystem types, with some transition to juniper and pine forest types occurring at higher elevations. The environment is typically dry, with hot summers and cold, windy winters. Riparian resources within the subbasin vary by watershed, but there are consistent problems with low flow waters and exotic species (Table 3-21). We discuss watersheds individually in context with both riparian and terrestrial causes for limiting factors.

Causes of terrestrial limiting factors by watershed (Table 3-22, Table 3-23, Table 3-24, Table 3-25, and

Table 3-26) show impacts to focal habitats and species. at the watershed level. Dominant concerns in the Closed Basin subbasin include

altered fire regime and habitat fragmentation. Altered fire regime is characteristically moderate to high, primarily due to over 100 years of intense fire suppression that created a greater potential for large, devastating fires. Currently, on the high desert, seasonal wildfires sparked by humans or dry lightning burn large tracts of land each year. This disturbed land is of primary concern for invasion of noxious and exotic weeds, such as cheatgrass. Cheatgrass is highly flammable in summer months and thrives from frequent burns, while other native vegetation is inhibited. Habitat fragmentation in this watershed is largely a function of agriculture, with the Snake River and interstate corridors being highly developed. Water supply concerns are at heightened levels in recent years, mainly due to many sequential years of below-average precipitation in combination with consistent

increases in water consumption due to agricultural development (including an increased dependence on environmentally inefficient irrigation techniques such as sprinkler irrigation). Water rights users

sometimes demand an increase in water diversions for consumptive use, and such increases dewater rivers, degrading the quantity and extent of pre-existing terrestrial habitats.

Table 3-21. Ranked impacts of altered ecosystem features impacting habitat quality and quantity for focal fish species in tributaries to the 5 watersheds of the Closed Basin subbasin. Degree of impact on habitat quality or quantity ranked as P (component is functioning properly, needs protection), 1 (least influence), 2 (moderate influence), and 3 (greatest influence, highest priority).

Ecosystem Feature	Altered Component	Beaver–Camas	Birch	Big Lost	Little Lost	Medicine Lodge
Channel structure	Floodplain	P	P	P	P	P
	Pool/riffle ratio	P	P	P	P	P
	Large woody debris	P	P	P	P	P
Hydrology	Discharge	P	P	3	3	P
	Low flow/ dewatering	3	3	3	3	P
Sediment	Increased fines	3	2	2	2	3
Water quality	Temperature	P	P	2	P	P
Riparian	Shade	3	2	2	2	P
	Streambank stability	3	2	2	2	P
Exogenous	Reservoir operations	P	P	3	P	P
	Barriers	P	P	P	3	P
	Exotics	3	P	P	3	3

3.1.3.1 Beaver–Camas (BCM)

This upper end of the Beaver–Camas watershed is considered to be in good shape despite some localized grazing impacts. Nonnative species (rainbow trout and brook trout) are a concern for the long-term persistence of Yellowstone cutthroat trout. In the lower end of the watershed, water diversions significantly reduce flows, riparian areas have been altered through land use, and increased sediment reduces habitat quality (Table 3-21). There are about 900 points of water diversion in the watershed.

There is significant habitat fragmentation in the watershed, mainly a function of agricultural development and, to some degree, grazing (Appendix 3-1). Some timber harvest occurs in the higher elevations and to the north in this watershed, and effects of this harvest may be of concern for causes of limiting factors (Table 3-22). All of these causes of limiting factors may contribute to increased risk of a fire (Figure 3-15).

Table 3-22. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Beaver–Camas watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 79	($10 < x > 60$) 19	($60 < x < 100$) 1	($100 < x > 300$)
Habitat fragmentation		4	46	50	
Altered fire regime		6	32	52	
Timber harvest (19% no harvest)		14	55	12	
Grazing/browsing (14% no grazing or status unknown)		70	22	4	

^a For information about ICBEMP data limitations, see Appendix 2-1.

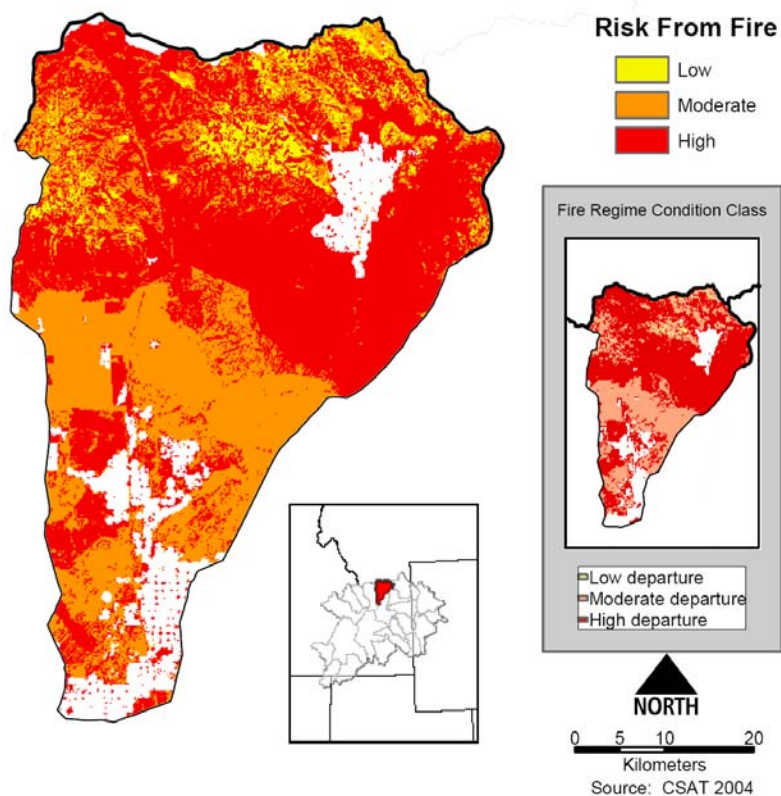


Figure 3-15. Predicted areas within the Beaver–Camas watershed, Closed Basin subbasin, most likely to be at risk for severe fire effects, taking into account fire regime condition class, ignition probability, and fire weather hazard. Ecosystems-at-risk integrates ignition probability, fire weather hazard, rate-of-spread, and fire regime condition class (the probability of severe fire effects). Source: Northern Regional National Fire Plan Cohesive Strategy Assessment Team, Flathead National Forest (CSAT 2004).

3.1.3.2 Birch Creek (BCK)

The Birch Creek watershed has no native salmonids. The shorthead sculpin is thought to be the only fish native to the watershed. The watershed has some localized grazing impacts, increased sedimentation, and altered riparian areas from land use (Table 3-21). Currently, the stream is seasonally dewatered at the lower end. An estimated 100 water diversions occur within the watershed.

The main sources for population in the Birch Creek watershed are a result of agricultural

development, and population and habitat fragmentation are moderate causes of limiting factors (Table 3-23). There is some timber harvest activity, but it is strongly restricted by the occurrence of timber. Although most of the watershed is grazed and much of the grazing is by cattle, the grazing status for about 32% of the watershed is unknown (Figure 3-16 and Appendix 3-1). Moreover, most of the watershed is rated highly vulnerable to grazing and browsing impacts by domestic animals.

Table 3-23. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Birch Creek watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 15	($10 < x > 60$) 83	($60 < x < 100$) 2	($100 < x > 300$)
Habitat fragmentation		12	88	<1%	
Altered fire regime		11	57	28	
Timber harvest (79% no harvest)		21			
Grazing/browsing (10% no grazing)		51	39		

^a For information about ICBEMP data limitations, see Appendix 2-1.

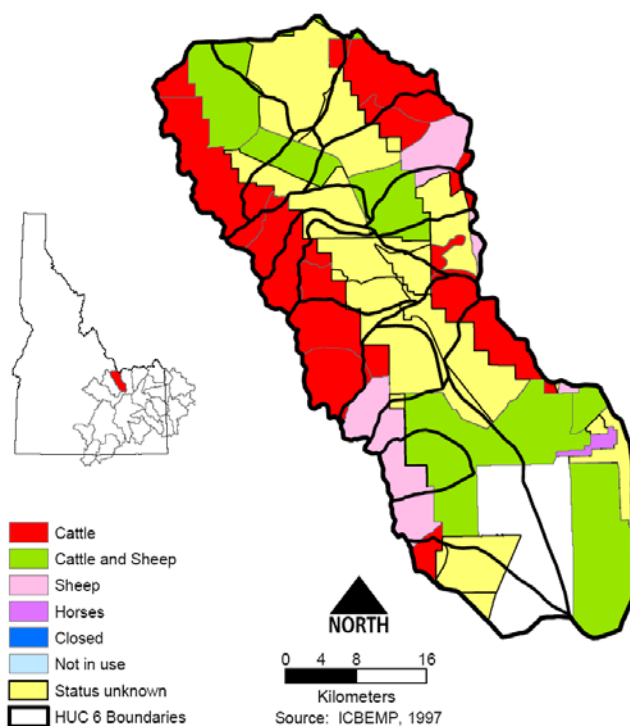


Figure 3-16. Status of grazing and browsing by domestic animals in the Birch Creek watershed, Closed Basin subbasin, Idaho (ICBEMP 1997).

3.1.3.3 Big Lost River (BLR)

Mountain whitefish are the only native salmonid in the watershed, and they have suffered substantial declines in recent years. Dewatering from water diversions and altered discharge regimes from Mackay Dam are the primary concerns in this watershed (Table 3-21). Numerous reaches are completely dewatered, a problem that is exacerbated by the natural geology of the area, as well as water withdrawals. There are about 3,800 water diversions (Figure 3-17) and an unknown number of road culverts in the Big Lost River watershed.

Mountain whitefish have also declined in areas higher in the drainage that are not dewatered, but these areas are thought to be marginal habitat for mountain whitefish, habitats that are used when populations are large and more suitable habitat is needed.

Historically, the Big Lost River flowed seasonally onto a series of playas on the Big Desert, where it would then drain through highly fractured basalts and enter the groundwater system. Currently, the stream is completely dewatered seasonally, and the natural playa system is no longer watered on a regular basis.

There is a moderate degree of agriculture in this area, resulting in a moderate degree of habitat fragmentation as a cause of limiting factors in the watershed (Table 3-24). There is no extensive timber harvest and there are no extensive effects from grazing. While most of the area is allotted for grazing, it is unclear how or for what the allotments are used, a situation that complicates this assessment (Appendix 2-1 and Appendix 3-1).

Irrigation Points of Diversion - Surface Water

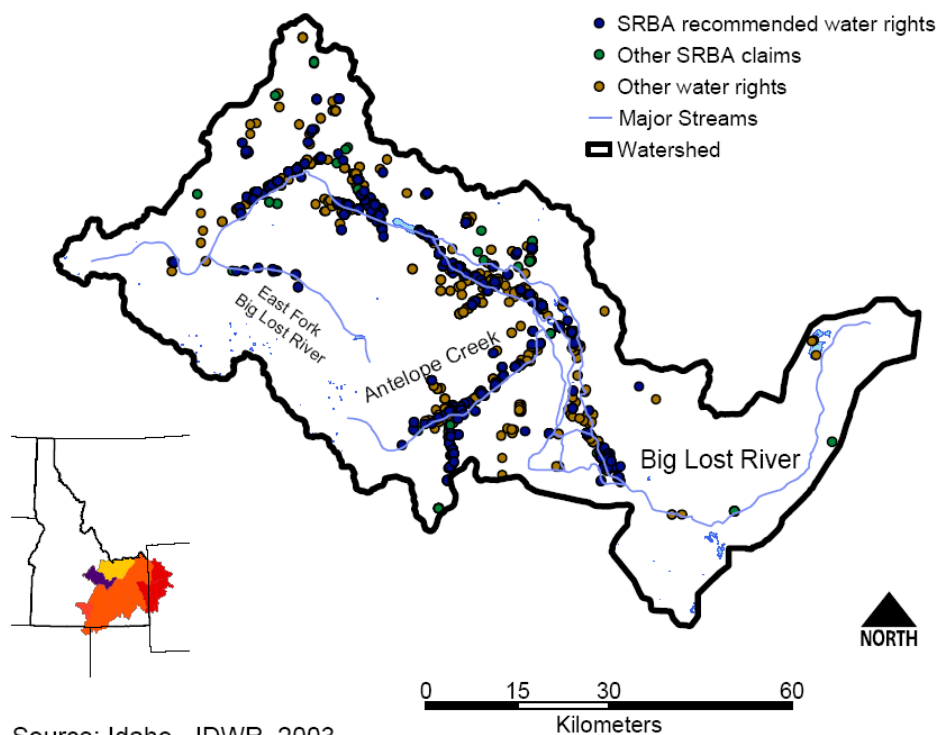


Figure 3-17. Idaho Department of Water Resources points of water diversions in the Big Lost River watershed, Closed Basin subbasin.

Table 3-24. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Big Lost River watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High	Extremely High
Human population density	($x < 1$)	($1 < x > 10$) 21	($10 < x > 60$) 67	($60 < x < 100$) 10	($100 < x > 300$) 1	($x > 300$) <1%
Habitat fragmentation		30	63	7		
Altered fire regime		19	61	11		
Timber harvest (62% no harvest)		14	11	12		
Grazing/browsing (26% no grazing or status known)		40	27	7		

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.3.4 Little Lost River (LLR)

Habitat conditions in the Little Lost River watershed have been improving over the last 10 years, especially in areas where bull trout are found. The biggest threats to long-term persistence of bull trout in this watershed are nonnative species (i.e., brook trout) and isolation and small population sizes. The Wet Creek population has declined severely, but the cause of the decline is unknown. The Badger/Williams creek populations are isolated by dewatering from stream withdrawal, and access to additional habitat has been blocked by legacy mine effects (Table 3-21). Approximately 650 points of water diversion are present in the watershed.

Riparian impacts and water diversions are secondary concerns throughout the remainder of the watershed (except Badger/Williams Creek).

The Little Lost River watershed has no large population centers, and its relatively low population density results from agricultural development. This development results in a moderate effect for habitat fragmentation as a cause of limiting factors (Table 3-25). Grazing is also a moderate cause for limiting factors. While most of the area is allotted for grazing, it is unclear how or for what the allotments are used, a situation that complicates this assessment (Appendix 2-1 and Appendix 3-1).

Table 3-25. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Little Lost River watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 15	($10 < x > 60$) 77	($60 < x < 100$) 8	($100 < x > 300$)
Habitat fragmentation		31	56	13	
Altered fire regime		15	60	16	
Timber harvest (54% no harvest)			33	13	
Grazing/browsing (2% no grazing or status unknown)		49	46	2	

^a For information about ICBEMP data limitations, see Appendix 2-1.

3.1.3.5 Medicine Lodge (MDL)

The Medicine Lodge watershed is considered to be in good shape. A fire in the upper part of the watershed is a concern for increased sediment impacts. Nonnative species are a concern for the long-term persistence of Yellowstone cutthroat trout populations in the drainage (Table 3-21). Still, there are approximately 500 points of water diversion in the watershed.

The Medicine Lodge watershed has a few notable population centers, including the towns of Spencer, Dubois, and Hamer. These towns provide a small increase in concern for causes of limiting factors due to population density. The economy in this area is dominantly driven by agriculture, as reflected by habitat fragmentation as a cause for limiting factors. There is some timber harvest, and where timber harvest occurs, it has a moderate to high effect on ecosystem

integrity. Finally, the entire watershed is grazed by domestic animals (Table 3-26); however, the status of this grazing is

unknown for about 43% of the watershed (Figure 3-18 and Appendix 3-1).

Table 3-26. Comparison of the relative percentages of area impacted by the causes of limiting factors in the Medicine Lodge watershed for terrestrial resources (ICBEMP 1997^a).

Causes of Limiting Factors	Very Low	Low	Medium	High	Very High
Human population density	($x < 1$)	($1 < x > 10$) 10	($10 < x > 60$) 84	($60 < x < 100$) 6	($100 < x > 300$)
Habitat fragmentation		20	46	34	
Altered fire regime		5	37	36	
Timber harvest (71% no harvest)			19	10	
Grazing/browsing or status unknown		71	29		

^a For information about ICBEMP data limitations, see Appendix 2-1.

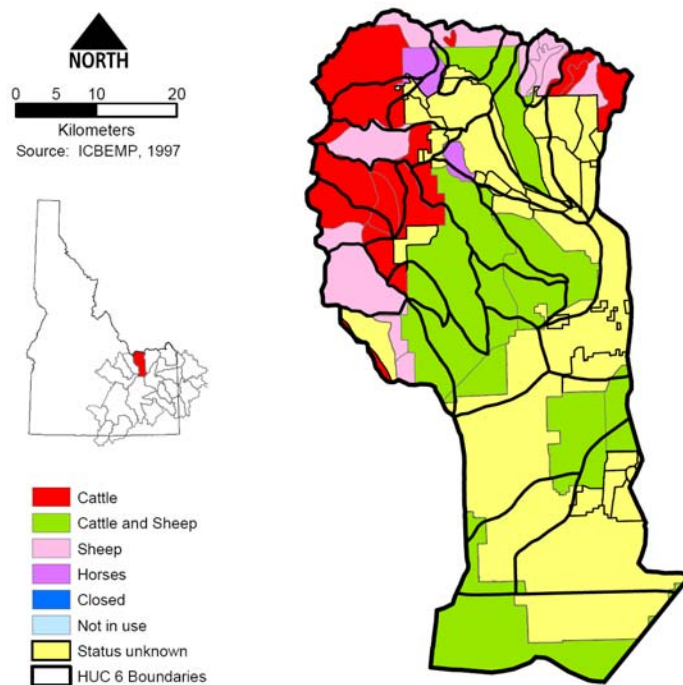


Figure 3-18. Status of grazing and browsing by domestic animals in the Medicine Lodge watershed, Closed Basin subbasin, Idaho (ICBEMP 1997).

3.2 Out-of-Basin Effects

3.2.1 Aquatic Resources

Dams within the Upper Snake and Snake Headwaters subbasins are operated to meet irrigation needs and generate electricity. Most of the points of use for irrigation water are within the subbasins, but the hydropower generated within the subbasins is part of the larger generating networks of the Federal Columbia River Power System (FCRPS), Idaho Power Company, PacifiCorp, other private entities, and rural cooperatives. Due to the interconnected nature of the power systems, reservoir operations for power production are influenced by power needs and generating capacities within and outside the subbasins. In addition to power generation, water from the upper Snake River basin (i.e., upstream of Lower Granite Dam) is used for flow augmentation for salmon migration in the lower Snake and Columbia rivers. Approximately 427,000 acre-feet of water are provided annually by the U.S. Bureau of Reclamation to meet flow-augmentation requirements of the 2000 biological opinion (NMFS 2000). The Bureau of Reclamation is obligated to ensure a high likelihood of providing this amount of water each year. To attain the requirement of 427,000 acre-feet, the Bureau of Reclamation has initiated a program to acquire reservoir storage space and natural flow rights throughout the drainage above Lower Granite Dam. This water can come from anywhere in the Snake River basin, including reservoirs in the Upper Snake or Snake Headwaters subbasins.

We were unable to identify any out-of-basin effects in the Closed Basin subbasin.

3.2.2 Terrestrial Resources

For terrestrial assessment purposes, out-of-basin effects in the Upper Snake province are

discussed in terms of the following categories:

- Noxious weeds
- Insect and disease outbreaks—natural and unnatural
- Invasive exotic wildlife
- Habitat loss and linkages
- Genetic linkages
- Development
- Climate cycles—short term and long term

3.2.2.1 *Noxious and Invasive Exotic Weeds*

The issues of noxious and invasive exotic weeds and the effects they are having on the Upper Snake province have been discussed in detail in other sections (section 1.7.4, Appendix 1-6 and in Appendix 3-1, section 6). Regarding noxious weeds in the Upper Snake province, out-of-basin effects result from the influx of people, livestock, and equipment into the subbasin for various occupational or recreational activities (Karl *et al.* 1996). The Upper Snake province is recognized by many as a premier recreational destination because of its fishing, hunting, and water sports opportunities. The rapid spread of many noxious weeds in the Upper Snake province can be primarily attributed to human activities that bring “contaminated” equipment, gear, livestock, and livestock supplies into the subbasin from other areas (Karl *et al.* 1996, NISC 2003). State, federal, and nongovernmental organizations are collaborating to document and track the spread of noxious weeds (USNAL 2004). The science of invasive species management seeks to develop management tools, technologies, and strategies to effectively control noxious weeds at the appropriate landscape scales (TNC 2003).

3.2.2.2 Insect and Disease Outbreaks

Both insect and disease outbreaks are natural and common events in the Upper Snake province. Generally, most insect infestations are localized occurrences that have little impact or ramifications at larger scales (Amman and Cole 1983). However, given the altered functionality of some aspects of the environment, each additional disruption of ecological function becomes cumulative and leads to further decline of environmental integrity (section 2.4).

Deleterious disease outbreaks in the form of whitebark pine blister rust are discussed in detail in section 2.3.6. Regarding insect and disease outbreaks in the Upper Snake province, out-of-basin effects may be discussed in terms of vectors and pathways (NISC 2003). Pathways are the means by which species are transported from one location to another. Natural pathways include wind, air and water currents, and other forms of dispersal that specific species have developed morphologically and behaviorally (NISC 2003). Manmade pathways are those that are enhanced or created by human activity. These are characteristically of two types (NISC 2003).

The first type is intentional or the result of a deliberate action to translocate an organism. Examples of intentional introductions include the intended movement of living seeds, whole plants, or pets. A specific intentional pathway can only be judged by the positive or negative impact of the organisms being moved (NISC 2003).

The second type is the result of unintentional movement of organisms. Examples of unintentional pathways are ballast water discharge (e.g., red-tide organisms), soil associated with the trade of nursery stock (e.g., fire ants), fruit and vegetable importation (e.g., plant pests), and the

international movement of people (e.g., pathogens). In these and countless other unintentional pathways, the movement of species is an indirect byproduct of our activities (NISC 2003).

For the purposes of the National Invasive Species Council (NISC), the term “vector” is viewed as a biological pathway for a disease or parasite (i.e., an organism that transmits pathogens to various hosts) and is not completely synonymous with the much broader definition of a pathway (NISC 2003).

3.2.2.3 Invasive Exotic Wildlife

Invasive exotic wildlife may have significant impacts on aquatic and terrestrial habitats and species of the Upper Snake province. Two species of exotic wildlife with potential negative impacts to the province watersheds include the New Zealand mudsnail and bullfrog.

Around 1986, the New Zealand mudsnail was most likely introduced to Idaho from imported products at a fish hatchery near Hagerman, Idaho, from which it was widely disseminated through trout stocking (Bowler 1991). This western American strain is clonal and apparently did not bring the normally associated trematode parasites with it. Without its natural enemies, the mudsnail has spread uncontrolled through some of the most productive waters in North America (Bowler 1991). The mudsnail has a tremendous propensity to populate its environment rapidly, and upward of 700,000 mudsnails per square meter have been found in some waters. The mudsnail does not appear to be self-limiting from density-dependent effects. Sheer numbers of the mudsnail dominate the base of the food web, and they can consume over 80% of a river's productivity (Bowler 1991). Introduced predators such as the bullfrog can have devastating effects on faunas that evolved without equivalent

predatory types (Schwalbe and Rosen 1988). The bullfrog, as an exotic in the absence of key original enemies (the basses, pikes, snapping turtles, and water snakes of the eastern United States), attains tremendous population densities. Such nonnative predators, in core population areas of native species, can lead to regional extinctions and may account for some unexplained amphibian declines (Schwalbe and Rosen 1988).

3.2.2.4 Habitat Losses and Linkages

Wildlife habitat losses due directly to the construction of Palisades and Minidoka dams have been identified in the BPA Wildlife Mitigation Program. Although mitigation for lost fish and wildlife habitats and populations has been primarily focused on terrestrial habitats, identified and quantified wildlife habitat mitigation for these projects is incomplete. Resident fish losses due to the construction and inundation of these two projects have not been mitigated for. Although habitat loss assessments and mitigation efforts have occurred in downstream sections of the lower Snake River, both direct and secondary/indirect fish and wildlife habitat and population losses in the Upper Snake province have not been assessed or mitigated for. We provide a resident fish loss assessment for Palisades and Minidoka projects in this assessment. The Northwest Power and Conservation Council has a funding process whereby terrestrial and aquatic habitats can potentially receive funding for restorative work. However, the aquatic and terrestrial components of the landscape in the Upper Snake province, although undermitigated and under assessed, have received comparatively little funding (NPCC 2004).

Maintaining wild habitats that support the long-term survival of native wildlife populations throughout the Columbia River basin and providing for the continued course

of the region's large-scale evolutionary and ecological processes require scientific and conservation action at the continental scale (Noss and Soule 1998, Robinson *et al.* 2004).

Habitat fragmentation has been recognized as a major threat to the survival of natural populations and the functioning of ecosystems. The reduction of large, more or less continuous habitats to small and isolated patches may affect the abundance and species composition of populations living in the area (Martin *et al.* 2000). Some factors that may contribute to this decline include changes in predation or food availability, microclimatic effects, loss of genetic variation, and lack of recolonization following local extinctions (Noss and Soule 1998, Robinson *et al.* 2004).

Unfortunately, the effects of this widespread habitat fragmentation on populations remain unknown. Further, some of the species affected may be dominant carnivores and act as "keystone predators." These carnivores are species whose removal dramatically alters the composition of ecological communities by resulting in the decline and extinction of some species and marked increases in others (Noss and Soule 1998, Carroll *et al.* 2001, Robinson *et al.* 2004).

Although certain species have much more influence than others do on an ecosystem's structure, not all ecosystems include a single species that exerts such a pervasive influence. In fact, most ecosystems are somewhat sensitive to the loss of any one of many species, though some losses have greater impact on the system than others (Noss and Soule 1998, Woodroffe and Ginsberg 1998, Gittleman *et al.* 2001, Mattson and Merrill 2002, Robinson *et al.* 2004).

One of the approaches that conservation biology implements to mitigate the effects of habitat fragmentation is the development of habitat reserves and wildlife corridors. All

species require a minimum amount of habitat for survival. Wildlife habitat reserves are established to meet these requirements for as many species as possible. Some national parks, wilderness areas, and other protected habitats are suitable for the survival of a wide range of species (Noss and Soule 1998, Haila 1999, Robinson *et al.* 2004). Maintaining connectivity or “linkage” between wildlife populations across the landscape will make for healthier populations and could prevent many of the detrimental consequences of habitat fragmentation. Maintaining opportunities for wildlife movement across the landscape preserves the natural processes that animals have used for centuries (Servheen and Sandstrom 1993, Ruediger *et al.* 1999, Ruediger *et al.* 2000).

The physical representation of a subbasin or watershed is defined primarily by the geomorphology of the landscape and secondarily by humans seeking to understand complex ecosystem structure and function in a context that is comprehensible. The functional components of the landscape do not necessarily “recognize” the anthropogenic or natural boundaries that are used to describe the environment. Habitat fragmentation, either natural or anthropogenic, may become an out-of-basin effect, if a specific functional component becomes limited outside of the subbasin, thereby increasing the importance or significance of that component inside the subbasin.

3.2.2.5 Genetic Linkages

Other effects of habitat fragmentation can be changes in population structure resulting from changes in dispersal patterns. As fragmentation proceeds, dispersal from one habitat fragment to another becomes more difficult. Many studies have addressed the threats to the small populations resulting from the fragmentation of formerly large populations (Noss 1991). The basic idea is

that local populations become separated so widely that their demography and genetic dynamics become independent of one another, a situation that may eventually lead to local extinctions and/or loss of genetic variation (Noss and Soule 1998, Robinson *et al.* 2004).

Regional groups of interconnected populations are called metapopulations. These metapopulations are connected to one another over broader geographic ranges. As local populations within a metapopulation fluctuate in size, they become vulnerable to extinction during periods when their numbers are low. Extinction of local populations is common in some species, and the regional persistence of such species is dependent on the existence of a metapopulation (Flather *et al.* 1998). As a result, the elimination of a portion of the metapopulation structure of some species can increase the chance of regional extinction of the species (Noss and Soule 1998, Robinson *et al.* 2004).

Out-of-basin losses of metapopulation structure may have important ramifications to aquatic and terrestrial components of the landscape within the Upper Snake province.

It is relatively easy to comprehend the significance of the loss of prominent species such as the Chinook salmon or grizzly bear. It is much more difficult to comprehend the role that less conspicuous species have in metapopulation structure and ecosystem function. Conserving genetic diversity at landscape scales is essential because genetic variation allows species to adapt and survive environmental changes (Noss and Soule 1998, Robinson *et al.* 2004).

Ecosystem diversity is thought of as the broadest means for protecting species diversity and genetic diversity (Noss 1983). To protect an ecosystem, all the species within that ecosystem must be protected

(Groves *et al.* 2002). Populations of many species are not completely isolated but are connected by the movement of individuals (immigration and emigration). Consequently, the dynamics and evolution of many local populations are determined by both the populations' life histories and individuals' patterns of movement between populations (Noss and Soule 1998, Robinson *et al.* 2004).

3.2.2.6 Development

Human impacts on wildlife and habitats have been accelerated in the Upper Snake province because of development of federal hydropower projects in the Columbia River basin. Having a reliable and affordable power source, irrigation water supply, and employment opportunities provided impetus for development of agriculture and other industry (NPCC 2003).

This development has led to increased human disturbance of wildlife populations, increased human use of wildlife, and accelerated habitat losses across the Upper Snake province. Extirpation of anadromous fishes in adjacent provinces has led to increased harvest pressure on wildlife for subsistence and cultural and recreational uses in the Upper Snake province. Factors limiting terrestrial resources in the Upper Snake province are dominated by modification of forested stands through timber management and combined effects of mining, grazing, agriculture, and residential development, including roads (NPCC 2003). Development, including agriculture, has converted 2.9% of lands in the Upper Snake province to unvegetated habitats (IBIS 2003).

An artifact of continued development outside of the Upper Snake province is the increased effect the populations of those out-of-basin provinces have within the Upper Snake province. A domino effect of sorts occurs as

development in this province places greater demand for resources in adjacent subbasins.

While difficult to quantify, the indirect effects of hydropower development can be far-reaching. Mitigation for these effects seeks to address a broad array of habitats and species. Protection of existing high-value habitats and restoration of habitats are viewed as primary goals (NPCC 2003).

3.2.2.7 Climate Cycles

Climatic variation is identified as an out-of-basin effect since research is beginning to show that land-use practices can influence regional climate and vegetation in adjacent natural areas in predictable ways (Pielke *et al.* 1994, Stohlgren *et al.* 1998). Northern ecosystems are expected to be particularly sensitive to climatic changes. In addition, climatic changes are predicted to be most pronounced in the North, with implications for biodiversity, annual growth pattern, forage quality, and carrying capacity for terrestrial species (UNEPWCMC 2004). Climate change is likely to have considerable impacts on most or all ecosystems. The distribution patterns of many species and communities are determined, to a large degree, by climatic parameters, but the responses to changes in these parameters are rarely simple (UNEPWCMC 2004).

At the simplest level, changing patterns of climate will change the natural distribution limits for species or communities. In the absence of barriers, it may be possible for species or communities to migrate in response to changing conditions. Vegetation zones may move toward higher latitudes or higher altitudes following shifts in average temperatures. In most cases, natural or manmade barriers will impact the natural movement of species or communities (UNEPWCMC 2004).

Rainfall and drought will also be of critical importance. Extreme flooding will have implications for large areas, especially riverine and valley ecosystems. Rates of change will also be important, and these rates will vary at regional and even local levels. The maximum rates of spread for some sedentary species, including large tree species, may be slower than the predicted rates of change in climatic conditions (UNEPWCMC 2004). In many cases, further complications will arise from the complexity of species interactions and differential sensitivities to changing conditions among species. Certain species may rapidly adapt to new conditions and act in competition with others (UNEPWCMC 2004). Negative impacts may include increased ranges of insect pests and diseases, as well as failure of crops in some regions from drought or flooding (UNEPWCMC 2004).

Mesoscale atmospheric/land-surface modeling, short-term trends in regional temperatures, forest distribution changes, and hydrology data indicate that the effects of land-use practices on regional climate may overshadow larger-scale temperature changes commonly associated with observed increases in carbon dioxide and other greenhouse gases (Pielke *et al.* 1994, Stohlgren *et al.* 1998).

4 Inventory/Synthesis

4.1 Inventory

The project inventory section provides a list of fish and wildlife restoration activities being conducted in each watershed in the Snake Snake Headwaters, Upper Snake, and Closed Basin subbasins, along with information about who is responsible for funding projects. Inventory information was collected from technical and planning team participants, from websites of funding and implementation agencies, and through interviews with nonparticipants. Due to the size of the Upper Snake province and the number of agencies, nonprofit organizations, and private parties actively engaged in fish and wildlife restoration activities, it is unlikely that all activities that have taken place in the last five years have been captured. However, the information provided is believed to be representative of the types of activities taking place.

4.1.1 Existing Protection

The Upper Snake province contains roadless and other protected areas, including land under wilderness and National Park designations and some unique areas such as Craters of the Moon National Monument and Idaho National Engineering and Environmental Laboratory (discussed in section 1.6.4 of this assessment). The Snake Headwaters subbasin contains the largest amount of protected area, estimated at one-third of the total area of the subbasin. The Upper Snake subbasin has an estimated 10% of its total area protected, with the largest portion associated with Idaho National Engineering and Environmental Laboratory and Craters of the Moon National Monument. Protected areas in the Closed Basin subbasin are primarily inventoried roadless areas.

4.1.2 Existing Management Plans and Programs

Existing management plans, programs, and initiatives with significance to fish, wildlife, water resources, riparian areas, and/or upland areas for subbasins within the Upper Snake province were reviewed in the respective subbasin summary documents (NPPC 2002a, Snake Headwaters, p. 206–221; NPPC 2002b, Upper Snake, p. 100–104; NPPC 2002c, Henrys Fork, p. 76–86; NPPC 2002d, Closed Basin, p. 102–113, NWPPC 2002e).

An important and ongoing management program includes mitigation for the Palisades and Minidoka federal hydropower projects under the Southern Idaho Wildlife Mitigation Project. The project cooperators, including the Idaho Department of Fish and Game (IDFG), Shoshone-Bannock Tribes, and Shoshone–Paiute Tribes, implement the project under authority of the Northwest Power and Conservation Council (NPCC, formerly the Northwest Power Planning Council or NPPC) as funded by the Bonneville Power Administration (BPA).

In 1984, the BPA funded an analysis of impacts on wildlife and wildlife habitat as a result of construction and operation of the U.S. Bureau of Reclamation's Palisades Project in eastern Idaho. The Habitat Evaluation Procedure (HEP) was used to evaluate pre-and post-construction habitat conditions of the Palisades Project. Eight evaluation species were selected, and losses were expressed in the number of habitat units (HUs). One HU is equivalent to one acre of prime habitat. The evaluation estimated that a loss of 2,454 HUs of mule deer habitat, 2,276 HUs of mink habitat, 2,622 HUs of mallard habitat, 18,565 HUs of bald eagle breeding and wintering habitat, and 1,336 and 704 HUs of forested and scrub-shrub wetland habitat for nongame species, respectively, occurred as a result of the project. A comparison of

pre- and post-construction flow conditions on the South Fork Snake River below the dam could not substantiate the claims that water releases from the dam were causing more Canada goose nest losses than flow in the river prior to construction (Martin and Hansen 1993). In 1986, under direction of the NPPC, the Conservation Act of 1980, and the subsequent NPPC Columbia River Basin Fish and Wildlife Program, projects were developed to mitigate the losses of wildlife habitat and annual production due to development and operation of the Palisades Project. A modified Habitat Evaluation Procedure (HEP) was used to assess the benefits of the preferred mitigation plan to wildlife. A total of 37,068 HUs were estimated to have been lost as a result of inundating the Palisades Reservoir area. Through a series of protection and enhancement projects, the intent of the preferred mitigation plan was to provide benefits of an estimated 37,070 HUs. Target species to be benefited by this mitigation plan included bald eagle, mule deer, elk, mallard, Canada goose, mink, yellow warbler, black-capped chickadee, ruffed grouse, and peregrine falcon (Sather-Blair and Preston 1985). The mitigation plan identified 18 potential projects in Idaho and Wyoming to mitigate losses for all target species. The South Fork Snake River proposal, which included the protection and enhancement of 3,200 acres of bald eagle and other wildlife habitat below Palisades Reservoir, was ranked highest of the proposals in Idaho.

In early 1990, the NPPC and IDFG developed a public review document that included a summary of the Palisades Project's wildlife losses and mitigation goals and objectives. It was distributed statewide and announced in local newspapers, local government publications, and the NPPC monthly newspaper. During the Columbia Basin Fish and Wildlife Authority and BPA implementation planning process, the South

Fork Snake River area was ranked as the top priority mitigation project in Idaho. In late 1990, the NPPC and BPA approved funding of the project to protect and improve bald eagle and other wildlife habitat along 65 miles of the South Fork Snake River riparian corridor, from Palisades Dam to the confluence with the Henrys Fork (IDFG 1993).

In 1995, an interagency work group was established to define and prioritize potential mitigation projects. Then in 1996, IDFG and the Shoshone-Bannock Tribes signed a Memorandum of Agreement to implement wildlife mitigation projects in the Palisades watershed. Accomplishments between 1997 and 2000 include the purchase of 11,376 acres of acquisitions and conservation easements, which provide up to 14,887 HUs toward Palisades wildlife mitigation. Mitigation for wildlife impacts of this federal hydropower project has not yet been completed.

The Minidoka project was initiated in 1903 and includes all the dams, reservoirs, and irrigation works from the Milner-Gooding Canal headworks upstream to Jackson Lake and Island Park dams. In 1989, an interagency work group assessed the impacts of the Minidoka Project on wildlife (Martin and Meuleman 1989). The interagency work group used the equal replacement (equal trade-off) method to credit benefits to certain wildlife species. This method weights the value of each wildlife species equally. The interagency work group's assessment of impacts to wildlife species showed a net loss of 5,374 HUs in the Minidoka project area. Estimated habitat losses included 181 acres of emergent wetlands, 396 acres of scrub-shrub wetlands, 3,215 acres of riverine habitat, and 7,736 acres of sagebrush-grassland. Wetland habitat losses in the project area were partially offset by an improvement in the quality of emergent wetland habitat and the gain of a

lacustrine area that supports an estimated 4,376 acres of submerged plant beds.

Although some aspects of the Minidoka project had been positive, the overall impact was found to be negative. As a result, the interagency work group agreed that a mitigation plan should be developed, with the goal of compensating for losses identified in the study area.

In 1991, a wildlife protection, mitigation, and enhancement plan was developed for the Bureau of Reclamation's Minidoka Dam and Reservoir in south-central Idaho, under the direction of the Conservation Act of 1980, the NPPC, and the Columbia River Basin Fish and Wildlife Program. Specific objectives of the plan included 1) developing protection, mitigation, and enhancement goals and objectives for target wildlife species; 2) identifying potential protection, mitigation, and enhancement opportunities to achieve the mitigation objectives; and 3) coordinating project activities with agencies, tribes, and the public. Mitigation efforts were directed toward wildlife species that were negatively impacted by the Minidoka Dam and Reservoir. The prioritized mitigation goals are 2,993 river otter HUs in riparian/river habitat, 3,755 greater sage-grouse HUs in shrub-steppe (sagebrush-grassland) habitat, 3,413 mule deer HUs in shrub-steppe habitat, and 342 yellow warbler HUs in deciduous scrub-shrub wetland habitat (Meuleman et al. 1991).

The following is a list of other planning and management efforts initiated or completed since completion of the subbasin summaries:

- *State of Idaho Strategic Plan for Management of Invasive Exotics* (ISDA 1999). This strategic plan recommends statewide formation of cooperative weed management areas and application of integrated weed management practices to reduce ecological, economic, and social

impacts of noxious weeds on the state's human and natural resources. To accomplish these objectives, supporters and cooperators incorporate resources, priorities, and strategies of federal, state, and county agencies into a unified approach to halt or slow the spread of noxious weeds across Idaho (ISDA 1999).

<http://www.agri.state.id.us/PDF/Animal/Strategic%20Plan.pdf>

- *Idaho BLM's Abandoned Mine Lands Plan (AML)*

<http://www.id.blm.gov/aml/program.htm>

- *Craters of the Moon National Monument and Preserve Draft Management Plan and environmental impact statement (EIS)*

<http://www.nps.gov/crmo/pphtml/documents.html>

- *Great Basin Restoration Initiative*

<http://www.fire.blm.gov/gbri/>

- *Standards for Rangeland Health and Guidelines for Livestock Grazing Management for Idaho*

<http://www.id.blm.gov/publications/data/SGFinal.pdf>

- *Pocatello Resource Management Plan and EIS*

<http://www.id.blm.gov/planning/pocrmp/brfpkt.pdf>

- *Medicine Lodge Resource Management Plan*

<http://www.id.blm.gov/offices/idahofalls/mlrmp/>

- *Upper Snake River District Fire, Fuels and Related Vegetation Management Direction Plan*

http://www.id.blm.gov/planning/usrd_fmnda/data/brfpkt.pdf

- *IDFG Wolf Management Plan*

http://fishandgame.idaho.gov/wildlife/plans/wolf_plan.pdf

- *State of Idaho, Yellowstone Grizzly Bear Management Plan*

- *Elk–Bison EIS*

<http://www.nps.gov/yell/technical/planning/bison%20eis/summary.htm>

- *Fire Management Plan (FMP) and environmental assessment*

http://www.nps.gov/crmo/firemp/fmp_ea.htm

- *Transportation plan EIS*

<http://www.itd.idaho.gov/planning/reports/plan20yr/plantoc.html>

- *Winter-use plans, Yellowstone and Grand Teton National Parks EISs*

<http://www.nps.gov/grte/winteruse/intro.htm>

- *Yellowstone Wildland Fire Management Plan*

<http://www.nps.gov/yell/technical/fire/FirePlan/fireplan.htm>

- *Yellowstone National Park Strategic Plan*

<http://www.nps.gov/yell/publications/pdfs/strategicplan.pdf>

- *Caribou National Forest Plan Revision and EIS*

<http://www.epa.gov/fedrgstr/EPA-IMPACT/2001/October/Day-09/i25190.htm>

- *Ririe Reservoir Resource Management Plan*

http://www.usbr.gov/pn/programs/ririe_rmp/pdf/EA/CH1_EA.pdf

- *Minidoka North Side Resource Management Plan*

http://www.usbr.gov/pn/programs/minidoka_rmp/pdfs/Mndka_Cover.pdf

- *Amended Biological Assessment for Bureau of Reclamation Operations and Maintenance in the Snake River Basin Above Brownlee Reservoir*

<http://www.usbr.gov/pn/programs/UpperSnake/UpperSnakeBA.htm>

- *Idaho Drought Plan with federal water-related drought-response programs*

<http://www.idwr.state.id.us/about/issues/Drought%20Plan.pdf>

- *Idaho Water Resources Board water resources planning*

Federal planning cycles typically incorporate an adaptive management scheme where pertinent objectives and strategies “evolve” as new information is collected and incorporated into the decision-making process. The information presented in this assessment is founded on information used in existing management plans, as well as more site-specific information. This building of information should enhance future planning, prioritization, and implementation efforts.

The direction and focus of existing management plans and ongoing management programs are based on many of the same issues that we have identified in this Upper Snake provincial assessment. However, lack of implementation of existing plans due to

funding, legal, and political constraints inhibits the protection and restoration of fish and wildlife resources. Furthermore, habitat restoration efforts may take years before effects are fully realized.

4.1.3 Restoration and Conservation Projects

The inventory identified 184 projects with objectives targeting a variety of species and/or habitat management issues. Of these, 31 projects were identified in the Snake Headwaters subbasin, 127 in the Upper Snake subbasin, and 26 in the Closed Basin subbasin. There were no habitat restoration projects reported for the Greys–Hoback or Gros Ventre watersheds. Projects were classified into the following activity categories based on project descriptions:

- wetland restoration
- upland habitat protection
- riparian fencing
- water conservation
- stream structure
- road/trail work
- access management
- fish passage
- grazing management
- riparian restoration

- diversions
- channel restoration
- miscellaneous

Criteria used to classify projects are summarized in

Table 4-1. If a project included numerous activities, the project was credited in all applicable categories. The values represent numerical tallies of project categories. Funding summaries are based on project counts only, not on funding levels. Projects identifying multiple funding groups are classified for all organizations involved. Project information is located in Appendix 4-1.

Funding for projects in the Snake Headwaters subbasin is primarily federal, with 28% of reported projects federally funded. Nonprofit (13%) and local (17%) groups also funded a substantial portion of the projects in the Snake Headwaters subbasin (Figure 4-1). Funding for projects in the Upper Snake subbasin was also primarily federal, with 22% of projects reporting some type of federal funding (Figure 4-2). Funding for projects in the Closed Basin subbasin was primarily through IDFG, with over 32% of projects reporting some type of IDFG funding (Figure 4-3).

Table 4-1. Project activity categories and criteria for habitat restoration projects identified in the Upper Snake province.

Project Activity	Criteria for Classification
Wetland restoration	Specifically mentioned purpose of “wetland restoration”
Upland habitat protection	Identified protection of habitat other than riparian or stream
Riparian fencing	Provided riparian habitat with natural (passive) recovery opportunity
Water conservation	Discussed diversion consolidation, conversion to more efficient methods, or retiring of the water right
Stream structure	Mentioned placement of structures (bank barbs, drop structures) to prevent erosion or protect/create habitat
Road/trails	Involved modification, moving, or closing of roads and trails to reduce sediment or protect habitat

Project Activity	Criteria for Classification
Access management	Pertained to recreation access (campgrounds, boat ramps) designed to reduce sediment or protect habitat
Fish passage	Allowed or increased fish movement (culvert replacement, dam modification)
Grazing management	Designed to protect habitat while allowing limited grazing typically in riparian areas
Riparian restoration	Discussed active work on riparian areas including vegetation planting
Diversion	Modified existing water diversion structure including fish screening or consolidation
Channel restoration	Reconnected side channels or eliminated stream crossings
Miscellaneous	Included projects that were unclassifiable

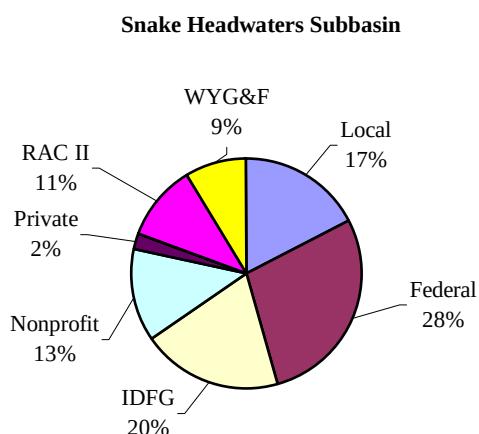


Figure 4-1. Funding breakdown for habitat restoration projects in the Snake Headwaters subbasin identified during the assessment process. WYG&F = Wyoming Game and Fish Department; Local = City or County; Federal = U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and Bureau of Reclamation; IDFG = Idaho Department of Fish and Game; Nonprofit = not for profit and nongovernmental organizations; Private = private business or citizens, RAC II = Resource Advisory Committees.

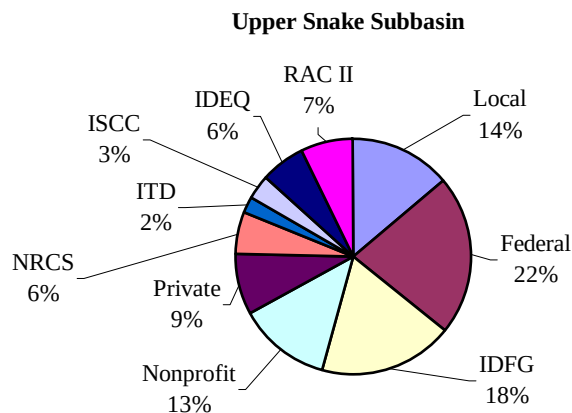


Figure 4-2. Funding breakdown for habitat restoration projects in the Upper Snake subbasin identified during the assessment process. Local= City or County, Federal= U.S Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and Bureau of Reclamation, IDFG= Idaho Department of Fish and Game, Nonprofit= not for profit and nongovernmental organizations, Private= private business or citizens, NRCS= Natural Resources Conservation Service, ITD= Idaho Department of Transportation, ISCC= Idaho Soil Conservation Commission, IDEQ= Idaho Department of Environmental Quality, RAC II= Resource Advisory Committees.

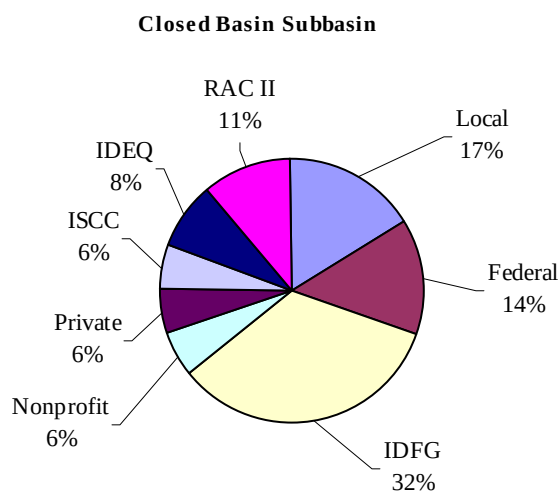


Figure 4-3. Funding breakdown for habitat restoration projects in the Closed Basin subbasin identified during the assessment process. Local = City or County; Federal = U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and Bureau of Reclamation; IDFG = Idaho Department of Fish and Game; Nonprofit =not for profit and nongovernmental organizations; Private = private business or citizens; ISCC = Idaho Soil Conservation Commission; IDEQ = Idaho Department of Environmental Quality; RAC II = Resource Advisory Committees.

4.1.3.1 Snake Headwaters Subbasin

Habitat Restoration Activities—We identified 31 projects designed to restore fish and wildlife habitat in the Snake Headwaters subbasin (Figure 4-4). We were unable to identify any habitat restoration projects for the Greys–Hoback and Gros Ventre watersheds. Upland habitat protection, water diversion modification, fish passage, and water conservation were the most common

restoration activities reported in the Snake Headwaters subbasin. We identified 8 habitat restoration activities for the Palisades watershed, with grazing management the most common restoration activity reported. Habitat restoration projects categorized by watershed in the Snake Headwaters subbasins are presented in Table 4-2.

Snake Headwaters Habitat Restoration Projects

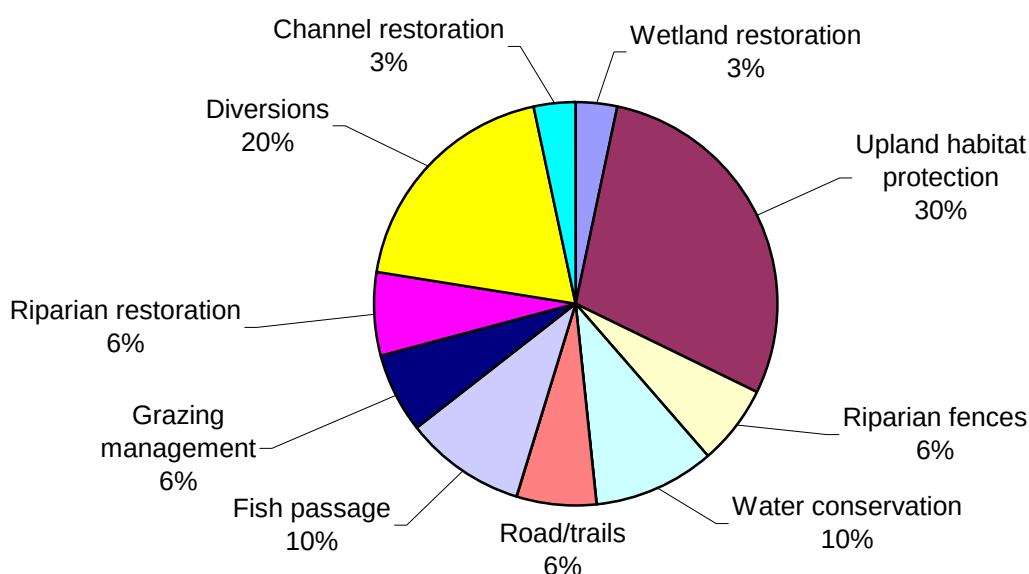


Figure 4-4. Summary of 31 habitat restoration activities in the Snake Headwaters subbasin identified during the assessment process.

Table 4-2. Number of habitat restoration projects by watershed in the Snake Headwaters subbasin identified for the 12 project activity categories.

Project Activity Category	Watershed				
	Snake Headwaters	Gros Ventre	Greys–Hoback	Palisades	Salt
Wetland restoration	1				
Upland habitat protection	3			3	3
Riparian fences				2	
Water conservation	3				
Stream structure					
Road/trails					2

Project Activity Category	Watershed				
	Snake Headwaters	Gros Ventre	Greys–Hoback	Palisades	Salt
Access management					
Fish passage	2			1	
Grazing management				2	
Riparian restoration	1				1
Diversions	6				
Channel restoration	1				
Totals	17	0	0	8	6

4.1.3.2 Upper Snake Subbasin

Habitat Restoration Activities—We identified 127 projects designed to restore fish and wildlife habitat in the Upper Snake subbasin (Figure 4-5). The Upper Snake subbasin had a diverse list of habitat restoration projects reported, covering all 12 habitat restoration categories. Overall, upland habitat protection, riparian restoration, water conservation, and wetland restoration were the most common activities reported in the Upper Snake subbasin (Table 4-3). In the Upper Snake–Rock watershed, we identified one wetland restoration and one upland

habitat protection project. Of the five projects identified in the Goose watershed, upland habitat protection was the most common (Figure 4-5). We identified 12 projects in the Lake Walcott watershed, with diversion modification, water conservation, and upland habitat protection the most commonly reported activities (Table 4-3).

All restoration projects identified for the American Falls watershed were for upland habitat protection.

Upper Snake Subbasin Habitat Projects

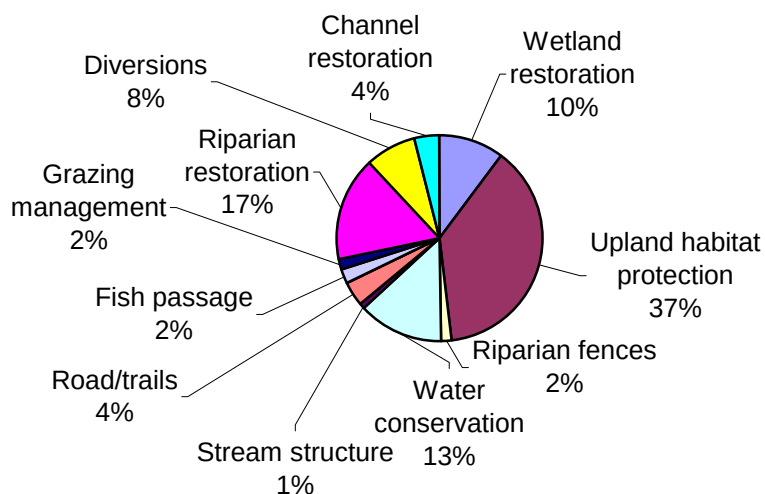


Figure 4-5. Summary of 127 habitat restoration activities in the Upper Snake subbasin identified during the assessment process.

Table 4-3. Number of habitat restoration projects by watershed in the Upper Snake subbasin identified for the 12 project activity categories.

Project Activity Category	Watershed ^a											
	IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR
Wetland restoration				9	1				1		1	1
Upland habitat protection	4	8	11	6	3	2	4	1	3	2	3	1
Riparian fences		2										
Water conservation	1	2	2	2			2	4	3	1		
Stream structure	1											
Road/trails	2		1				2					
Access management												
Fish passage	1	1		1								
Grazing management		2										
Riparian restoration	1		4	9			2	3	1		1	
Diversions		4						1	4	1		
Channel restoration			1				2	2				
Totals	10	19	19	27	4	2	12	11	12	4	5	2

^a See Table 1-1 for watershed acronyms.

4.1.3.3 Closed Basin Subbasin

Habitat Restoration Activities—We identified 26 projects designed to restore fish and wildlife habitat in the Closed Basin subbasin (Figure 4-6). All restoration projects identified for the Beaver–Camas and Birch Creek watersheds were for upland habitat protection (Table 4-4).

most common activities reported in the Closed Basin subbasin (Table 4-4). In the Big Lost watershed we identified nine habitat restoration projects, mostly in upland habitat protection. We also identified nine projects in the Medicine Lodge watershed with upland habitat protection and road/trail maintenance the most commonly reported activities (Table 4-4).

Overall, stream structure and upland habitat protection and road/trail restoration were the

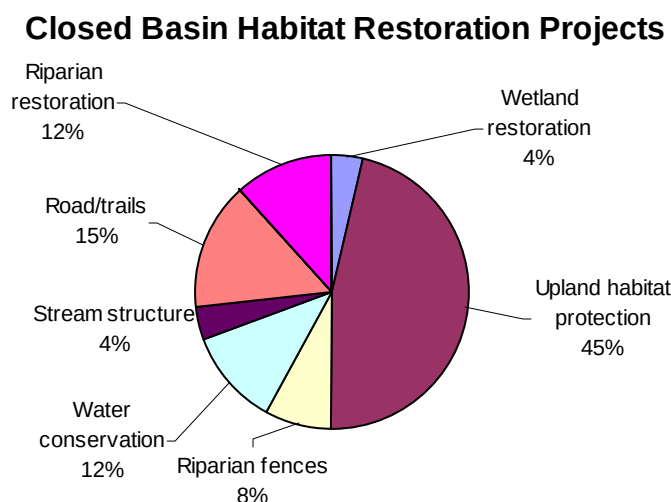


Figure 4-6. Summary of 26 habitat restoration activities in the Closed Basin subbasin identified during the assessment process.

Table 4-4. Number of habitat restoration projects by watershed in the Closed Basin subbasin identified for the 12 project activity categories.

Project Activity Category	Watershed				
	Beaver–Camas	Medicine Lodge	Birch	Little Lost	Big Lost
Wetland restoration					1
Upland habitat protection	2	3	1	2	4
Riparian fences				1	1
Water conservation		2			1
Stream structure				1	
Road/trails		3		1	
Access management					
Fish passage					
Grazing management					

Project Activity Category	Watershed				
	Beaver–Camas	Medicine Lodge	Birch	Little Lost	Big Lost
Riparian restoration		1			2
Diversions					
Channel restoration					
Totals	2	9	1	5	9

4.1.5 Monitoring and Evaluation Activities

4.1.5.1 *Aquatics*

Within the Upper Snake province, state and federal agencies, tribes, and occasionally private parties collect data on focal fish species. Where data were accessible, we presented them in section 2 of this assessment. However, because new data are constantly being collected, it is impossible to provide an assessment of all available data. Additionally, there is no central location that archives data or even a centralized location for project information. Project descriptions and accomplishments are presented in Appendix 4-1.

4.1.5.2 *Terrestrial*

Terrestrial research, monitoring, and evaluation activities in the Upper Snake province are limited in number and scope (Appendix 4-3). Most research, monitoring, and evaluation effort is expended on threatened, endangered, candidate, or recently delisted species (Appendix 4-3). Focal habitats have also received negligible research, monitoring, and evaluation effort, resulting in significant data gaps that inhibit the land management decision-making process. Additional information is needed for these habitats and the focal species that depend on those habitats.

4.1.6 Project Gap Assessment

4.1.6.1 *Aquatics*

The habitat restoration projects identified in the inventory address many of the limiting factors identified in this assessment (see section 3). A topic identified with great potential to increase habitat quality and quantity for focal fish species is the reconnection of tributaries that have been isolated from dewatering or fish passage barriers. While some progress has been made in the Upper Snake province to reconnect tributaries, there is a substantial amount of spawning and rearing habitat for fish focal species in Palisades, Lower Henrys Fork and other watersheds that is currently isolated or inaccessible.

4.1.6.2 *Terrestrial*

The Upper Snake and Closed Basin subbasins are unique in terms of the proportional distribution of project activity among the various habitat restoration categories. Project activities in the Snake Headwaters subbasin were less diversified, with the predominate amount of activity focused on stream diversions. All conservation activities are important, and prioritization of activities would be challenging. Currently, no prioritization protocol of project activity at watershed or provincial scales exists. Provincial coordination of conservation activities is necessary to ensure that limited funding is

distributed appropriately. Provincial coordination is discussed in detail in later sections.

4.1.6.3 Terrestrial Monitoring and Evaluation

Perhaps the greatest need for implementing fish and wildlife conservation in the Upper Snake province is status and trend information for each of the focal habitats. Current research, monitoring, and evaluation activities do not address the significant data gaps that exist regarding focal habitat quantity and quality. Watershed scale goals, objectives, and strategies with quantifiable results cannot be measured using the current information available. Undoubtedly, a tremendous amount of information has been collected at scales finer than the watershed. However, the current planning process does not allow time to compile all of the pieces into a cohesive summary. Additional research, monitoring, and evaluation effort should be spent collecting and compiling existing data regarding focal habitat structure, function, quantity, and quality.

Prescribed fire activities were not submitted during the data-collection process for the inventory. Ecosystem structure and function in the Upper Snake province is intricately tied to natural fire regimes across all focal habitats but most importantly the shrub steppe habitats. Additional research, monitoring, and evaluation pertaining to anthropogenic interference of natural fire regimes is needed to ensure that adaptive fire management strategies can be implemented across the province.

A growing body of expertise and technology is being developed for the management of invasive exotic weeds. Future research, monitoring, and evaluation efforts need to incorporate even broader coordination and collaboration due to the “out-of-basin”

implications of spreading invasive exotics across the western landscape.

Altered hydrologic function at all scales has been identified as a significant cause limiting habitat quantity and function in the Upper Snake province. Based on the inventory, significant effort has been expended to address this issue in the Snake Headwaters subbasin. However, additional coordination and collaborative across multiple jurisdictions is required to begin addressing altered hydrology within the Upper Snake province.

4.2 Synthesis of Findings

4.2.1 Key Findings

Current and historic land-use activities have degraded freshwater habitat for fish in the Upper Snake province. Impacts are associated with alterations to natural hydrologic regimes, decreased function of riparian habitat associated with land use and conversion, and increased sedimentation from upland habitat impacts. Alterations to hydrologic regimes and riparian habitat also impact water temperatures, which may decrease habitat quality if impacts are severe enough.

Analyses of focal habitats in the assessment have attempted to determine not only the most significantly altered habitats, but also where they occur in the Upper Snake province, the causes of those declines, and the priority for conservation activities.

Riparian habitats in the Upper Snake province provide rich and vital resources to subbasin fish and wildlife due to their high productivity and diversity. Riparian areas contain elements of both aquatic and terrestrial ecosystems, which mutually influence each other and function as transitions between aquatic and upland

habitats. Thirty-four species of fish inhabit aquatic habitats, and more than 51% of the Upper Snake province's terrestrial vertebrate species use riparian habitats for essential life activities. Riparian habitats, in particular, are critical for maintaining instream conditions necessary for continued persistence of native fish species. Aquatic habitats are limited geographically (by definition, they are tied to water sources), and they are vulnerable to loss and degradation through human activities and land uses. Protecting riparian habitat may yield the greatest gains for fish and wildlife across the landscape while involving the least amount of area and perhaps the best cost:benefit ratio.

The analysis of key ecological functions and environmental correlates for focal habitats and species in the Upper Snake province indicated that there are areas within watersheds showing both increases and decreases in total functional diversity. However, the overall trend is a decline in total functional diversity for all focal habitats and species (with the exception of the common loon). The common loon appears to have gained some increase in total functional diversity due to increases in open water habitats. The juniper/mountain mahogany, whitebark pine, and open water habitats have all declined by as much as 81% in total functional diversity. The decline in total functional diversity for wildlife species in the Upper Snake province reduces the resilience of habitats and communities and exaggerates the effects of limiting factors identified in this assessment.

We are unable to explain why there are increases in total functional diversity for some of the focal habitats and species in the Upper Snake province. One possible explanation is that our analysis tool (IBIS) is limited by information gaps or inaccuracies. Alternatively, we know that wildlife species move within their preferred habitats, but we

have very little information on focal species movements within their known ranges at the watershed scale. This lack of information may affect functional diversity measures. In addition, information on focal species population dynamics and abundance is lacking.

4.2.1.1 Snake Headwaters Subbasin—Key Findings

Following is a list of key findings for the Snake Headwaters subbasin:

1. Inundation of the Snake River by construction of Palisades Dam resulted in impacts to wildlife, including 37,070 HUs of target species habitats (bald eagle, mule deer, elk, mallard, Canada goose, mink, yellow warbler, black-capped chickadee, ruffed grouse, and peregrine falcon). Mitigation for this impact has yet to be completed.
2. Approximately 346 hectares (3.46 km²) of free-flowing river habitat was inundated by construction of Palisades Dam and Reservoir, resulting in the loss of an estimated 70,000 Yellowstone cutthroat trout and 200,000 mountain whitefish yearly since 1957 (see Appendix 4-2 about loss assessment).
3. Migratory (fluvial/adfluvial) Yellowstone cutthroat trout populations are present in good numbers in the mainstem Snake River in the Snake Headwaters subbasin. These populations are relatively unique in the Upper Snake province.
4. Impacts to migratory Yellowstone cutthroat trout by construction of Palisades and Jackson dams are unknown.

5. Downstream of Palisades Dam, rainbow trout are a major threat to the long-term persistence of Yellowstone cutthroat trout.
6. Hybrid (Yellowstone cutthroat trout × rainbow trout) and rainbow trout are present in the Snake Headwaters subbasin above Palisades Dam, but they are not as widespread or pervasive as they are downstream of Palisades Dam.
7. Levy construction along the main Snake River downstream of Jackson Lake Dam has altered the hydrologic regimes (by preventing flushing flows) in important Yellowstone cutthroat trout spawning streams, requiring active human intervention to maintain suitable spawning gravels.
8. Levy construction along the main Snake River downstream of Jackson Lake Dam prevents water from overtopping banks, impacting cottonwood forest (riparian) habitat by preventing cottonwood regeneration.
9. Approximately 90% of the aspen habitats in the Snake Headwaters subbasin have been lost due to the effects of an altered fire regime.
10. Pine/fir forest habitats in the Snake Headwaters subbasin have greatly altered structure and function due to the effects of an altered fire regime.
11. Invasive exotics with negative impacts to biodiversity, forage, habitat and aesthetic quality, soil productivity, and biodiversity have impacted all habitats in the Snake Headwaters subbasin.
12. Approximately 95% of all whitebark pine habitats in the Snake Headwaters subbasin have been lost due to the exotic blister rust fungus and effects of an altered fire regime.
13. Legacy timber-harvest activities have impacted significant amounts of forested habitat primarily within the Salt watershed.
14. Grazing/browsing activities by sheep and cattle in the Greys–Hoback and Gros Ventre watersheds have impacted plant species composition, diversity, and density; disrupted ecosystem functioning; and altered forest dynamics.
15. Development and other land-use practices have fragmented habitats in the Greys–Hoback watershed, principally in the vicinity of the rapidly growing community of Jackson.
16. An altered fire regime is likely the most significant ecological influence affecting ecosystem structure and function in the Snake Headwaters subbasin.
17. Approximately 99% of the mountain mahogany habitat in the Greys–Hoback watershed has been lost due to the effects of an altered fire regime.

4.2.1.2 Upper Snake Subbasin—Key Findings

Following is a list of key findings for the Upper Snake subbasin:

1. Inundation of the Snake River by construction of Minidoka Dam resulted in impacts to wildlife, including 2,993 river otter HUs in riparian /river habitat, 3,755 greater sage-grouse HUs in shrub-steppe (sagebrush-grassland) habitat, 3,413 mule deer HUs in shrub-steppe habitat, and 342 yellow warbler HUs in deciduous scrub-shrub wetland habitat. Mitigation for this impact has yet to be completed.

2. Based on preliminary estimates, approximately 1,385 hectares (13.9 km²) of free-flowing river habitat was inundated by construction of Minidoka Dam and Lake Walcott, resulting in a loss of approximately 550 Yellowstone cutthroat trout and 995,000 mountain whitefish yearly since 1906 (see Appendix 4-2 about loss assessment).
3. Strong populations of resident life history type Yellowstone cutthroat trout are present throughout the Upper Snake subbasin.
4. Migratory (fluvial/adfluvial) populations of Yellowstone cutthroat trout are present in Henrys Lake, Willow Creek, Blackfoot River, and Teton River, but they are depressed throughout most of the subbasin.
5. All watersheds except Lake Walcott have documented core or conservation status Yellowstone cutthroat trout populations.
6. All watersheds except Willow Creek have documented Yellowstone cutthroat trout × rainbow trout hybrid populations.
7. Historic Yellowstone cutthroat trout habitat, especially large river habitat, has become dominated by rainbow trout throughout most of the Upper Snake subbasin.
8. Dewatering has isolated many of the Yellowstone cutthroat trout populations located in tributary habitats.
9. Two species of ESA-listed snails exist in the Upper Snake subbasin: Snake River physa and Utah valvata. Very little is known about their current or historic distributions.
10. Listed snail species are thought of as riparian associates and therefore influenced by management of riparian zones.
11. Water management has substantially altered the Snake River, changing it from a free-flowing coldwater system to a slower-moving warmwater system based on an anthropogenic hydrologic cycle.
12. Tributary habitat quality for Yellowstone cutthroat trout has been reduced by dewatering, land use that has altered riparian habitat, and increased sedimentation in the Upper Snake subbasin.
13. To protect the genetic diversity of Yellowstone cutthroat trout in the Upper Snake subbasin, it is necessary to conserve populations within each watershed.
14. Shrub-steppe habitat structure and function has been greatly altered by recent fire history, invasive exotic weeds, and large-scale conversion to dryland and irrigated agriculture.
15. Shrub-steppe habitat quantity and quality have been impacted by the encroachment of western juniper due to an altered fire regime in portions of the subbasin.
16. Open water habitat quantity and quality are affected by water-level fluctuations resulting from multiple anthropogenic uses of water resources.
17. Pine/fir forest habitats in the Upper Henrys, Lower Henrys, and Teton watersheds have greatly altered structure and function due to the effects of an altered fire regime.

18. Approximately 60% of the aspen habitats in the subbasin have been lost due to the effects of an altered fire regime.
19. Approximately 50% of the mountain mahogany habitats in the subbasin have been lost due to the effects of an altered fire regime.
20. An altered fire regime is likely the most significant ecological influence affecting ecosystem structure and function in the subbasin.
21. Development, habitat conversion, and other land-use practices have fragmented habitats in all but the remotest areas of the subbasin. The central Snake River Plain is the area most severely impacted by these sources of disturbance.
22. Numerous water diversion structures in the subbasin have altered hydrologic processes, with significant impacts to terrestrial and aquatic resources.
23. Altered hydrologic processes have had significant impacts to riparian and herbaceous wetland habitat quantity, quality, structure, and function.
24. Grazing/browsing activities by sheep and cattle in the subbasin have impacted plant species composition, diversity, and density, and they have disrupted ecosystem functioning.
2. Mountain whitefish declines in the Big Lost River appear to be related to altered discharge from Mackay Dam and dewatering throughout the system.
3. Migratory populations of bull trout in the Little Lost watershed are depressed, and most bull trout populations are now made up of residents.
4. Core and conservation Yellowstone cutthroat trout populations are present in the Beaver–Camas and Medicine Lodge watersheds.
5. Hybrid (Yellowstone cutthroat trout × rainbow trout) and rainbow trout are present in the Medicine Lodge watershed close to core and conservation Yellowstone Cutthroat trout populations.
6. Habitat quality for fish focal species has been reduced by dewatering, land use that has altered riparian habitat, and increased sedimentation in the Closed Basin subbasin.
7. Approximately 65% of the aspen habitats in the subbasin have been lost due to the effects of an altered fire regime.
8. Shrub-steppe habitat quantity and quality have been impacted by the encroachment of western juniper due to an altered fire regime in portions of the subbasin.

4.2.1.3 Closed Basin Subbasin— Key Findings

Following is a list of key findings for the Closed Basin subbasin:

1. Substantial declines in mountain whitefish distribution and abundance have occurred in the Big Lost River in the last 20 years.
9. Approximately 96% of the mountain mahogany habitats in the subbasin have been lost due to the effects of an altered fire regime.
10. Approximately, 56% of all whitebark pine habitats in the subbasin have been lost due to the exotic blister rust fungus and the effects of an altered fire regime.

11. Altered hydrologic processes have had significant impacts to riparian and herbaceous wetland habitat quantity, quality, structure, and function, primarily in the Beaver–Camas and Medicine Lodge watersheds.
12. Numerous water diversion structures in the subbasin have altered hydrologic processes, with important ramifications for terrestrial and aquatic resources.
13. Legacy timber-harvest activities have impacted forested habitats, primarily within the Big Lost and Beaver–Camas watersheds.
14. Grazing/browsing activities by sheep and cattle in the subbasin have impacted plant species composition, diversity, and density, and they have disrupted ecosystem functioning.
15. An altered fire regime is likely the most significant ecological influence affecting ecosystem structure and function in the subbasin.

4.2.2 Reference Conditions

Reference condition is defined as the range of factors (e.g., meteorology, surface water and groundwater, soils, geology, vegetation, topography, channel geometry factors, and natural and human disturbances) that is representative of the watershed's recent historical values prior to significant alteration of its environment (ESA 2000). The reference condition is considered pristine, with no or very minor human impacts. The reference could represent conditions found in a relic site or a site that has had little significant disturbance. The reference condition does not necessarily represent conditions that are attainable.

The purpose of reference conditions is to establish a basis for comparing what currently exists to what has existed in recent history. Reference conditions can be obtained through actual data or extrapolated techniques such as modeling (ESA 2000). Reference sites represent high-quality assemblages of aquatic and terrestrial ecosystem components. Anthropogenic effects often coincide with landform, thereby limiting availability of pristine reference conditions for assessments. Consequently, reference conditions must be defined within a background of land use. In the context of a habitat-based assessment, a fundamental assumption is that aquatic and terrestrial focal species inhabiting reference sites are themselves reference populations. "True" reference conditions likely do not exist in the Upper Snake province at watershed scales. Certainly, at finer environmental scales, ecosystem structure and function are theorized to be operating within the assumptions of reference conditions. However, data to either quantifiably or qualitatively describe them with accuracy or precision are lacking. We have opted, in some contexts, to describe Upper Snake subbasin habitats in terms of optimal quality and quantity to avoid any misconception that might result from the use of the term reference condition.

In the Upper Snake province, terrestrial and aquatic habitat quality and quantity are optimal in the most protected, least impacted watersheds. These watersheds include the Snake Headwaters, Gros Ventre, and Greys–Hoback watersheds and the upper elevations of the Big Lost, Little Lost, Beaver–Camas, and Lower Henrys watersheds. These watersheds are subject to the least amount of impact from the anthropogenic influences identified in the assessment. However, fire suppressive policies continue to be implemented, even in the roadless managed areas, and invasive exotics have begun to

have greater impacts. Landscape characteristics resulting from the altered fire regime will continue to prevail until natural fire regimes are allowed to function within these watersheds.

4.2.2.1 Aquatic Habitat and Fish Focal Species

Snake Headwaters—The Snake Headwaters subbasin contains substantial amounts of riparian and stream habitat that would be considered to be in reference condition. Numerous small streams and the headwaters of the mainstem Snake River are located within the Yellowstone and Grand Teton National Parks and are likely candidates for consideration as reference sites. The Gros Ventre and Greys–Hoback watersheds are relatively unimpacted and should contain numerous streams that could be considered as reference sites.

Upper Snake—Within the Upper Snake subbasin, reference sites for stream systems are extremely rare. Virtually all major streams within the subbasin have been dammed and diverted, altering the hydrologic regimes. Land use has altered the riparian vegetation in many areas. Headwater areas of small streams scattered throughout roadless and wilderness portions of the subbasin are likely candidates for consideration as reference sites.

Closed Basin—Within the Closed Basin subbasin, the large rivers and streams in the Big Lost and Little Lost watersheds have been diverted or dammed. Any reference aquatic or riparian areas in the Closed Basin subbasin are likely to occur in inventoried roadless areas.

4.2.2.2 Riparian/Herbaceous wetlands

Although riparian/herbaceous wetland habitats occur throughout the Upper Snake province, these habitats are assumed to be in “proper functioning condition” within the Greys–Hoback, Gros Ventre, and Snake Headwaters watersheds. Roads and their associated impacts are less significant, and water diversions are relatively nonexistent compared with the more developed watersheds. Although not necessarily described as reference condition based on the best available data, these watersheds may contain some of the best naturally occurring riparian and herbaceous wetland habitats in the Upper Snake province.

4.2.2.3 Shrub-Steppe

Despite dramatic reductions in shrub-steppe habitats across the Upper Snake province, reference condition habitat likely occurs at the Idaho National Engineering and Environmental Laboratory and Craters of the Moon National Monument. Anthropogenic impacts within these protected areas have largely been localized and insignificant relative to the rest of the Upper Snake province. In addition, fire regime processes have been allowed to function with minimal anthropogenic interference.

4.2.2.4 Pine/Fir Forest

Pine/fir forest habitats are the predominant landscape feature in the Closed Basin and Snake Headwaters subbasins. The watersheds with the greatest forested composition are the Upper Henrys, Lower Henrys, Snake Headwaters, Gros Ventre, Greys–Hoback, Salt, Palisades, Willow, Blackfoot, and Portneuf watersheds. Based on available data, the Upper Henrys watershed is classified as having the least

amount of departure from historic fire regimes. Data about fire regime condition class are unavailable for the Snake Headwaters subbasin watersheds; however, it is assumed that fire regimes in those watersheds are similar to that of the Upper Henrys watershed. The portions of the watersheds that occur in the protected areas of the National Parks and wilderness areas are assumed to be functioning at nearly optimal condition.

4.2.2.5 Aspen

Historically, aspen habitats were broadly distributed across many of the Snake Headwaters subbasin watersheds. Elsewhere in the province, aspen habitat is a patchily distributed resource. A dramatic reduction in the amount of aspen habitat on the landscape has resulted in greater interest in understanding the causes limiting aspen habitat quantity and quality. In the Upper Snake province, aspen habitat declines have been attributed to a combination of altered fire regime, grazing and browsing, and in some cases, localized alteration of the hydrologic regime. Due to its scarcity on the landscape and difficulties in assessing it, reference condition aspen habitat has not been identified in the Upper Snake province. Reference condition habitat probably occurs in the largest blocks of remaining habitat located in the Teton, Palisades, Salt, and Greys–Hoback watersheds. However, data to support that assumption have not been collected.

4.2.3 Near-Term Opportunities

4.2.3.1 Aquatic

Snake Headwaters—Within the Snake Headwaters subbasin, protection of populations within designated wilderness waters and National Parks is high priority due to the functional riparian and aquatic

habitat, though these populations currently benefit from protective land management actions. Near-term opportunities for restoration actions include management actions designed to benefit the Yellowstone cutthroat trout population and its habitat on the mainstem Snake River and tributaries downstream of Jackson Lake Dam, as well as populations in the Salt watershed.

Upper Snake—Within the Upper Snake subbasin, Yellowstone cutthroat trout populations identified as high-density core or conservation populations within each watershed should be high priority for protection. Populations within each watershed should be protected to ensure the protection of the maximum amount of genetic diversity within Yellowstone cutthroat trout populations in the Upper Snake subbasin.

Opportunities for improving habitat conditions to improve Yellowstone cutthroat trout populations exist throughout the subbasin. Populations identified as core or conservation populations at low density are likely candidates for habitat restoration efforts. Future hybridization risk should be evaluated in relation to barrier removal projects. Efforts to protect and enhance migratory populations of Yellowstone cutthroat trout should also be prioritized, as this life history form is the most impacted throughout the subbasin.

Closed Basin—Watersheds within the Closed Basin subbasin contain unique fish assemblages. Within the Big Lost watershed, mountain whitefish are the only native salmonid and should be considered high priority for restoration and for protection of the remaining individuals. Within the Little Lost watershed, ESA-listed bull trout are considered to be native. Bull trout populations are depressed in this watershed and should be considered for

restoration and protection. Within the Beaver–Camas and Medicine Lodge watersheds, no high-density core or conservation populations of Yellowstone cutthroat trout were identified, so protection and restoration efforts should focus on maintaining core and conservation populations.

4.2.3.2 Open Water

Statistically, open water habitat in the Upper Snake province is not a significant component of the landscape either historically or currently. Nevertheless, the spatial and temporal ecological significance of open water habitats in the province for numerous terrestrial and aquatic species has been thoroughly documented. Most of the open water habitat in the province is created and maintained through anthropogenic means. Thus, apart from riparian/herbaceous wetlands, no other habitat has greater potential for achieving positive impacts to aquatic and terrestrial natural resources. Coordinated management of water resources across the entire province is essential to benefit both terrestrial and aquatic resources.

The common loon is the only focal species that appears to be benefiting from the anthropogenic creation of open water habitats. Restoration of the near-shore and aquatic vegetation cover and protection of nesting sites could benefit the trumpeter swan and American avocet.

4.2.3.3 Riparian/Herbaceous Wetlands

Completion of wildlife mitigation projects, according to the Palisades mitigation plan, would benefit riparian focal habitats and species. Restoration of riparian habitats would benefit both terrestrial and aquatic focal species. Restoration of no other habitat has greater potential for collectively

enhancing aquatic and terrestrial resources in the Upper Snake province.

Reintroduction of beavers and reduction of riparian grazing are two strategies to restore riparian habitats. Cooperative efforts to reintroduce beavers to areas on U.S. Forest Service lands in the Upper Snake province are ongoing and should be expanded where possible.

4.2.3.4 Shrub-Steppe

Shrub-steppe habitat cores within the Idaho National Engineering and Environmental Laboratory and Craters of the Moon Monument should be protected and maintained through fire and weed management. In addition, other shrub-steppe reference habitats in the Upper Snake subbasin should be inventoried, identified, and protected. Different species of sagebrush provide food, cover, and nesting substrate for sage-steppe obligates, such as the greater sage-grouse, and are important winter forage for big game species. Continuing or expanding research to determine how an altered fire regime affects the shrub-steppe community is necessary.

4.2.3.5 Pine/Fir Forest

Significant amounts of pine/fir forest habitat occur in the Snake Headwater and Closed Basin subbasins. Apart from legacy timber-harvest activities, altered fire regime is the driving force behind current pine/fir forest habitat structure and function. These areas most in need of protection from anthropogenic fire regimes include portions of the Big Lost and Upper Henrys watersheds. Forest areas in the Beaver–Camas and Medicine Lodge watersheds provide potential to restore pine/fir forest structure and function through changes in how fire is managed on the landscape.

Focal species for the xeric, old forest habitat in the Upper Snake province include the black-backed woodpecker, great gray owl, boreal owl, and northern goshawk. Studies are needed to further our understanding of the relationship between snag availability and population dynamics of the great gray and boreal owls. Also needed is information on the relationships between mature stand characteristics and northern goshawk distribution and population dynamics.

4.2.3.6 *Juniper/Mountain Mahogany*

Like aspen habitats, mountain mahogany habitat is patchily distributed, primarily in the upper elevations of the Upper Snake subbasin watersheds. The Goose and Raft watersheds have the greatest composition of juniper/mountain mahogany habitat, while the Raft watershed has experienced the greatest proportional losses. Mountain mahogany habitat quantity and quality are assumed less limited in the protected watersheds where fire regimes more closely resemble natural processes. Data to support this assumption is lacking. Significant improvement in mountain mahogany structure and function is achievable if fire processes are allowed to operate normally.

4.2.3.7 *Whitebark Pine*

Throughout its range, whitebark pine habitat has declined, primarily due to the blister rust fungus. The direct mortality caused by the disease agent is exacerbated by an altered fire regime that inhibits normal regenerative processes. A priority action for whitebark pine habitat structure and function is restoring natural fire regimes and allowing natural selection processes to “cull” the blister rust-susceptible trees from the landscape. Research to determine how blister rust functions in whitebark pine habitats would be beneficial.

4.2.4 Summary of Priorities

Based on this assessment, we identified several priorities for directing future fish and wildlife management, restoration, and protection activities in the Upper Snake province. These priorities are scientifically justifiable from the assessment, should be integrated into current and future planning efforts, and are realistic and achievable within the current planning horizon.

4.2.4.1 *Aquatic Habitat Protection*

Within the Upper Snake province migratory populations of YCT are limited and protection of these existing populations should be a priority as well as expanding opportunities for populations to express the migratory life history.

Areas within each watershed in the Upper Snake Province were identified as having high density populations of core and conservation YCT. These areas should have the aquatic habitat maintained or protected to ensure the continued existence of these populations.

4.2.4.2 *Riparian/Wetland Habitat Data*

Appendix 2-1 of this assessment identifies the constraints inherent with the existing data used in this assessment. From a scientific assessment perspective, the most important piece of information that is currently unavailable at the scale required for reasonable quantification is accurate and precise data regarding riparian, and herbaceous wetland habitats. If we operate under the assumption that these habitats are the critical link between the terrestrial and aquatic environments, then it becomes imperative that the data be collected to make justifiable management decisions.

4.2.4.3 Noxious and Exotic Invasive Weeds

The most important anthropogenic cause of habitat quality and quantity limitation that can be addressed by management actions is the introduction of noxious and exotic invasive weeds. Collaborative weed management efforts have been established in the Upper Snake province, but effective control of noxious and invasive weeds requires greater coordination and cooperation across multiple jurisdictions and political boundaries.

4.2.4.4 Altered Fire Regime

Based on this assessment and others, anthropogenic influences limiting natural fire regimes are the most significant impact to ecosystem processes in the Upper Snake province. Restoration of natural fire regimes in shrub-steppe and forested focal habitats is a priority.

4.2.4.5 Subbasinwide Coordination of Management Plans

The Upper Snake provincial assessment has identified, with the best available scientific data and information, the most significant anthropogenic causes that limit focal habitats, fish, and wildlife species. However, scientific information cannot make up for the fact that there are numerous state, federal, tribal, and nongovernmental entities conducting active management activities across the Upper Snake province with often minimal coordination. We encourage collaborative efforts to coordinate implementation of management plan goals and objectives in a manner that minimizes duplicated efforts, enhances logistical efficiencies, and ensures that biological objectives are achieved with increased cost effectiveness.

4.2.5 Identification of Strategic Actions to Address Highest Priorities

4.2.5.1 Aquatic and Riparian Habitat

Riparian protection and restoration actions should focus on waters with core populations of Yellowstone cutthroat trout. In addition, flooding and natural hydrologic regimes should be restored to maintain forested riparian habitats in the Snake Headwaters and Upper Snake subbasins.

Conserving water and reducing water diversions are important steps for increasing stream flow and protecting and maintaining riparian habitats. Seeking minimum streamflows would also protect and maintain riparian habitats.

Watershed-scale assessments of aquatic habitat quantity and quality are the necessary first steps for current and future iterations of management planning in the Upper Snake province. These aquatic habitat assessments would incorporate concerted research effort into replicable habitat assessment methodology and be implemented basinwide.

4.2.5.2 Noxious and Exotic Invasive Weeds

The necessary first step is collection and compilation of comprehensive distribution information about noxious and exotic invasive weeds. This information can constantly be updated, disseminated, and incorporated into weed management plans. This effort would build on existing weed management strategies, goals, and objectives and expand coordinated efforts throughout the province.

4.2.5.3 Public Education Campaign

From a subbasin assessment perspective, the technical teams believed that addressing watershed-scale fire regime issues through the BPA funding process was neither realistic nor appropriate, given the scale of the problem. However, the necessary first step is to tackle the problem of public perception with a concerted wildfire education campaign that would target not only the public but also private and public land managers.

4.2.6 Working Hypotheses

The following is the working hypothesis H_A for the entire Upper Snake province: Anthropogenic influences in the Upper Snake province and factors outside the province limit the abundance, distribution, and ecological functions of focal fish and wildlife populations and habitats.

More specific H_A hypotheses have been developed around limiting factors and their causes as identified in this assessment. These hypotheses are organized by province and subbasin.

4.2.6.1 Upper Snake Province Working Hypotheses

H_A : Human impacts to natural hydrologic regimes limit riparian and aquatic habitats and focal species populations.

H_A : Land use and conversion result in habitat fragmentation and reduce the quality and quantity of focal aquatic, riparian, and shrub-steppe habitats and their focal species.

H_A : Fire suppression in forested habitats limits resilience and health of these ecosystems and their focal habitats and increases risks to watershed integrity.

H_A : Legacy timber-harvest activities have reduced function and increased fragmentation of focal forest and aquatic habitats.

H_A : The spread of noxious weeds and other exotic invasives reduce, degrade, or eliminate terrestrial focal habitats and species in all watersheds.

H_A : Focal habitats and fish and wildlife populations within the protected areas act as refugia and reference areas useful for determining the impacts of out-of-subbasin activities and the effectiveness of restoration and conservation activities designed to benefit focal habitats and their focal species.

H_A : The status and trend of terrestrial and aquatic focal habitats and species are predictable with measurable scientific assessment and monitoring.

H_A : Old growth- and cavity-dependent wildlife species have declined as a result of legacy timber-harvest and fire suppression activities.

4.2.6.2 Snake Headwaters Subbasin Working Hypotheses

H_A : Construction of and inundation by Palisades Dam limit identified wildlife populations until mitigation is fully implemented.

H_A : Flow regulation from Jackson Lake Dam limits habitat quality and population abundance of Yellowstone cutthroat trout.

H_A : Distribution and abundance of Yellowstone cutthroat trout populations are limited by competition and hybridization with nonnative salmonids.

4.2.6.3 Upper Snake Working Hypotheses

H_A: Construction of and inundation by Minidoka Dam limits identified wildlife populations until mitigation is fully implemented.

H_A: Focal shrub-steppe habitats in the Goose, Raft, Upper Snake–Rock, Lake Walcott, American Falls, Portneuf, Lower Henrys, and Medicine Lodge watersheds are limited by noxious weeds, increasing fire frequency, and livestock grazing.

H_A: Yellowstone cutthroat trout distribution and abundance are limited by competition and hybridization with nonnative salmonids.

H_A: Habitat quality limits the distribution and abundance of Yellowstone cutthroat trout.

H_A: Isolation and fragmentation of Yellowstone cutthroat trout populations and habitats limit abundance, distribution, and life history expression.

H_A: Changes in the hydrologic regime and temperatures associated with impoundments and water diversion in the mainstem Snake River limit habitat quality for Utah valvata and Snake River physa.

H_A: Human impacts to natural hydrologic regimes reduce, degrade, and/or eliminate riparian and aquatic habitats and therefore limit focal species populations.

H_A: Land use and conversion resulting in habitat fragmentation limit the quality and quantity of focal aquatic, riparian, and shrub-steppe habitats and their focal species.

H_A: Fire suppression in forested habitats limits resilience and health of these ecosystems and their focal habitats and increases risks to watershed integrity.

H_A: Noxious weeds, fire management, and livestock grazing limit focal shrub-steppe habitat quality and quantity.

4.2.6.2 Closed Basin Subbasin Working Hypotheses

H_A: Mountain whitefish abundance and distribution are limited by habitat quality affected by altered discharge and dewatering in the Big Lost River.

H_A: Habitat quality limits bull trout abundance and distribution in the Little Lost watershed.

H_A: Yellowstone cutthroat trout distribution and abundance are limited by competition and hybridization with nonnative salmonids in the Medicine Lodge watershed.

H_A: Land use and conversion resulting in habitat fragmentation limit the quality and quantity of focal aquatic, riparian, and shrub-steppe habitats and their focal species.

H_A: Fire suppression in forested habitats limits resilience and health of these ecosystems and their focal habitats and increases risks to watershed integrity.

H_A: Focal shrub-steppe habitats in the Birch and Willow watersheds are limited by noxious weeds, fire management, and livestock grazing.

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APPENDIX 1-1—LIST OF TERRESTRIAL VERTEBRATE SPECIES WITHIN THE UPPER SNAKE PROVINCE

Table 1. Terrestrial vertebrate species within the Upper Snake province and their associations with salmonids and riparian/herbaceous wetlands (source: IBIS 2003; Conservation Status-Idaho Department of Fish and Game, Idaho Conservation Data Center).

Common Name	Scientific Name	Conservation Status	Salmonid Relationship	Closely Associated with Riparian	Closely Associated with Wetlands
Amphibians (Total Number: 10)					
Tiger salamander	<i>Ambystoma tigrinum</i>	G5/S5		Yes	Yes
Long-toed salamander	<i>Ambystoma macrodactylum</i>	G5/S5		Yes	Yes
Inland tailed frog	<i>Ascaphus montanus</i>	G5/SNA		Yes	
Great Basin spadefoot	<i>Scaphiopus intermontanus</i>	G4/S3		Yes	Yes
Western toad	<i>Bufo boreas</i>	G5/S4		Yes	Yes
Pacific chorus (tree) frog	<i>Pseudacris regilla</i>	G5/S3?		Yes	Yes
Red-legged frog	<i>Rana aurora</i>	G5/S5		Yes	Yes
Columbia spotted frog	<i>Rana luteiventris</i>	G4/S3S4		Yes	Yes
Northern leopard frog	<i>Rana pipiens</i>	G5/S3		Yes	Yes
Bullfrog	<i>Rana catesbeiana</i>	G5/SNA		Yes	Yes
Total Amphibians: 10		Totals	0	10	9
Reptiles (Total Number: 20)					
Mojave black-collared lizard	<i>Crotaphytus bicinctores</i>	G5/S2			
Long-nosed leopard lizard	<i>Gambelia wislizenii</i>	G5/S5			
Short-horned lizard	<i>Phrynosoma douglassii</i>	G5/S5			
Desert horned lizard	<i>Phrynosoma platyrhinos</i>	G5/S4			
Northern sagebrush lizard	<i>Sceloporus graciosus graciosus</i>	G5/T5			
Western fence lizard	<i>Sceloporus occidentalis</i>	G5/S4			
Side-blotched lizard	<i>Uta stansburiana</i>	G5/S5			
Western skink	<i>Eumeces skiltonianus</i>	S5/S5			
Western whiptail	<i>Cnemidophorus tigris</i>	G5/S4			
Rubber boa	<i>Charina bottae</i>	G5/S5			
Racer	<i>Coluber constrictor</i>	G5/S5			
Ringneck snake	<i>Diadophis punctatus</i>	G5/S1?			
Night snake	<i>Hypsiglena torquata</i>	G5/S3			
Striped whipsnake	<i>Masticophis taeniatus</i>	S5/S4			
Gopher snake	<i>Pituophis catenifer</i>	G5/S5			

Common Name	Scientific Name	Conservation Status	Salmonid Relationship	Closely Associated with Riparian	Closely Associated with Wetlands
Western terrestrial garter snake	<i>Thamnophis elegans</i>	G5/S5	Yes		
Common garter snake	<i>Thamnophis sirtalis</i>	G5/S5	Yes	Yes	Yes
Western rattlesnake	<i>Crotalus viridis</i>	G5/S5			
Total: Reptiles: 20	Totals:		2	1	1
Birds (Total Number: 274)					
Common loon	<i>Gavia immer</i>	G5/S1B,S2N	Yes		Yes
Pied-billed grebe	<i>Podilymbus podiceps</i>	G5/S4B,S3N	Yes		Yes
Horned grebe	<i>Podiceps auritus</i>	G5/S1?	Yes		Yes
Red-necked grebe	<i>Podiceps grisegena</i>	G5/S3B	Yes		Yes
Eared grebe	<i>Podiceps nigricollis</i>	G5/S4B			Yes
Western grebe	<i>Aechmophorus occidentalis</i>	G5/S4B	Yes		Yes
Clark’s grebe	<i>Aechmophorus clarkii</i>	G5/S2B	Yes		Yes
American white pelican	<i>Pelecanus erythrorhynchos</i>	G3/S1B	Yes		
Double-crested cormorant	<i>Phalacrocorax auritus</i>	G5/S2B	Yes	Yes	
American bittern	<i>Botaurus lentiginosus</i>	G4/S4B			Yes
Least bittern	<i>Ixobrychus exilis</i>	G5/SNA			Yes
Great blue heron	<i>Ardea herodias</i>	G5/S2B	Yes	Yes	
Great egret	<i>Ardea alba</i>	G5/S1B	Yes	Yes	
Snowy egret	<i>Egretta thula</i>	G5/S2B	Yes	Yes	
Cattle egret	<i>Bubulcus ibis</i>	G5/S2B			
Green heron	<i>Butorides virescens</i>	G5/SNA	Yes	Yes	
Black-crowned night-heron	<i>Nycticorax nycticorax</i>	G5/S3B	Yes	Yes	
White-faced ibis	<i>Plegadis chihi</i>	G5/S2B			Yes
Turkey vulture	<i>Cathartes aura</i>	G5/S4B	Yes		
Greater white-fronted goose	<i>Anser albifrons</i>	G5/SNA			
Snow goose	<i>Chen caerulescens</i>	G5/SN2			
Ross’s goose	<i>Chen rossii</i>	G4/SNA			
Canada goose	<i>Branta canadensis</i>	S5/S5B,S5N			Yes
Trumpeter swan	<i>Cygnus buccinator</i>	G4/S1B,S2N	Yes		Yes
Tundra swan	<i>Cygnus columbianus</i>	G5/S2N			
Wood duck	<i>Aix sponsa</i>	G5/S4B,S1N		Yes	
Gadwall	<i>Anas strepera</i>	G5/S5B,S3N			Yes
American wigeon	<i>Anas americana</i>	G5/S5B,S5N			Yes
Mallard	<i>Anas platyrhynchos</i>	G5/S5B,S5N	Yes	Yes	Yes
Blue-winged teal	<i>Anas discors</i>	G5/S5B			Yes
Cinnamon teal	<i>Anas cyanoptera</i>	G5/S5B			Yes
Northern shoveler	<i>Anas clypeata</i>	G5/S5B,S1N			Yes

Common Name	Scientific Name	Conservation Status	Salmonid Relationship	Closely Associated with Riparian	Closely Associated with Wetlands
Northern pintail	<i>Anas acuta</i>	G5/S5B,S3N			Yes
Green-winged teal	<i>Anas crecca</i>	G5/S4B,S4N	Yes		Yes
Canvasback	<i>Aythya valisineria</i>	G5/S4B,S2N	Yes		Yes
Redhead	<i>Aythya americana</i>	G5/S5B			Yes
Ring-necked duck	<i>Aythya collaris</i>	G5/S3B		Yes	
Greater scaup	<i>Aythya marila</i>	G5/SNA	Yes		
Lesser scaup	<i>Aythya affinis</i>	G5/S4			Yes
Harlequin duck	<i>Histrionicus histrionicus</i>	G4/S1B	Yes	Yes	
Bufflehead	<i>Bucephala albeola</i>	G5/S3B,S3N			
Common goldeneye	<i>Bucephala clangula</i>	G5/S3B,S3N	Yes		
Barrow's goldeneye	<i>Bucephala islandica</i>	G5/S3B,S3N	Yes		
Hooded merganser	<i>Lophodytes cucullatus</i>	G5/S2B,S3N	Yes	Yes	
Common merganser	<i>Mergus merganser</i>	G5/S5B,S5N	Yes	Yes	
Red-breasted merganser	<i>Mergus serrator</i>	G5/SNA	Yes		
Ruddy duck	<i>Oxyura jamaicensis</i>	G5G5/S5B			Yes
Osprey	<i>Pandion haliaetus</i>	G5/S5B	Yes		
Bald eagle	<i>Haliaeetus leucocephalus</i>	G4/S3B,S4N	Yes		
Northern harrier	<i>Circus cyaneus</i>	G5/S5B,S5N			
Sharp-shinned hawk	<i>Accipiter striatus</i>	G5/S5			
Cooper's hawk	<i>Accipiter cooperii</i>	G5/S4			
Northern goshawk	<i>Accipiter gentilis</i>	G5/S4			
Swainson's hawk	<i>Buteo swainsoni</i>	G5/S4B			
Red-tailed hawk	<i>Buteo jamaicensis</i>	G5/S5B,S5N	Yes		
Ferruginous hawk	<i>Buteo regalis</i>	G4/S3B			
Rough-legged hawk	<i>Buteo lagopus</i>	G5/S4N			
Golden eagle	<i>Aquila chrysaetos</i>	G5/S4B,S4N	Yes		
American kestrel	<i>Falco sparverius</i>	G5/S5B,S5N			
Merlin	<i>Falco columbarius</i>	G5/S1B,S2N			
Peregrine falcon	<i>Falco peregrinus</i>	G4T3/S1B	Yes		
Prairie falcon	<i>Falco mexicanus</i>	G5/S5B,S3N			
Chukar	<i>Alectoris chukar</i>	G5/SNA			
Gray partridge	<i>Perdix perdix</i>	G5/SNA			
Ring-necked pheasant	<i>Phasianus colchicus</i>	G5/SNA		Yes	
Ruffed grouse	<i>Bonasa umbellus</i>	G5/S5		Yes	
Greater sage grouse	<i>Centrocercus urophasianus</i>	G4/S4			
Spruce grouse	<i>Falcapennis canadensis</i>	G5/S4			
Blue grouse	<i>Dendragapus obscurus</i>	G5/S5		Yes	
Sharp-tailed grouse	<i>Tympanuchus phasianellus</i>	G4/S3			
Wild turkey	<i>Meleagris gallopavo</i>	G5/SNA			

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Mountain quail	<i>Oreortyx pictus</i>	G5/S2			
California quail	<i>Callipepla californica</i>	G5/SNA			
Virginia rail	<i>Rallus limicola</i>	G5/S5B			Yes
Sora	<i>Porzana carolina</i>	G5/S5B			Yes
American coot	<i>Fulica americana</i>	G5/S5B			Yes
Sandhill crane	<i>Grus canadensis</i>	S5/S5B			Yes
Whooping crane	<i>Grus americana</i>	G5/N5B,N5N			
Black-bellied plover	<i>Pluvialis squatarola</i>	G5/S2N			
American golden-plover	<i>Pluvialis dominica</i>	G5/SNA			
Snowy plover	<i>Charadrius alexandrinus</i>	G4/SNA			
Semipalmated plover	<i>Charadrius semipalmatus</i>	G5/S2N			
Killdeer	<i>Charadrius vociferus</i>	G5/S5B,S3N	Yes		
Black-necked stilt	<i>Himantopus mexicanus</i>	G5/S4B			Yes
American avocet	<i>Recurvirostra americana</i>	G5/S5B			Yes
Greater yellowlegs	<i>Tringa melanoleuca</i>	G5/S2N	Yes		
Lesser yellowlegs	<i>Tringa flavipes</i>	G5/S2N			
Solitary sandpiper	<i>Tringa solitaria</i>	G5/SNA			
Willet	<i>Catoptrophorus semipalmatus</i>	G5/S4B			Yes
Spotted sandpiper	<i>Actitis macularia</i>	G5/S5B	Yes		
Upland sandpiper	<i>Bartramia longicauda</i>	G5/S1B			
Whimbrel	<i>Numenius phaeopus</i>	G5/SNA			
Long-billed curlew	<i>Numenius americanus</i>	G5/S3B			
Marbled godwit	<i>Limosa fedoa</i>	G5/S2N			
Sanderling	<i>Calidris alba</i>	G5/SNA			
Semipalmated sandpiper	<i>Calidris pusilla</i>	G5/S2N			
Western sandpiper	<i>Calidris mauri</i>	G5/S2N			
Least sandpiper	<i>Calidris minutilla</i>	G5/S2N			
Baird's sandpiper	<i>Calidris bairdii</i>	G5/S2N			
Pectoral sandpiper	<i>Calidris melanotos</i>	G5/SNA			
Dunlin	<i>Calidris alpina</i>	G5/SNA			
Stilt sandpiper	<i>Calidris himantopus</i>	G5/SNA			
Long-billed dowitcher	<i>Limnodromus scolopaceus</i>	G5/S2N			
Common snipe	<i>Gallinago gallinago</i>	G5/N5B,N5N			Yes
Wilson's phalarope	<i>Phalaropus tricolor</i>	G5/S4B			Yes
Red-necked phalarope	<i>Phalaropus lobatus</i>	G4G5/S2N			
Franklin's gull	<i>Larus pipixcan</i>	G4G5/S2B	Yes		Yes
Bonaparte's gull	<i>Larus philadelphia</i>	G5/SNA	Yes		

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Ring-billed gull	<i>Larus delawarensis</i>	G5/S2SB,S3	Yes		
California gull	<i>Larus californicus</i>	G5/S2SB,S3	Yes		
Herring gull	<i>Larus argentatus</i>	G5/S2N	Yes		
Glaucous gull	<i>Larus hyperboreus</i>	G5/N5B,N5N	Yes		
Caspian tern	<i>Sterna caspia</i>	G5/S1B	Yes		
Common tern	<i>Sterna hirundo</i>	G5/S1B	Yes		
Forster's tern	<i>Sterna forsteri</i>	G5/S2S3B	Yes		Yes
Black tern	<i>Chlidonias niger</i>	G4/S2B			Yes
Rock dove	<i>Columba livia</i>	G5/SNA			
Band-tailed pigeon	<i>Columba fasciata</i>	G4/SNA		Yes	
Mourning dove	<i>Zenaidura macroura</i>	G5/S5B		Yes	
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	G5/S1B		Yes	
Barn owl	<i>Tyto alba</i>	G5/S3?			
Flammulated owl	<i>Otus flammeolus</i>	G4/S3B			
Western screech-owl	<i>Otus kennicottii</i>	G5/S4		Yes	
Great horned owl	<i>Bubo virginianus</i>	G5/S5			
Northern pygmy-owl	<i>Glaucidium gnoma</i>	G5/S4			
Burrowing owl	<i>Athene cunicularia</i>	S4/S3S4			
Barred owl	<i>Strix varia</i>	G5/S4			
Great gray owl	<i>Strix nebulosa</i>	G5/S3			
Long-eared owl	<i>Asio otus</i>	G5/S5		Yes	
Short-eared owl	<i>Asio flammeus</i>	G5/S5			Yes
Boreal owl	<i>Aegolius funereus</i>	G5/S2			
Northern saw-whet owl	<i>Aegolius acadicus</i>	G5/S4			
Common nighthawk	<i>Chordeiles minor</i>	G5/S5B			
Common poorwill	<i>Phalaenoptilus nuttallii</i>	G5/S4B			
Black swift	<i>Cypseloides niger</i>	G4/S1B			
Vaux's swift	<i>Chaetura vauxi</i>	G5/S4B			
White-throated swift	<i>Aeronautes saxatalis</i>	G5/S4B			
Black-chinned hummingbird	<i>Archilochus alexandri</i>	G5/S5B			
Calliope hummingbird	<i>Stellula calliope</i>	G5/S5B			
Broad-tailed hummingbird	<i>Selasphorus platycercus</i>	G5/S5B			
Rufous hummingbird	<i>Selasphorus rufus</i>	G5/S5B			
Belted kingfisher	<i>Ceryle alcyon</i>	G5/S5	Yes	Yes	
Lewis's woodpecker	<i>Melanerpes lewis</i>	G4/S4B			
Williamson's sapsucker	<i>Sphyrapicus thyroideus</i>	G5/S5B			
Red-naped sapsucker	<i>Sphyrapicus nuchalis</i>	G5/S5B		Yes	
Downy woodpecker	<i>Picoides pubescens</i>	G5/S5			
Hairy woodpecker	<i>Picoides villosus</i>	G5/S5			

Common Name	Scientific Name	Conservation Status	Salmonid Relationship	Closely Associated with Riparian	Closely Associated with Wetlands
White-headed woodpecker	<i>Picoides albolarvatus</i>	G4/S2B			
Three-toed woodpecker	<i>Picoides tridactylus</i>	G5/S3?			
Black-backed woodpecker	<i>Picoides arcticus</i>	G5/S3			
Northern flicker	<i>Colaptes auratus</i>	G5/S5			
Pileated woodpecker	<i>Dryocopus pileatus</i>	G5/S4			
Olive-sided flycatcher	<i>Contopus cooperi</i>	G4/S4B			
Western wood-pewee	<i>Contopus sordidulus</i>	G5/S5B			
Willow flycatcher	<i>Empidonax traillii</i>	G5/S5B	Yes	Yes	
Least flycatcher	<i>Empidonax minimus</i>	G5/SNA			
Hammond's flycatcher	<i>Empidonax hammondi</i>	G5/S5B			
Gray flycatcher	<i>Empidonax wrightii</i>	G5/S2B,S2N			
Dusky flycatcher	<i>Empidonax oberholseri</i>	G5/S5B			
Cordilleran flycatcher	<i>Empidonax occidentalis</i>	G5/S4B		Yes	
Say's phoebe	<i>Sayornis saya</i>	G5/S5B			
Ash-throated flycatcher	<i>Myiarchus cinerascens</i>	G5/S3S4B			
Western kingbird	<i>Tyrannus verticalis</i>	G5/S5B			
Eastern kingbird	<i>Tyrannus tyrannus</i>	G5/S4B			
Loggerhead shrike	<i>Lanius ludovicianus</i>	G4/S3			
Northern shrike	<i>Lanius excubitor</i>	G5/S3N			
Cassin's vireo	<i>Vireo cassinii</i>	G5/N3N,N5B			
Warbling vireo	<i>Vireo gilvus</i>	G5/S5B		Yes	
Red-eyed vireo	<i>Vireo olivaceus</i>	G5/S5B		Yes	
Gray jay	<i>Perisoreus canadensis</i>	G5/S5	Yes		
Steller's jay	<i>Cyanocitta stelleri</i>	G5/S5	Yes		
Western scrub-jay	<i>Aphelocoma californica</i>	G5/S2?			
Pinyon jay	<i>Gymnorhinus cyanocephalus</i>	G5/S2?			
Clark's nutcracker	<i>Nucifraga columbiana</i>	G5/S5			
Black-billed magpie	<i>Pica pica</i>	G5/S5	Yes	Yes	
American crow	<i>Corvus brachyrhynchos</i>	G5/S5	Yes		
Common raven	<i>Corvus corax</i>	G5/S5	Yes		
Horned lark	<i>Eremophila alpestris</i>	G5/S5			
Purple martin	<i>Progne subis</i>	G5/N5B			
Tree swallow	<i>Tachycineta bicolor</i>	G5/S5B	Yes	Yes	
Violet-green swallow	<i>Tachycineta thalassina</i>	G5/S5B	Yes		
Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	G5/S5B	Yes	Yes	
Bank swallow	<i>Riparia riparia</i>	G5/S5B	Yes	Yes	
Cliff swallow	<i>Petrochelidon pyrrhonota</i>	G5/S5B	Yes	Yes	
Barn swallow	<i>Hirundo rustica</i>	G5/S5B	Yes	Yes	

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Black-capped chickadee	<i>Poecile atricapillus</i>	G5/S5			
Mountain chickadee	<i>Poecile gambeli</i>	G5/S5			
Juniper titmouse	<i>Baeolophus griseus</i>	G5/N5			
Bushtit	<i>Psaltiriparus minimus</i>	G5/S4			
Red-breasted nuthatch	<i>Sitta canadensis</i>	G5/S5			
White-breasted nuthatch	<i>Sitta carolinensis</i>	G5/S4			
Pygmy nuthatch	<i>Sitta pygmaea</i>	G5/S2S3		Yes	
Brown creeper	<i>Certhia americana</i>	G5/S5			
Rock wren	<i>Salpinctes obsoletus</i>	G5/S5B			
Canyon wren	<i>Catherpes mexicanus</i>	G5/S5B			
House wren	<i>Troglodytes aedon</i>	G5/N5B,N5N			
Winter wren	<i>Troglodytes troglodytes</i>	G5/S5	Yes		
Marsh wren	<i>Cistothorus palustris</i>	G5/S5B			Yes
American dipper	<i>Cinclus mexicanus</i>	G5/S5	Yes	Yes	
Golden-crowned kinglet	<i>Regulus satrapa</i>	G5/S5		Yes	
Ruby-crowned kinglet	<i>Regulus calendula</i>	G5/S5B			
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>	G5/S3?			
Western bluebird	<i>Sialia mexicana</i>	G5/S4B			
Mountain bluebird	<i>Sialia currucoides</i>	G5/S4B			
Townsend's solitaire	<i>Myadestes townsendi</i>	G5/S5			
Veery	<i>Catharus fuscescens</i>	G5/S5B		Yes	
Swainson's thrush	<i>Catharus ustulatus</i>	G5/S5B			
Hermit thrush	<i>Catharus guttatus</i>	G5/S5B			
American robin	<i>Turdus migratorius</i>	G5/S5B,S3N	Yes		
Varied thrush	<i>Ixoreus naevius</i>	G5/S5B	Yes		
Gray catbird	<i>Dumetella carolinensis</i>	G5/S5B		Yes	
Northern mockingbird	<i>Mimus polyglottos</i>	G5/S1B			
Sage thrasher	<i>Oreoscoptes montanus</i>	G5/S5B			
European starling	<i>Sturnus vulgaris</i>	G5/SNA		Yes	
American pipit	<i>Anthus rubescens</i>	G5/S4B			
Bohemian waxwing	<i>Bombycilla garrulus</i>	G5/S1B,S3N			
Cedar waxwing	<i>Bombycilla cedrorum</i>	G5/S5B,S3N		Yes	
Orange-crowned warbler	<i>Vermivora celata</i>	G5/S5B			
Nashville warbler	<i>Vermivora ruficapilla</i>	G5/S5B			
Yellow warbler	<i>Dendroica petechia</i>	G5/S5B		Yes	
Yellow-rumped warbler	<i>Dendroica coronata</i>	G5/S5B			
Black-throated gray warbler	<i>Dendroica nigrescens</i>	G5/S3?B		Yes	
Townsend's warbler	<i>Dendroica townsendi</i>	G5/S4B			
American redstart	<i>Setophaga ruticilla</i>	G5/S4B		Yes	
Northern waterthrush	<i>Seiurus noveboracensis</i>	G5/S3?		Yes	

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MacGillivray's warbler	<i>Oporornis tolmiei</i>	G5/S5B			
Common yellowthroat	<i>Geothlypis trichas</i>	G5/S5B		Yes	Yes
Wilson's warbler	<i>Wilsonia pusilla</i>	G5/S5B		Yes	
Yellow-breasted chat	<i>Icteria virens</i>	G5/S5B		Yes	
Western tanager	<i>Piranga ludoviciana</i>	G5/S5B			
Green-tailed towhee	<i>Pipilo chlorurus</i>	G5/S5B			
Spotted towhee	<i>Pipilo maculatus</i>	G5/S5B	Yes		
American tree sparrow	<i>Spizella arborea</i>	G5/S3N			
Chipping sparrow	<i>Spizella passerina</i>	G5/S5B			
Clay-colored sparrow	<i>Spizella pallida</i>	G5/SNA			
Brewer's sparrow	<i>Spizella breweri</i>	G5/S4B			
Vesper sparrow	<i>Pooecetes gramineus</i>	G5/S4B			
Lark sparrow	<i>Chondestes grammacus</i>	G5/S5B			
Black-throated sparrow	<i>Amphispiza bilineata</i>	G5/S2B			
Sage sparrow	<i>Amphispiza belli</i>	G5/S4B			
Savannah sparrow	<i>Passerculus sandwichensis</i>	G5/S5B			
Grasshopper sparrow	<i>Ammodramus savannarum</i>	G5/S3B			
Fox sparrow	<i>Passerella iliaca</i>	G5/S5B		Yes	
Song sparrow	<i>Melospiza melodia</i>	G5/S5B,S5N	Yes		
Lincoln's sparrow	<i>Melospiza lincolni</i>	G5/S5B		Yes	Yes
White-throated sparrow	<i>Zonotrichia albicollis</i>	G5/SNA			
Harris's sparrow	<i>Zonotrichia querula</i>	G5/SNA			
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	G5/S5B,S4N			
Golden-crowned sparrow	<i>Zonotrichia atricapilla</i>	G5/N5B,N5N			
Dark-eyed junco	<i>Junco hyemalis</i>	G5/S5			
Lapland longspur	<i>Calcarius lapponicus</i>	G5/SNA			
Snow bunting	<i>Plectrophenax nivalis</i>	G5/S3N			
Black-headed grosbeak	<i>Pheucticus melanocephalus</i>	G5/S5B			
Lazuli bunting	<i>Passerina amoena</i>	G5/S5B		Yes	
Bobolink	<i>Dolichonyx oryzivorus</i>	G5/S4B			
Red-winged blackbird	<i>Agelaius phoeniceus</i>	G5/S5B,S3N			Yes
Western meadowlark	<i>Sturnella neglecta</i>	G5/S5B,S3N			
Yellow-headed blackbird	<i>Xanthocephalus xanthocephalus</i>	G5/S5B			Yes
Brewer's blackbird	<i>Euphagus cyanocephalus</i>	G5/S5B,S5N			
Brown-headed cowbird	<i>Molothrus ater</i>	G5/S5B			
Bullock's oriole	<i>Icterus bullockii</i>	G5/S5B		Yes	

Common Name	Scientific Name	Conservation Status	Salmonid Relationship	Closely Associated with Riparian	Closely Associated with Wetlands
Gray-crowned rosy-finch	<i>Leucosticte tephrocotis</i>	G5/N5			
Black rosy-finch	<i>Leucosticte atrata</i>	G4/S4B,S3N			
Pine grosbeak	<i>Pinicola enucleator</i>	G5/S4			
Purple finch	<i>Carpodacus purpureus</i>	G5/SNA		Yes	
Cassin’s finch	<i>Carpodacus cassinii</i>	G5/S5			
House finch	<i>Carpodacus mexicanus</i>	G5/S5			
Red crossbill	<i>Loxia curvirostra</i>	G5/S5			
White-winged crossbill	<i>Loxia leucoptera</i>	G5/S1?			
Common redpoll	<i>Carduelis flammea</i>	G5/S2N			
Pine siskin	<i>Carduelis pinus</i>	G5/S5			
Lesser goldfinch	<i>Carduelis psaltria</i>	G5/S1B		Yes	
American goldfinch	<i>Carduelis tristis</i>	G5/S5			
Evening grosbeak	<i>Coccothraustes vespertinus</i>	G5/S5			
Total Birds: 274	Totals:		61	52	42
Mammals (Total Number: 97)					
Masked shrew	<i>Sorex cinereus</i>	G5/S5	Yes		
Vagrant shrew	<i>Sorex vagrans</i>	G5/S5	Yes		
Montane shrew	<i>Sorex monticolus</i>	G5/S4?	Yes		
Water shrew	<i>Sorex palustris</i>	G5/S4?	Yes	Yes	
Merriam’s shrew	<i>Sorex merriami</i>	G5/S2?			
Dwarf shrew	<i>Sorex nanus</i>	G4/N4			
California myotis	<i>Myotis californicus</i>	G5/S1?			
Western small-footed myotis	<i>Myotis ciliolabrum</i>	G5/S4?		Yes	
Yuma myotis	<i>Myotis yumanensis</i>	G5/S3?		Yes	
Little brown myotis	<i>Myotis lucifugus</i>	G5/S5			
Long-legged myotis	<i>Myotis volans</i>	G5/S3?		Yes	
Fringed myotis	<i>Myotis thysanodes</i>	G4G5/S1?			
Long-eared myotis	<i>Myotis evotis</i>	G5/S3?			
Silver-haired bat	<i>Lasionycteris noctivagans</i>	G5/S4?			
Western pipistrelle	<i>Pipistrellus hesperus</i>	G5/S1?		Yes	
Big brown bat	<i>Eptesicus fuscus</i>	G5/S4?		Yes	
Hoary bat	<i>Lasiurus cinereus</i>	G5/S4?			
Spotted bat	<i>Euderma maculatum</i>	G4/S2			
Townsend’s big-eared bat	<i>Corynorhinus townsendii</i>	G4/S2?			
Pallid bat	<i>Antrozous pallidus</i>	G5/S1?		Yes	
American pika	<i>Ochotona princeps</i>	G5/S5			
Pygmy rabbit	<i>Brachylaqus idahoensis</i>	G5/S3			

Common Name	Scientific Name	Conservation Status	Salmonid Relationship	Closely Associated with Riparian	Closely Associated with Wetlands
Nuttall's (mountain) cottontail	<i>Sylvilagus nuttallii</i>	G5/S5			
Snowshoe hare	<i>Lepus americanus</i>	G5/S5		Yes	
White-tailed jackrabbit	<i>Lepus townsendii</i>	G5/S5			
Black-tailed jackrabbit	<i>Lepus californicus</i>	G5/S5			
Least chipmunk	<i>Tamias minimus</i>	G5/S5			
Yellow-pine chipmunk	<i>Tamias amoenus</i>	G5/S5			
Red-tailed chipmunk	<i>Tamias ruficaudus</i>	G5/S4			
Yellow-bellied marmot	<i>Marmota flaviventris</i>	G5/S5			
Hoary marmot	<i>Marmota caligata</i>	G5/S5			
White-tailed antelope squirrel	<i>Ammospermophilus leucurus</i>	S5/S4			
Townsend's ground squirrel	<i>Spermophilus townsendii</i>	G5/S5			
Paiute ground squirrel	<i>Spermophilus mollis</i>	G5/N5			
Belding's ground squirrel	<i>Spermophilus beldingi</i>	G5/S4?			
Columbian ground squirrel	<i>Spermophilus columbianus</i>	G5/S5			
Golden-mantled ground squirrel	<i>Spermophilus lateralis</i>	G5/S5			
Rock squirrel	<i>Spermophilus variegatus</i>	G5/N5			
Red squirrel	<i>Tamiasciurus hudsonicus</i>	G5/S5			
Northern flying squirrel	<i>Glaucomys sabrinus</i>	G5/S4	Yes		
Northern pocket gopher	<i>Thomomys talpoides</i>	G5/S5			
Idaho pocket gopher	<i>Thomomys idahoensis</i>	G5/S4?			
Townsend's pocket gopher	<i>Thomomys townsendii</i>	G4G5/S4?			
Great Basin pocket mouse	<i>Perognathus parvus</i>	G5/S5			
Little pocket mouse	<i>Perognathus longimembris</i>	G5/S1?			
Dark kangaroo mouse	<i>Microdipodops megacephalus</i>	G5/N5			
Ord's kangaroo rat	<i>Dipodomys ordii</i>	G5/S5			
Chisel-toothed kangaroo rat	<i>Dipodomys microps</i>	G5/S3?			
American beaver	<i>Castor canadensis</i>	G5/S5		Yes	Yes
Western harvest mouse	<i>Reithrodontomys megalotis</i>	G5/S5		Yes	Yes
Deer mouse	<i>Peromyscus maniculatus</i>	G5/S5	Yes	Yes	Yes

Common Name	Scientific Name	Conservation Status	Salmonid Relationship	Closely Associated with Riparian	Closely Associated with Wetlands
Canyon mouse	<i>Peromyscus crinitus</i>	G5/S3,S4			
Piñon mouse	<i>Peromyscus truei</i>	G5/S2			
Northern grasshopper mouse	<i>Onychomys leucogaster</i>	G5/S4			
Desert woodrat	<i>Neotoma lepida</i>	G5/S4			
Bushy-tailed woodrat	<i>Neotoma cinerea</i>	G5/S5		Yes	
Southern red-backed vole	<i>Clethrionomys gapperi</i>	G5/S5		Yes	
Heather vole	<i>Phenacomys intermedius</i>	G5/S4			
Meadow vole	<i>Microtus pennsylvanicus</i>	G5/S5		Yes	Yes
Montane vole	<i>Microtus montanus</i>	G5/S5			Yes
Long-tailed vole	<i>Microtus longicaudus</i>	G5/S5		Yes	Yes
Water vole	<i>Microtus richardsoni</i>	G5/S4		Yes	
Sagebrush vole	<i>Lemmys curtatus</i>	G5/S4			
Muskrat	<i>Ondatra zibethicus</i>	G5/S5		Yes	Yes
Northern bog lemming	<i>Synaptomys borealis</i>	G4/S1			Yes
Black rat	<i>Rattus rattus</i>	G5/NNA			
Norway rat	<i>Rattus norvegicus</i>	G5/SNA			
House mouse	<i>Mus musculus</i>	G5/SNA			
Western jumping mouse	<i>Zapus princeps</i>	S5/S5		Yes	
Common porcupine	<i>Erethizon dorsatum</i>	G5/S5			
Coyote	<i>Canis latrans</i>	S5/S5	Yes		
Gray wolf	<i>Canis lupus</i>	G4/S1	Yes		
Red fox	<i>Vulpes vulpes</i>	G5/S5	Yes		
Kit fox	<i>Vulpes macrotis</i>	G4/N4			
Black bear	<i>Ursus americanus</i>	G5/s5	Yes		
Grizzly bear	<i>Ursus arctos horribilis</i>	G4T3T4/S1	Yes		
Raccoon	<i>Procyon lotor</i>	G5/S4	Yes	Yes	
American marten	<i>Martes americana</i>	G5/S5	Yes		
Fisher	<i>Martes pennanti</i>	G5/S1	Yes	Yes	
Ermine	<i>Mustela erminea</i>	G5/S5			
Long-tailed weasel	<i>Mustela frenata</i>	G5/S5	Yes		
Mink	<i>Mustela vison</i>	G5/S5	Yes	Yes	
Wolverine	<i>Gulo gulo</i>	G5/S2	Yes		
American badger	<i>Taxidea taxus</i>	G5/S5			
Western spotted skunk	<i>Spilogale gracilis</i>	G5/S5			
Striped skunk	<i>Mephitis mephitis</i>	S5/S5	Yes		
Northern river otter	<i>Lutra canadensis</i>	S5/S4	Yes	Yes	Yes
Mountain lion	<i>Puma concolor</i>	G5/S5	Yes		
Canada lynx	<i>Lynx canadensis</i>	G5/S1			
Bobcat	<i>Lynx rufus</i>	G5/S5	Yes		

Common Name	Scientific Name	Conservation Status	Salmonid Relationship	Closely Associated with Riparian	Closely Associated with Wetlands
Rocky Mountain elk	<i>Cervus elaphus nelsoni</i>	G5/S5			
Mule deer	<i>Odocoileus hemionus</i>	G5/S5			
White-tailed deer	<i>Odocoileus virginianus</i>	G5/S5			
Moose	<i>Alces alces</i>	G5/S5			
Pronghorn	<i>Antilocapra americana</i>	G5/S5			
Mountain goat	<i>Oreamnos americanus</i>	G5/S3			
Bighorn sheep	<i>Ovis canadensis</i>	G4T1/S1			
Total Mammals: 97	Totals:		21	22	9
Total Species: 401	Overall Totals:		84	85	62

Table 2. Occurrence of terrestrial species in the four states of the Upper Snake province.

Common Name	Idaho	Wyoming	Utah	Nevada
Amphibian				
Tiger salamander	occurs	occurs	occurs	does not occur
Long-toed salamander	occurs	does not occur	does not occur	does not occur
Inland tailed frog	occurs	does not occur	does not occur	does not occur
Great Basin spadefoot	occurs	does not occur	occurs	Occurs
Western toad	occurs	occurs	does not occur	Occurs
Pacific chorus (tree) frog	occurs	does not occur	occurs	Occurs
Red-legged frog	does not occur	does not occur	occurs	does not occur
Columbia spotted frog	occurs	does not occur	does not occur	does not occur
Northern leopard frog	occurs	occurs	occurs	Occurs
Bullfrog	nonnative	does not occur	does not occur	Nonnative
Painted turtle	occurs	does not occur	does not occur	does not occur
Birds				
Common loon	occurs	occurs	occurs	Occurs
Pied-billed grebe	occurs	occurs	occurs	Occurs
Horned grebe	occurs	occurs	occurs	Occurs
Red-necked grebe	occurs	accidental	does not occur	does not occur
Eared grebe	occurs	occurs	occurs	Occurs
Western grebe	occurs	occurs	occurs	Occurs
Clark's grebe	occurs	occurs	occurs	Occurs
American white pelican	occurs	occurs	occurs	Occurs
Double-crested cormorant	occurs	occurs	occurs	Occurs
American bittern	occurs	occurs	occurs	Occurs
Great blue heron	occurs	occurs	occurs	Occurs
Great egret	occurs	accidental	accidental	Occurs
Snowy egret	occurs	occurs	occurs	Occurs
Cattle egret	occurs	accidental	occurs	occurs

Common Name	Idaho	Wyoming	Utah	Nevada
Black-crowned night-heron	occurs	accidental	occurs	occurs
White-faced ibis	occurs	occurs	occurs	occurs
Turkey vulture	occurs	occurs	occurs	occurs
Greater white-fronted goose	occurs	accidental	accidental	occurs
Snow goose	occurs	occurs	occurs	occurs
Ross's goose	occurs	accidental	accidental	accidental
Canada goose	occurs	occurs	occurs	occurs
Trumpeter swan	occurs	occurs	accidental	occurs
Tundra swan	occurs	occurs	occurs	occurs
Wood duck	occurs	occurs	occurs	occurs
Gadwall	occurs	occurs	occurs	occurs
American wigeon	occurs	occurs	occurs	occurs
Mallard	occurs	occurs	occurs	occurs
Blue-winged teal	occurs	occurs	occurs	occurs
Cinnamon teal	occurs	occurs	occurs	occurs
Northern shoveler	occurs	occurs	occurs	occurs
Northern pintail	occurs	occurs	occurs	occurs
Green-winged teal	occurs	occurs	occurs	occurs
Canvasback	occurs	occurs	occurs	occurs
Redhead	occurs	occurs	occurs	occurs
Ring-necked duck	occurs	occurs	occurs	occurs
Greater scaup	accidental	accidental	accidental	occurs
Lesser scaup	occurs	occurs	occurs	occurs
Harlequin duck	occurs	occurs	accidental	does not occur
Bufflehead	occurs	occurs	occurs	occurs
Common goldeneye	occurs	occurs	occurs	occurs
Barrow's goldeneye	occurs	occurs	accidental	accidental
Hooded merganser	occurs	occurs	occurs	occurs
Common merganser	occurs	occurs	occurs	occurs
Red-breasted merganser	occurs	occurs	occurs	occurs
Ruddy duck	occurs	occurs	occurs	occurs
Osprey	occurs	occurs	occurs	occurs
Bald eagle	occurs	occurs	occurs	occurs
Northern harrier	occurs	occurs	occurs	occurs
Sharp-shinned hawk	occurs	occurs	occurs	occurs
Cooper's hawk	occurs	occurs	occurs	occurs
Northern goshawk	occurs	occurs	occurs	occurs
Swainson's hawk	occurs	occurs	occurs	occurs
Red-tailed hawk	occurs	occurs	occurs	occurs
Ferruginous hawk	occurs	occurs	occurs	occurs
Rough-legged hawk	occurs	occurs	occurs	occurs
Golden eagle	occurs	occurs	occurs	occurs
American kestrel	occurs	occurs	occurs	occurs

Common Name	Idaho	Wyoming	Utah	Nevada
Merlin	occurs	occurs	occurs	occurs
Peregrine falcon	occurs	occurs	occurs	occurs
Prairie falcon	occurs	occurs	occurs	occurs
Chukar	nonnative	nonnative	nonnative	nonnative
Gray partridge	nonnative	nonnative	nonnative	nonnative
Ring-necked pheasant	nonnative	does not occur	nonnative	does not occur
Ruffed grouse	occurs	occurs	does not occur	does not occur
Greater sage grouse	occurs	occurs	occurs	occurs
Spruce grouse	occurs	does not occur	does not occur	does not occur
Blue grouse	occurs	occurs	occurs	occurs
Sharp-tailed grouse	occurs	occurs	extirpated	extirpated
Wild turkey	nonnative	does not occur	does not occur	does not occur
Mountain quail	occurs	does not occur	does not occur	occurs
California quail	nonnative	does not occur	nonnative	nonnative
Virginia rail	occurs	accidental	occurs	occurs
Sora	occurs	occurs	occurs	occurs
American coot	occurs	occurs	occurs	occurs
Sandhill crane	occurs	occurs	occurs	occurs
Whooping crane	reintroduced	reintroduced	does not occur	does not occur
Black-bellied plover	occurs	accidental	occurs	accidental
American golden-plover	occurs	accidental	accidental	does not occur
Snowy plover	accidental	does not occur	occurs	does not occur
Semipalmated plover	occurs	accidental	accidental	does not occur
Killdeer	occurs	occurs	occurs	occurs
Black-necked stilt	occurs	accidental	occurs	occurs
American avocet	occurs	occurs	occurs	occurs
Greater yellowlegs	occurs	occurs	occurs	occurs
Lesser yellowlegs	occurs	occurs	occurs	occurs
Solitary sandpiper	occurs	occurs	occurs	occurs
Willet	occurs	occurs	occurs	occurs
Spotted sandpiper	occurs	occurs	occurs	occurs
Upland sandpiper	occurs	accidental	does not occur	does not occur
Long-billed curlew	occurs	occurs	occurs	occurs
Marbled godwit	occurs	occurs	occurs	accidental
Sanderling	occurs	accidental	occurs	does not occur
Semipalmated sandpiper	occurs	occurs	accidental	does not occur
Western sandpiper	occurs	occurs	occurs	occurs
Least sandpiper	occurs	occurs	occurs	occurs
Baird's sandpiper	occurs	occurs	occurs	accidental
Pectoral sandpiper	occurs	accidental	accidental	does not occur
Dunlin	occurs	accidental	occurs	occurs
Long-billed dowitcher	occurs	occurs	occurs	occurs
Wilson's snipe	occurs	occurs	occurs	occurs

Common Name	Idaho	Wyoming	Utah	Nevada
Wilson's phalarope	occurs	occurs	occurs	occurs
Red-necked phalarope	occurs	accidental	occurs	occurs
Franklin's gull	occurs	occurs	occurs	occurs
Bonaparte's gull	occurs	occurs	occurs	accidental
Ring-billed gull	occurs	occurs	occurs	occurs
California gull	occurs	occurs	occurs	occurs
Herring gull	occurs	does not occur	occurs	occurs
Caspian tern	occurs	occurs	occurs	occurs
Common tern	occurs	accidental	accidental	does not occur
Forster's tern	occurs	occurs	occurs	occurs
Black tern	occurs	occurs	occurs	occurs
Rock dove	nonnative	nonnative	nonnative	nonnative
Mourning dove	occurs	occurs	occurs	occurs
Yellow-billed cuckoo	occurs	occurs	accidental	does not occur
Barn owl	occurs	accidental	occurs	occurs
Flammulated owl	occurs	accidental	does not occur	accidental
Western screech-owl	occurs	occurs	occurs	occurs
Great horned owl	occurs	occurs	occurs	occurs
Northern pygmy-owl	occurs	occurs	occurs	does not occur
Burrowing owl	occurs	occurs	occurs	occurs
Barred owl	occurs	accidental	does not occur	does not occur
Great gray owl	occurs	occurs	does not occur	does not occur
Long-eared owl	occurs	occurs	occurs	occurs
Short-eared owl	occurs	occurs	occurs	occurs
Boreal owl	occurs	occurs	does not occur	does not occur
Northern saw-whet owl	occurs	occurs	occurs	occurs
Common nighthawk	occurs	occurs	occurs	occurs
Common poorwill	occurs	occurs	occurs	occurs
Black swift	occurs	occurs	does not occur	does not occur
Vaux's swift	occurs	accidental	does not occur	occurs
White-throated swift	occurs	accidental	occurs	occurs
Black-chinned hummingbird	occurs	occurs	occurs	occurs
Calliope hummingbird	occurs	occurs	occurs	occurs
Broad-tailed hummingbird	occurs	occurs	occurs	occurs
Rufous hummingbird	occurs	occurs	occurs	occurs
Belted kingfisher	occurs	occurs	occurs	occurs
Lewis's woodpecker	occurs	occurs	occurs	occurs
Williamson's sapsucker	occurs	occurs	does not occur	occurs
Red-naped sapsucker	occurs	occurs	occurs	occurs
Downy woodpecker	occurs	occurs	occurs	occurs
Hairy woodpecker	occurs	occurs	occurs	occurs
White-headed woodpecker	occurs	accidental	does not occur	does not occur
Three-toed woodpecker	occurs	occurs	does not occur	does not occur

Common Name	Idaho	Wyoming	Utah	Nevada
Black-backed woodpecker	occurs	occurs	does not occur	does not occur
Northern flicker	occurs	occurs	occurs	occurs
Pileated woodpecker	occurs	accidental	does not occur	does not occur
Olive-sided flycatcher	occurs	occurs	occurs	occurs
Western wood-pewee	occurs	occurs	occurs	occurs
Willow flycatcher	occurs	occurs	occurs	occurs
Least flycatcher	occurs	occurs	does not occur	does not occur
Hammond's flycatcher	occurs	occurs	occurs	occurs
Gray flycatcher	occurs	does not occur	occurs	occurs
Dusky flycatcher	occurs	occurs	occurs	occurs
Cordilleran flycatcher	occurs	occurs	occurs	occurs
Say's phoebe	occurs	occurs	occurs	occurs
Ash-throated flycatcher	occurs	does not occur	occurs	occurs
Western kingbird	occurs	occurs	occurs	occurs
Eastern kingbird	occurs	occurs	occurs	occurs
Loggerhead shrike	occurs	occurs	occurs	occurs
Northern shrike	occurs	occurs	occurs	occurs
Cassin's vireo	occurs	does not occur	occurs	occurs
Warbling vireo	occurs	occurs	occurs	occurs
Red-eyed vireo	occurs	occurs	does not occur	accidental
Gray jay	occurs	occurs	does not occur	does not occur
Steller's jay	occurs	occurs	accidental	occurs
Western scrub-jay	occurs	does not occur	occurs	occurs
Pinyon jay	occurs	accidental	occurs	occurs
Clark's nutcracker	occurs	occurs	occurs	occurs
Black-billed magpie	occurs	occurs	occurs	occurs
American crow	occurs	occurs	occurs	occurs
Common raven	occurs	occurs	occurs	occurs
Horned lark	occurs	occurs	occurs	occurs
Tree swallow	occurs	occurs	occurs	occurs
Violet-green swallow	occurs	occurs	occurs	occurs
Northern rough-winged swallow	occurs	occurs	occurs	occurs
Bank swallow	occurs	occurs	occurs	occurs
Cliff swallow	occurs	occurs	occurs	occurs
Barn swallow	occurs	occurs	occurs	occurs
Black-capped chickadee	occurs	occurs	occurs	occurs
Mountain chickadee	occurs	occurs	occurs	occurs
Chestnut-backed chickadee	occurs	does not occur	does not occur	does not occur
Juniper titmouse	occurs	accidental	occurs	occurs
Bushtit	occurs	does not occur	occurs	occurs
Red-breasted nuthatch	occurs	occurs	occurs	occurs
White-breasted nuthatch	occurs	occurs	occurs	occurs
Pygmy nuthatch	occurs	accidental	does not occur	does not occur

Common Name	Idaho	Wyoming	Utah	Nevada
Brown creeper	occurs	occurs	occurs	occurs
Rock wren	occurs	occurs	occurs	occurs
Canyon wren	occurs	accidental	occurs	occurs
Bewick's wren	occurs	does not occur	accidental	does not occur
House wren	occurs	occurs	occurs	occurs
Winter wren	occurs	occurs	does not occur	occurs
Marsh wren	occurs	occurs	occurs	occurs
American dipper	occurs	occurs	occurs	occurs
Golden-crowned kinglet	occurs	occurs	occurs	occurs
Ruby-crowned kinglet	occurs	occurs	occurs	occurs
Blue-gray gnatcatcher	occurs	accidental	occurs	occurs
Western bluebird	occurs	occurs	does not occur	occurs
Mountain bluebird	occurs	occurs	occurs	occurs
Townsend's solitaire	occurs	occurs	occurs	occurs
Veery	occurs	occurs	occurs	occurs
Swainson's thrush	occurs	occurs	occurs	occurs
Hermit thrush	occurs	occurs	occurs	occurs
American robin	occurs	occurs	occurs	occurs
Varied thrush	occurs	accidental	does not occur	accidental
Gray catbird	occurs	occurs	occurs	does not occur
Northern mockingbird	occurs	accidental	occurs	occurs
Sage thrasher	occurs	occurs	occurs	occurs
European starling	nonnative	nonnative	nonnative	nonnative
American pipit	occurs	occurs	occurs	occurs
Bohemian waxwing	occurs	occurs	occurs	occurs
Cedar waxwing	occurs	occurs	occurs	occurs
Orange-crowned warbler	occurs	occurs	occurs	occurs
Nashville warbler	occurs	accidental	occurs	occurs
Yellow warbler	occurs	occurs	occurs	occurs
Yellow-rumped warbler	occurs	occurs	occurs	occurs
Black-throated gray warbler	occurs	occurs	occurs	occurs
Townsend's warbler	occurs	occurs	occurs	occurs
American redstart	occurs	occurs	occurs	occurs
Northern waterthrush	occurs	occurs	accidental	accidental
MacGillivray's warbler	occurs	occurs	occurs	occurs
Common yellowthroat	occurs	occurs	occurs	occurs
Wilson's warbler	occurs	occurs	occurs	occurs
Yellow-breasted chat	occurs	accidental	occurs	occurs
Western tanager	occurs	occurs	occurs	occurs
Green-tailed towhee	occurs	occurs	occurs	occurs
Spotted towhee	occurs	occurs	occurs	occurs
American tree sparrow	occurs	occurs	occurs	occurs
Chipping sparrow	occurs	occurs	occurs	occurs

Common Name	Idaho	Wyoming	Utah	Nevada
Clay-colored sparrow	accidental	occurs	does not occur	does not occur
Brewer's sparrow	occurs	occurs	occurs	occurs
Vesper sparrow	occurs	occurs	occurs	occurs
Lark sparrow	occurs	occurs	occurs	occurs
Black-throated sparrow	occurs	accidental	occurs	occurs
Sage sparrow	occurs	accidental	occurs	occurs
Savannah sparrow	occurs	occurs	occurs	occurs
Grasshopper sparrow	occurs	accidental	occurs	occurs
Fox sparrow	occurs	occurs	occurs	occurs
Song sparrow	occurs	occurs	occurs	occurs
Lincoln's sparrow	occurs	occurs	occurs	occurs
White-throated sparrow	occurs	occurs	accidental	accidental
Harris's sparrow	occurs	accidental	accidental	accidental
White-crowned sparrow	occurs	occurs	occurs	occurs
Dark-eyed junco	occurs	occurs	occurs	occurs
Lapland longspur	occurs	accidental	occurs	occurs
Snow bunting	occurs	occurs	occurs	accidental
Black-headed grosbeak	occurs	occurs	occurs	occurs
Lazuli bunting	occurs	occurs	occurs	occurs
Bobolink	occurs	occurs	accidental	occurs
Red-winged blackbird	occurs	occurs	occurs	occurs
Western meadowlark	occurs	occurs	occurs	occurs
Yellow-headed blackbird	occurs	occurs	occurs	occurs
Brewer's blackbird	occurs	occurs	occurs	occurs
Brown-headed cowbird	occurs	occurs	occurs	occurs
Bullock's oriole	occurs	occurs	occurs	occurs
Gray-crowned rosy-finch	occurs	occurs	occurs	occurs
Black rosy-finch	occurs	occurs	occurs	occurs
Pine grosbeak	occurs	occurs	does not occur	does not occur
Cassin's finch	occurs	occurs	occurs	occurs
House finch	occurs	occurs	occurs	occurs
Red crossbill	occurs	occurs	occurs	occurs
White-winged crossbill	occurs	accidental	does not occur	does not occur
Common redpoll	occurs	occurs	does not occur	does not occur
Pine siskin	occurs	occurs	occurs	occurs
Lesser goldfinch	occurs	does not occur	occurs	occurs
American goldfinch	occurs	occurs	occurs	occurs
Evening grosbeak	occurs	occurs	occurs	occurs
House sparrow	nonnative	nonnative	nonnative	nonnative
Reptiles				
Common Kingsnake	does not occur	does not occur	does not occur	occurs
California Mountain Kingsnake	does not occur	does not occur	does not occur	occurs
Mojave black-collared lizard	does not occur	does not occur	occurs	occurs

Common Name	Idaho	Wyoming	Utah	Nevada
Long-nosed leopard lizard	occurs	does not occur	occurs	occurs
Short-horned lizard	occurs	occurs	occurs	occurs
Desert horned lizard	occurs	does not occur	does not occur	occurs
Northern sagebrush lizard	occurs	occurs	occurs	occurs
Western fence lizard	occurs	does not occur	occurs	occurs
Side-blotched lizard	occurs	does not occur	occurs	occurs
Western skink	occurs	does not occur	occurs	occurs
Western whiptail	occurs	does not occur	does not occur	occurs
Rubber boa	occurs	occurs	does not occur	occurs
Racer	occurs	does not occur	occurs	occurs
Ringneck snake	occurs	does not occur	does not occur	occurs
Night snake	occurs	does not occur	occurs	occurs
Striped whipsnake	occurs	does not occur	occurs	does not occur
Gopher snake	occurs	does not occur	occurs	occurs
Western terrestrial garter snake	occurs	does not occur	occurs	occurs
Common garter snake	occurs	occurs	occurs	does not occur
Western rattlesnake	occurs	does not occur	does not occur	occurs
Mammals				
Botta's (Pistol River) pocket gopher	does not occur	does not occur	occurs	occurs
Black rat	does not occur	does not occur	occurs	occurs
Gray fox	does not occur	does not occur	does not occur	occurs
Red-legged frog	does not occur	does not occur	does not occur	occurs
Columbia spotted frog	does not occur	occurs	does not occur	occurs
Common kingsnake	does not occur	does not occur	does not occur	occurs
California mountain kingsnake	does not occur	does not occur	does not occur	occurs
Norway rat	nonnative	nonnative	nonnative	nonnative
House mouse	nonnative	does not occur	occurs	occurs
Idaho pocket gopher	occurs	does not occur	does not occur	does not occur
Dwarf shrew	does not occur	occurs	does not occur	does not occur
Masked shrew	occurs	occurs	does not occur	does not occur
Vagrant shrew	occurs	occurs	occurs	occurs
Montane shrew	occurs	occurs	occurs	does not occur
Water shrew	occurs	occurs	occurs	occurs
Merriam's shrew	occurs	occurs	occurs	occurs
California myotis	occurs	does not occur	does not occur	occurs
Western small-footed myotis	occurs	occurs	occurs	occurs
Yuma myotis	occurs	does not occur	occurs	occurs
Little brown myotis	occurs	occurs	occurs	occurs
Long-legged myotis	occurs	occurs	occurs	occurs
Fringed myotis	occurs	does not occur	does not occur	occurs
Long-eared myotis	occurs	occurs	occurs	occurs
Silver-haired bat	occurs	occurs	occurs	occurs

Common Name	Idaho	Wyoming	Utah	Nevada
Western pipistrelle	occurs	does not occur	does not occur	occurs
Big brown bat	occurs	occurs	occurs	occurs
Hoary bat	occurs	occurs	occurs	occurs
Spotted bat	occurs	occurs	does not occur	occurs
Townsend's big-eared bat	occurs	occurs	does not occur	occurs
Pallid bat	occurs	occurs	does not occur	occurs
American pika	occurs	occurs	does not occur	occurs
Pygmy rabbit	occurs	does not occur	occurs	occurs
Nuttall's (mountain) cottontail	occurs	occurs	occurs	occurs
Snowshoe hare	occurs	occurs	does not occur	does not occur
White-tailed jackrabbit	occurs	occurs	occurs	occurs
Black-tailed jackrabbit	occurs	does not occur	occurs	occurs
Least chipmunk	occurs	occurs	occurs	occurs
Yellow-pine chipmunk	occurs	occurs	occurs	occurs
Red-tailed chipmunk	occurs	does not occur	does not occur	does not occur
Yellow-bellied marmot	occurs	occurs	occurs	occurs
Hoary marmot	occurs	does not occur	does not occur	does not occur
White-tailed antelope squirrel	occurs	does not occur	occurs	occurs
Townsend's ground squirrel	occurs	does not occur	does not occur	occurs
Paiute ground squirrel	occurs	does not occur	occurs	does not occur
Belding's ground squirrel	occurs	does not occur	occurs	occurs
Columbian ground squirrel	occurs	does not occur	does not occur	does not occur
Golden-mantled ground squirrel	occurs	occurs	occurs	occurs
Rock squirrel	occurs	does not occur	does not occur	occurs
Red squirrel	occurs	occurs	does not occur	does not occur
Northern flying squirrel	occurs	occurs	does not occur	does not occur
Northern pocket gopher	occurs	occurs	occurs	occurs
Townsend's pocket gopher	occurs	does not occur	does not occur	occurs
Great basin pocket mouse	occurs	does not occur	occurs	occurs
Little pocket mouse	occurs	does not occur	occurs	occurs
Dark kangaroo mouse	does not occur	does not occur	does not occur	occurs
Ord's kangaroo rat	occurs	does not occur	occurs	occurs
Chisel-toothed kangaroo rat	occurs	does not occur	occurs	occurs
American beaver	occurs	occurs	occurs	occurs
Western harvest mouse	occurs	does not occur	occurs	occurs
Deer mouse	occurs	occurs	occurs	occurs
Canyon mouse	occurs	does not occur	occurs	occurs
Pinon mouse	occurs	does not occur	occurs	occurs
Northern grasshopper mouse	occurs	does not occur	occurs	occurs
Desert woodrat	occurs	does not occur	occurs	occurs
Bushy-tailed woodrat	occurs	occurs	occurs	occurs
Southern red-backed vole	occurs	occurs	does not occur	does not occur
Heather vole	occurs	occurs	does not occur	does not occur

Common Name	Idaho	Wyoming	Utah	Nevada
Meadow vole	occurs	occurs	does not occur	does not occur
Montane vole	occurs	occurs	occurs	occurs
Long-tailed vole	occurs	occurs	occurs	occurs
Water vole	occurs	occurs	does not occur	does not occur
Sagebrush vole	occurs	occurs	occurs	occurs
Muskrat	occurs	occurs	occurs	occurs
Northern bog lemming	occurs	does not occur	does not occur	does not occur
Western jumping mouse	occurs	occurs	occurs	occurs
Common porcupine	occurs	occurs	occurs	occurs
Coyote	occurs	occurs	occurs	occurs
Gray wolf	occurs	occurs	does not occur	does not occur
Red fox	occurs	occurs	does not occur	occurs
Kit fox	occurs	does not occur	occurs	occurs
Black bear	occurs	occurs	occurs	does not occur
Grizzly bear	occurs	occurs	extirpated	extirpated
Raccoon	occurs	occurs	occurs	occurs
American marten	occurs	occurs	does not occur	does not occur
Fisher	occurs	does not occur	does not occur	does not occur
Ermine	occurs	occurs	occurs	occurs
Long-tailed weasel	occurs	occurs	occurs	occurs
Mink	occurs	occurs	occurs	occurs
Wolverine	occurs	occurs	does not occur	does not occur
American badger	occurs	occurs	occurs	occurs
Western spotted skunk	occurs	does not occur	occurs	occurs
Striped skunk	occurs	occurs	occurs	occurs
Northern river otter	occurs	occurs	occurs	occurs
Mountain lion	occurs	occurs	occurs	occurs
Canada lynx	occurs	occurs	does not occur	does not occur
Bobcat	occurs	occurs	occurs	occurs
Rocky Mountain elk	occurs	occurs	occurs	occurs
White-tailed deer	occurs	occurs	does not occur	does not occur
Moose	occurs	occurs	does not occur	does not occur
Pronghorn	occurs	occurs	occurs	occurs
Mountain goat	occurs	occurs	does not occur	does not occur
Rocky Mountain bighorn sheep	occurs	occurs	does not occur	occurs
Mule deer	occurs	occurs	occurs	occurs

Global and State Conservation Ranking Descriptions

(Idaho Department of Fish and Game, Idaho Conservation Data Center)

The network of Natural Heritage Programs and Conservation Data Centers—which currently consists of installations in all 50 states, several Canadian provinces, and several Latin American and Caribbean countries—ranks the status of plants, animals, and plant communities at the rangewide or global (G-rank) and state (S-rank) levels on a scale of 1 to 5. The rank is based primarily on the number of known occurrences, but other factors—such as habitat quality, estimated number of individuals, narrowness of range of habitat, trends in populations and habitat, and threats to the species—are also considered. The ranking system is meant to exist alongside national and state rare species lists because these lists often include additional criteria (e.g., recovery potential and depth of knowledge) that go beyond assessing threats to extinction.

Components of Ranks:

- G** Global rank indicator: rank is based on rangewide status
- T** Trinomial rank indicator: global status is for intraspecific taxa
- S** State rank indicator: rank is based on status within Idaho
- 1** Critically imperiled because of extreme rarity or because some factor of its biology makes it especially vulnerable to extinction (typically 5 or fewer occurrences)
- 2** Imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction (typically 6 to 20 occurrences)
- 3** Rare or uncommon but not imperiled (typically 21 to 100 occurrences)
- 4** Not rare and apparently secure but with cause for long-term concern (usually more than 100 occurrences)
- 5** Demonstrably widespread, abundant, and secure
- U** Unrankable
- H** Historical occurrence (i.e., formerly part of the native biota; implied expectation is that it might be rediscovered or possibly be extinct)
- X** Presumed extinct or extirpated
- Q** Uncertainty exists about taxonomic status
- ?** Uncertainty exists about the stated rank
- NR** Not ranked
- NA** Conservation status rank is not applicable

Examples of Use:

G4T2 = Species is apparently secure rangewide, but this particular subspecies or variety is imperiled.

S2S3 = Uncertainty exists about whether the species or subspecies should be ranked S2 or S3.

Components of State Ranks Specific to Long-Distance Migrants (Bats and Birds):

- A** Accidental (occurring only once or a few times) or casual (occurring more regularly although not every year) in Idaho; a few of these species might have bred during one or more of the periods in which they were recorded
- B** Breeding population
- M** Migrant that resident only in an irregular, transitory, and dispersed manner; occurrences cannot be predicted from year to year
- N** Nonbreeding population

Examples of Use:

S4N = Fairly common winter resident

S1B,S5N = Rare breeder but a common winter resident

S2B,SMN = Rare breeder and an uncommon spring and fall transient among which a few remain as local and irregular (in location) winter residents

APPENDIX 1-2—POTENTIAL AND CURRENT NATURAL VEGETATION

Table 1. Percent representation of potential natural vegetation, by major watershed, for the Snake Headwaters subbasin (source: ICBEMP 1997). (GHB= Greys–Hoback watershed; GVT= Gros Ventre watershed; PAL=Palisades watershed; SAL=Salt watershed; SHW=Snake Headwaters watershed).

Potential Natural Vegetation	Major Hydrologic Unit (Watershed)					Total Area (km ²)
	GHB	GVT	PAL	SAL	SHW	
Barren			<1%		<1%	12
Dry Douglas-fir without Ponderosa Pine	14	16	39	47	15	3,507
Dry Grand Fir/White Fir						0
Grand Fir/White Fir Inland						0
Historic Salix/Carex	<1%	2			<1%	46
Historic Agropyron Steppe	<1%	<1%	<1%	<1%	<1%	46
Historic Alpine Shrub-Herbaceous	<1%				5	241
Historic Antelope Bitterbrush			<1%			1
Historic Aspen	24	3	15	12	11	2,148
Historic Big Sage Steppe						0
Historic Big Sage-Cool			<1%	<1%		11
Historic Big Sage-Warm						0
Historic Cottonwood Riverine			<1%		<1%	43
Historic Fescue Grassland						0
Historic Fescue Grassland with Conifer	2	3	11	3	2	504
Historic Juniper						0
Historic Low Sage-Mesic						0
Historic Low Sage-Xeric						0
Historic Mountain Big Sage Mesic West w/Juniper	<1%					1
Historic Mountain Big Sage-Mesic-East	<1%	<1%			<1%	18
Historic Mountain Big Sage-Mesic-East w/Conifer						0
Historic Mountain Big Sage-Mesic-West						0
Historic Mountain Mahogany						0
Historic Mountain Mahogany with ArtRva						0
Historic Mountain Riparian Low Shrub	<1%	<1%			<1%	42
Historic Mountain Shrub						0
Historic Salt Desert Shrub						0

Potential Natural Vegetation	Major Hydrologic Unit (Watershed)					Total Area (km ²)
	GHB	GVT	PAL	SAL	SHW	
Historic Saltbrush Riparian						0
Historic ThreeTipp Sage						0
Interior Ponderosa Pine						0
Limber Pine						0
Lodgepole Pine-Yellowstone					3	121
Moist Douglas-fir						0
Spruce-Fir Dry with Aspen	38	29	31	33	26	4,657
Spruce-Fir Dry without Aspen	7	21	4	<1%	8	1,057
Spruce-Fir Wet						0
Spruce-Fir(LPP>WBP)	13	22	<1%	4	21	1,896
Water			<1%		4	198
White Bark Pine/Alpine Larch South	<1%	3	<1%	<1%	3	207

Table 2. Percent representation of potential natural vegetation, by major watershed, for the Upper Snake subbasin (source: ICBEMP 1997). (AMF=American Falls watershed; BFT=Blackfoot watershed; GSE=Goose watershed; IFA= Idaho Falls watershed; LHF=Lower Henrys Fork watershed; Portneuf watershed; RFT=Raft watershed; TET=Teton watershed; UHF=Upper Henrys Fork watershed; LWT=Lake Walcott watershed; WIL=Willow watershed).

Potential Natural Vegetation	Major Hydrologic Unit (Watershed)												Total Area (km ²)
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL	
Barren													0
Dry Douglas-fir with Ponderosa Pine	<1%	<1%	<1%	<1%	<1%	<1%	<1%	2	3		<1%		229
Dry Douglas-fir without Ponderosa Pine	<1%	5		2	4	8		2	3		<1%	12	955
Dry Grand Fir/White Fir													0
Grand Fir/White Fir Inland							<1%		<1%				24
Historic Salix/Carex		<1%	<1%									10	167
Historic Agropyron Steppe	<1%	<1%	<1%			2	<1%			<1%	<1%	4	162
Historic Alpine Shrub-Herbaceous							<1%	<1%					13
Historic Antelope Bitterbrush	<1%		<1%	<1%			<1%				<1%	<1%	26
Historic Aspen	3	32	3	4	14	23	2	11	19		1	28	4,017
Historic Big Sage Steppe	<1%	4	2	<1%	<1%	2	2	3	<1%	1	<1%	<1%	471
Historic Big Sage-Cool	2	<1%				34					<1%	2	1,424
Historic Big Sage-Warm	81	40	68	88	36	21	64	37	<1%	95	87	16	2,7811

Potential Natural Vegetation	Major Hydrologic Unit (Watershed)												Total Area (km ²)
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL	
Historic Cottonwood Riverine													0
Historic Fescue Grassland	<1%	<1%	2	<1%	<1%	<1%	2	<1%	3	<1%	<1%	2	346
Historic Fescue Grassland with Conifer	<1%			1	4	<1%		<1%	6		<1%	9	528
Historic Juniper			<1%	<1%	<1%		2			<1%	<1%		102
Historic Low Sage-Mesic	6	<1%		<1%		<1%	<1%	<1%		<1%	4		870
Historic Low Sage-Xeric	1			<1%			<1%				<1%		161
Historic Mountain Big Sage Mesic West w/Juniper	2	2	6	<1%	1	2	11		<1%	<1%	2	<1%	1,087
Historic Mountain Big Sage-Mesic-East	<1%	<1%	12	<1%	6	<1%	7		<1%	1	2		1,064
Historic Mountain Big Sage-Mesic-East w/Conifer			<1%				<1%				<1%		18
Historic Mountain Big Sage-Mesic-West	<1%	<1%	<1%	<1%			<1%			<1%	<1%	1	75
Historic Mountain Mahogany	<1%	3	<1%	<1%	<1%	<1%	<1%	7	<1%	<1%	<1%	<1%	389
Historic Mountain Mahogany with ArtRva											<1%		1
Historic Mountain Riparian Low Shrub		<1%										<1%	20
Historic Mountain Shrub	<1%			<1%	<1%			<1%	2		<1%		121
Historic Salt Desert Shrub	<1%			<1%			<1%			<1%	1		209
Historic Saltbrush Riparian	<1%			<1%			<1%				<1%		31
Historic ThreeTipp Sage	<1%	3	6	<1%	<1%	<1%	3	<1%		<1%	<1%	2	516
Interior Ponderosa Pine	<1%	<1%	<1%	<1%		<1%	<1%	1	<1%		<1%		121
Limber Pine													0
Lodgepole Pine-Yellowstone					4			<1%	1				148
Moist Douglas-fir													0
Spruce-Fir Dry with Aspen	<1%	9	<1%	<1%	9	6	<1%	14	20		<1%	13	2,039
Spruce-Fir Dry without Aspen	<1%	<1%		<1%	3	<1%		4	18			<1%	744
Spruce-Fir Wet			<1%				<1%						2
Spruce-Fir(LPP>WBP)		<1%			16	<1%		16	21				1,497
Water		<1%							<1%				22
White Bark Pine/Alpine Larch South					<1%	<1%		<1%	<1%				14

Table 3. Percent representation of potential natural vegetation, by major watershed, for the Closed Basin subbasin (source: ICBEMP 1997). (BCM=Beaver-Camas watershed; BCK=Birch watershed; Big Lost River watershed; Little Lost River watershed; Medicine Lodge watershed.)

Potential Natural Vegetation	Major Hydrologic Unit (Watershed)					Total Area (km ²)
	BCM	BCK	BLR	LLR	MDL	
Barren		5	1	6	<1%	325
Dry Douglas-fir with Ponderosa Pine	3	4	4	4	6	579
Dry Douglas-fir without Ponderosa Pine	<1%	<1%	<1%	<1%	7	260
Dry Grand Fir/White Fir			5			269
Grand Fir/White Fir Inland	<1%	1	<1%	<1%	<1%	75
Historic Salix/Carex						0
Historic Agropyron Steppe	<1%	4	<1%	3	<1%	208
Historic Alpine Shrub-Herbaceous			1			58
Historic Antelope Bitterbrush				<1%	<1%	5
Historic Aspen	5	<1%	<1%	<1%	2	195
Historic Big Sage Steppe	<1%	2		<1%	1	79
Historic Big Sage-Cool	3	21	13	34	2	2,019
Historic Big Sage-Warm	43	2	13	<1%	22	2,380
Historic Cottonwood Riverine			<1%	<1%		46
Historic Fescue Grassland	5					117
Historic Fescue Grassland with Conifer	10	2	4	4	9	820
Historic Juniper	<1%		<1%	<1%	<1%	26
Historic Low Sage-Mesic	<1%	<1%	2	<1%	<1%	100
Historic Low Sage-Xeric	<1%	3	7	2	6	615
Historic Mountain Big Sage Mesic West w/Juniper	2	<1%	1	3	2	229
Historic Mountain Big Sage-Mesic-East	2	28	21	20	5	2,260
Historic Mountain Big Sage-Mesic-East w/Conifer						0
Historic Mountain Big Sage-Mesic-West	<1%			<1%	<1%	13
Historic Mountain Mahogany		<1%	<1%		<1%	5
Historic Mountain Mahogany with ArtRva	<1%	2	<1%	2	<1%	138
Historic Mountain Riparian Low Shrub						0
Historic Mountain Shrub	1		<1%	<1%	<1%	53
Historic Salt Desert Shrub		7	4	3	<1%	430
Historic Saltbrush Riparian	4	6	<1%	5	23	914
Historic ThreeTipp Sage	<1%		<1%			15
Interior Ponderosa Pine	<1%	2	7	3	<1%	509
Limber Pine	1	2	<1%	3	3	241
Lodgepole Pine-Yellowstone						0

Potential Natural Vegetation	Major Hydrologic Unit (Watershed)					Total Area (km ²)
	BCM	BCK	BLR	LLR	MDL	
Moist Douglas-fir	<1%	<1%	<1%	<1%	<1%	20
Spruce-Fir Dry with Aspen	3					69
Spruce-Fir Dry without Aspen	2	1	2	3	<1%	300
Spruce-Fir Wet						0
Spruce-Fir(LPP>WBP)	10	3	2	3	7	611
Water					<1%	1
White Bark Pine/Alpine Larch South		5	7	2	<1%	526

Table 4. Percent representation of current vegetation cover types within each of the major watersheds in the Snake Headwaters subbasin (source: GAP II, Scott *et al.* 2002).

Current Vegetation	Major Hydrologic Unit (Watershed)					Total Area (km ²)
	GHB	GVT	PAL	SAL	SHW	
Agricultural			6			149.960
Alpine Meadow	5	3	<1%	1	6	551.935
Aquatic Bed						0.000
Aspen	5	2	24	19	<1%	1275.67
Basin & Wyoming Big Sagebrush			2	<1%		45.5803
Bitterbrush			<1%	<1%		6.87057
Broadleaf-Dominated Riparian			<1%	<1%		12.1679
Curl-leaf Mountain Mahogany			<1%	<1%		0.83982
Deep Marsh						0.000
Disturbed, High			<1%			0.05304
Disturbed, Low						0.000
Douglas-fir	14	3	12	19	1	1407.74
Douglas-fir/Limber Pine						0.000
Douglas-fir/Lodgepole Pine			1	<1%		28.9713
Dry Meadow						0.000
Engelmann Spruce	<1%		<1%			3.17065
Exposed Rock			1	<1%		27.1666
Foothills Grassland	<1%	<1%	<1%	1	<1%	93.5269
Graminoid- or Forb-Dominated Riparian			<1%	<1%		0.75338
Herbaceous Burn					3	130.558
Herbaceous Clearcut	<1%	2	<1%	<1%	1	100.477
High Intensity Urban						0.000
Lava						0.000
Lodgepole Pine	23	32	3	8	33	3179.99
Low Intensity Urban	<1%		<1%	<1%		11.8686
Low Sagebrush			<1%	<1%		2.18848

Current Vegetation	Major Hydrologic Unit (Watershed)					Total Area (km ²)
	GHB	GVT	PAL	SAL	SHW	
Maple			<1%	<1%		0.75639
Mixed Barren Land	<1%	<1%		<1%	<1%	16.5425
Mixed Needleleaf/Broadleaf Forest			4	4		169.467
Mixed Subalpine Forest			9	6		362.462
Montane Parklands and Subalpine Meadow	19	19	3	4	21	2191.97
Mountain Big Sagebrush	9	6	9	13	3	1109.92
Mountain Low Sagebrush			<1%	<1%		7.38071
Mud Flat						0.000
Needleleaf-Dominated Riparian	1	<1%	<1%	<1%	<1%	141.883
Perennial Grass Slope	<1%		<1%	<1%	<1%	25.2782
Perennial Grassland	<1%		<1%	<1%		63.8729
Perennial Ice or Snow			<1%	<1%		4.78497
Pinyon Pine/Juniper						0.000
Rabbitbrush						0.000
Salt-desert Shrub						0.000
Sand Dune						0.000
Shallow Marsh						0.000
Shrub-Dominated Riparian	1	3	1	1	2	247.004
Shrub/Steppe Annual Grass-Forb	<1%					18.3614
Silver Sage				<1%		0.24311
Subalpine Fir	14	22	<1%	<1%	10	1372.66
Subalpine fir/Whitebark Pine			<1%	<1%	2	93.9119
Subalpine Pine			<1%	<1%		0.53553
Utah Juniper			<1%			1.5255
Vegetated Lava						0.000
Vegetated Sand Dune						0.000
Warm Mesic Shrubs			8	1		224.11
Water		<1%	3	<1%	3	221.505
Wet Meadow	<1%		<1%	<1%	<1%	19.5108
Other	5	6	8	20	12	1504.12

Table 5. Percent representation of current vegetation cover types within each of the major watersheds in the Upper Snake subbasin (source: GAP II, Scott *et al.* 2002).

Potential Natural Vegetation	Major Hydrologic Unit (Watershed)												Total Area (km ²)
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL	
Agricultural	28	5	13	58	20	13	14	48	2	48	20	6	10,511
Alpine Meadow		<1%					<1%	<1%	<1%			<1%	9

Potential Natural Vegetation	Major Hydrologic Unit (Watershed)												Total Area (km ²)
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL	
Aquatic Bed	<1%		<1%										0
Aspen	1	12	1	1	5	7	2	15	4	<1%	<1%	22	1,892
Basin & Wyoming Big Sagebrush	36	7	15	12	5	14	24	<1%	2	14	42	8	9,754
Bitterbrush	<1%	2	<1%	4	16	2	<1%	<1%	<1%	<1%	<1%	<1%	719
Broadleaf-Dominated Riparian	<1%	<1%	<1%	<1%	2	<1%	<1%	<1%	<1%	<1%	<1%	<1%	193
Curl-leaf Mountain Mahogany	<1%	<1%	<1%			<1%	<1%	<1%			<1%	<1%	4
Deep Marsh	<1%	<1%	<1%	<1%		<1%			<1%	<1%	<1%	5	93
Disturbed, High	<1%	<1%	<1%		<1%	<1%	<1%		<1%	<1%	<1%	<1%	40
Disturbed, Low	<1%		<1%	<1%		<1%	<1%	<1%	<1%	<1%	<1%		11
Douglas-fir	<1%	<1%	<1%	<1%	<1%	7	<1%	6	8	<1%	<1%	<1%	834
Douglas-fir/Limber Pine					<1%				<1%				0
Douglas-fir/Lodgepole Pine		<1%		<1%	<1%	<1%		<1%	1		<1%	<1%	69
Dry Meadow					<1%		<1%		<1%				20
Engelmann Spruce					<1%			2	<1%				68
Exposed Rock		<1%	<1%				<1%	<1%	<1%		<1%	<1%	7
Foothills Grassland	<1%	2	<1%	<1%	<1%	<1%	<1%	<1%	3	<1%	<1%	2	288
Graminoid or Forb-Dominated Riparian	<1%	<1%		<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	78
Herbaceous Burn					5				1				178
Herbaceous Clearcut		<1%			<1%			<1%	6			<1%	201
High Intensity Urban	<1%	<1%	<1%		<1%	2	<1%			<1%	<1%		101
Lava	<1%			<1%							7		631
Lodgepole Pine	<1%	2	<1%	<1%	25	<1%	<1%	10	26	<1%	<1%	<1%	1,763
Low Intensity Urban	<1%	<1%	<1%	<1%	<1%	<1%	<1%		<1%	<1%	<1%	<1%	29
Low Sagebrush	1	2	<1%	3	<1%	<1%	<1%	<1%		<1%	<1%	2	425
Maple		<1%				<1%						<1%	14
Mixed Barren Land	<1%		<1%	<1%	<1%		<1%	<1%	<1%	<1%	<1%		37
Mixed Needleleaf/Broadleaf Forest	<1%	3		<1%	3	2	<1%	2	9		<1%	2	574
Mixed Subalpine Forest	<1%	4	1	<1%	<1%	<1%	<1%	3	5	<1%	<1%	<1%	439
Montane Parklands and Subalpine Meadow	<1%	<1%	<1%	<1%	<1%	<1%	<1%	1	1	<1%	<1%	<1%	103
Mountain Big Sagebrush	3	18	8	<1%	3	18	13	2	8	<1%	3	17	3,110

Potential Natural Vegetation	Major Hydrologic Unit (Watershed)												Total Area (km ²)
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL	
Mountain Low Sagebrush	<1%	<1%	<1%	<1%		<1%	1	<1%	<1%	<1%	<1%	<1%	101
Mud Flat		<1%							<1%			<1%	2
Needleleaf-Dominated Riparian	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	64
Perennial Grass Slope	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	24
Perennial Grassland	5	2	3	7	<1%	2	13	<1%	<1%	29	5	<1%	2,524
Perennial Ice or Snow												<1%	0
Pinyon Pine/Juniper			1				5						209
Rabbitbrush	<1%	<1%		<1%						<1%			26
Salt-desert Shrub	<1%		<1%			<1%	<1%			<1%	<1%		48
Sand Dune				<1%	1								48
Shallow Marsh	<1%	<1%	<1%	<1%	<1%	<1%	<1%		<1%	<1%	<1%	<1%	42
Shrub-Dominated Riparian	1	2	<1%	<1%	<1%	1	<1%	1	4	<1%	<1%	3	433
Shrub/Steppe Annual Grass-Forb	<1%	<1%	29			<1%	9			<1%	<1%		1,228
Silver Sage		<1%							<1%			<1%	5
Subalpine Fir	<1%	<1%	<1%		<1%	<1%	1	<1%	1		<1%	<1%	148
Subalpine fir/Whitebark Pine		<1%			1		<1%	<1%	<1%				45
Subalpine Pine					<1%			<1%	<1%		<1%	<1%	8
Utah Juniper	<1%	<1%	5	<1%	<1%	1	3	<1%	<1%	<1%	<1%	<1%	444
Vegetated Lava	6			2							10		1,487
Vegetated Sand Dune				<1%	<1%								29
Warm Mesic Shrubs	1	6	<1%	1	<1%	8	1	1	1	<1%	<1%	6	863
Water	<1%	2	<1%	<1%	<1%	<1%	<1%	<1%	2	<1%	<1%	<1%	232
Wet Meadow	<1%	<1%		<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	2	95
Other	11	28	19	7	9	20	9	2	10	6	7	19	5,197

Table 6. Percent representation of current vegetation cover types within each of the major watersheds in the Closed Basin subbasin (source: GAP II, Scott *et al.* 2002).

Current Vegetation Cover Types	Major Hydrologic Unit (Watershed)					Total Area (km ²)
	BCM	BCK	BLR	LLR	MDL	
Agricultural	8	2			21	757
Alpine Meadow	<1%	<1%	<1%	<1%	<1%	46
Aquatic Bed			<1%			0
Aspen	2	<1%	<1%	<1%	<1%	63

Current Vegetation Cover Types	Major Hydrologic Unit (Watershed)					Total Area (km ²)
	BCM	BCK	BLR	LLR	MDL	
Basin & Wyoming Big Sagebrush	7	5	24	19	6	2,131
Bitterbrush	2		<1%		<1%	65
Broadleaf-Dominated Riparian	<1%	<1%	<1%	<1%	<1%	31
Curl-leaf Mountain Mahogany	<1%	2	1	3	1	201
Deep Marsh	<1%		<1%	<1%	<1%	2
Disturbed, High	<1%	<1%	<1%			4
Disturbed, Low	<1%		<1%			2
Douglas-fir	7	7	4	8	6	840
Douglas-fir/Limber Pine						0
Douglas-fir/Lodgepole Pine	<1%		<1%			55
Dry Meadow						0
Engelmann Spruce						0
Exposed Rock	<1%	4	5	6	<1%	503
Foothills Grassland	<1%	<1%	<1%	<1%	<1%	45
Graminoid- or Forb-Dominated Riparian	<1%		<1%	<1%	<1%	3
Herbaceous Burn			<1%			18
Herbaceous Clearcut						0
High Intensity Urban						0
Lava			<1%			1
Lodgepole Pine	1	<1%	<1%	<1%	<1%	88
Low Intensity Urban	<1%	<1%	<1%	<1%	<1%	22
Low Sagebrush	14	7	7	8	8	1,225
Maple						0
Mixed Barren Land			<1%		<1%	2
Mixed Needleleaf/Broadleaf Forest	2		<1%			44
Mixed Subalpine Forest	2		3	<1%	<1%	236
Montane Parklands and Subalpine Meadow	<1%	<1%	<1%	<1%	<1%	109
Mountain Big Sagebrush	27	16	14	10	15	2,291
Mountain Low Sagebrush	<1%	13	8	10	3	973
Mud Flat	<1%		<1%		<1%	1
Needleleaf-Dominated Riparian	<1%	<1%	<1%	<1%	<1%	28
Perennial Grass Slope	<1%	<1%	<1%	1	<1%	55
Perennial Grassland	6	3	3	6	4	582
Perennial Ice or Snow						0
Pinyon Pine/Juniper						0
Rabbitbrush	<1%				<1%	37
Salt-desert Shrub		<1%	<1%	<1%	<1%	8
Sand Dune						0
Shallow Marsh	<1%		<1%	<1%	<1%	25
Shrub-Dominated Riparian	1	<1%	1	<1%	<1%	135

Current Vegetation Cover Types	Major Hydrologic Unit (Watershed)					Total Area (km ²)
	BCM	BCK	BLR	LLR	MDL	
Shrub/Steppe Annual Grass-Forb		<1%	<1%		<1%	1
Silver Sage	<1%					0
Subalpine Fir	<1%	3	2	3	1	290
Subalpine fir/Whitebark Pine			<1%			7
Subalpine Pine	<1%	6	7	7	2	722
Utah Juniper	<1%	<1%	<1%	<1%		8
Vegetated Lava			<1%			2
Vegetated Sand Dune						0
Warm Mesic Shrubs	<1%	<1%	1	<1%	<1%	80
Water	<1%	<1%	<1%	<1%	<1%	16
Wet Meadow	<1%	<1%	<1%		<1%	8
Other	14	30	15	16	27	2,742

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APPENDIX 1-3—RARE AND SENSITIVE VEGETATION IN THE UPPER SNAKE SUBBASINS

Rare and endemic vegetation is a good indicator of the stability of a natural system. This assessment makes the assumption that rare and threatened vegetation at a point prior to the introduction of anthropogenic effects was sustainable in a natural state. Thus, if a vegetative species is now threatened, it is likely to be highly coorelated to changes in its habitat due to human activities. The authors of the assessment did not write the content of this appendix. Rather, this appendix as generated directly from texts of existing literature, including the Idaho Conservation Data Center website (accessed in April 2003) and Atwood et al. (2000).

In the three subbasins of the Upper Snake province, there are 76 documented species of rare vegetation (Table 1). Of these, 16 have detailed records developed by the sources listed above and are included in this appendix.

Table 1. Vegetation in the Upper Snake province that is listed as either globally (G Rank 1-3) or state (S Rank 1-2) rare (IDCDC 2003). These data were accessed in 2003 and may have changed since. Also, this list is restricted to watersheds in Idaho.

Common Name	Scientific Name	Watershed																		
		AMF	BCK	BCM	BFT	BLR	CJS	GSE	IFA	LHF	LLR	LWT	MDL	PAL	PTF	RFT	SAL	TET	UHF	USR
Pink agoseris	<i>Agoseris lackschewitzii</i>			X															X	
Iodine bush	<i>Allenrolfea occidentalis</i>	X																		
Two-headed onion	<i>Allium anceps</i>											X								X
Green spleenwort	<i>Asplenium trichomanes-ramosum</i>													X						
Rush aster	<i>Aster junciformis</i>					X												X	X	
Lost river milkvetch	<i>Astragalus amnis-amissi</i>					X					X									
Goose creek milkvetch	<i>Astragalus anserinus</i>							X												
Lemhi milkvetch	<i>Astragalus aquilonius</i>					X					X									
Two-groove milkvetch	<i>Astragalus bisulcatus</i> var. <i>bisulcatus</i>			X									X						X	
Meadow milkvetch	<i>Astragalus diversifolius</i>	X	X			X					X									
Drummond's milkvetch	<i>Astragalus drummondii</i>		X	X									X							
Plains milkvetch	<i>Astragalus gilviflorus</i>		X																X	
Picabo milkvetch	<i>Astragalus oniciformis</i>											X								X
Payson's milkvetch	<i>Astragalus paysonii</i>													X						
Blue gramma	<i>Bouteloua gracilis</i>			X									X							
Winged-seed evening primrose	<i>Camissonia pterosperma</i>		X			X					X									
Maritime sedge	<i>Carex incurviformis</i> var. <i>incurviformis</i>					X														
Pale sedge	<i>Carex livida</i>																	X	X	
Idaho sedge	<i>Carex parryana</i> ssp. <i>idaho</i>		X	X	X								X				X			
Mt. Shasta sedge	<i>Carex stramineiformis</i>					X														
Foothill sedge	<i>Carex tumulicola</i>	X													X					
Christ's indian paintbrush	<i>Castilleja christii</i>							X												
Beautiful indian paintbrush	<i>Castilleja pulchella</i>																		X	
McCune earth lichen	<i>Catapyrenium congestum</i>		X			X														
Centennial rabbitbrush	<i>Chrysothamnus parryi</i> ssp. <i>montanus</i>												X							
Bulb-bearing waterhemlock	<i>Cicuta bulbifera</i>																		X	
Yellow spring-beauty	<i>Claytonia lanceolata</i> var. <i>multiscapa</i>																		X	
Sepal-tooth dodder	<i>Cuscuta denticulata</i>		X																	

Common Name	Scientific Name	Watershed																		
		AMF	BCK	BCM	BFT	BLR	CJS	GSE	IFA	LHF	LLR	LWT	MDL	PAL	PTF	RFT	SAL	TET	UHF	USR
Davis' wavewing	<i>Cymopterus davisii</i>							X								X				
Douglass' wavewing	<i>Cymopterus douglassii</i>					X					X									
Austrian draba	<i>Draba fladnizensis</i>					X														
Pointed draba	<i>Draba globosa</i>		X			X														
Yellowstone draba	<i>Draba incerta</i>												X						X	
Slender spike-rush	<i>Eleocharis tenuis</i>																		X	
Giant helleborine	<i>Epipactis gigantea</i>								X				X							X
Low fleabane	<i>Erigeron humilis</i>					X					X									
Welsh's buckwheat	<i>Eriogonum capistratum</i> var. <i>welshii</i>					X					X									
Green keeled cotton-grass	<i>Eriophorum viridicarinatum</i>																	X	X	
Four-parted gentian	<i>Gentianella propinqua</i>					X													X	
Slender gentian	<i>Gentianella tenella</i>					X														
Spreading gilia	<i>Ipomopsis polycladon</i>	X	X			X					X									
Simple kobresia	<i>Kobresia simpliciuscula</i>		X								X							X		
Manyhead bladderpod	<i>Lesquerella multiceps</i>	X																		
Payson's bladderpod	<i>Lesquerella paysonii</i>													X						
Marsh felwort	<i>Lomatogonium rotatum</i>		X			X					X									
Northern bog clubmoss	<i>Lycopodiella inundata</i>																		X	
Green muhly	<i>Muhlenbergia racemosa</i>	X			X					X								X	X	
St. Anthony evening primrose	<i>Oenothera psammophila</i>								X	X										
Hall's orthotrichum moss	<i>Orthotrichum hallii</i>					X					X									
Kotzebue's grass-of-parnassus	<i>Parnassia kotzebuei</i> var. <i>kotzebuei</i>					X														
Idaho penstemon	<i>Penstemon idahoensis</i>							X												
Obscure phacelia	<i>Phacelia inconspicua</i>	X				X						X								
White spruce	<i>Picea glauca</i>																		X	
Small-flowered ricegrass	<i>Piptatherum micranthum</i>		X																	
Marsh's bluegrass	<i>Poa abbreviata</i> ssp. <i>marshii</i>		X			X														
Kruckeberg's sword-fern	<i>Polystichum kruckebergii</i>															X				
Alkali primrose	<i>Primula alcalina</i>		X								X									
Jones' primrose	<i>Primula incana</i>																	X		
Arctic buttercup	<i>Ranunculus gelidus</i>					X														
Pygmy buttercup	<i>Ranunculus pygmaeus</i>					X														
Red glasswort	<i>Salicornia rubra</i>	X													X	X	X			

Common Name	Scientific Name	Watershed																		
		AMF	BCK	BCM	BFT	BLR	CJS	GSE	IFA	LHF	LLR	LWT	MDL	PAL	PTF	RFT	SAL	TET	UHF	USR
Hoary willow	<i>Salix candida</i>		X		X						X							X	X	
Gray willow	<i>Salix glauca</i>													X					X	
False mountain willow	<i>Salix pseudomonticola</i>		X								X								X	
Sierra sanicle	<i>Sanicula graveolens</i>																		X	
Wedge-leaf saxifrage	<i>Saxifraga adscendens</i> var. <i>oregonensis</i>					X					X									
Nodding saxifrage	<i>Saxifraga cernua</i>					X					X								X	
Pod grass	<i>Scheuchzeria palustris</i>																		X	
Rolland bulrush	<i>Scirpus rollandii</i>		X								X									
Petalless campion	<i>Silene uralensis</i> ssp. <i>montana</i>					X					X									
Ute ladies' tresses	<i>Spiranthes diluvialis</i>								X					X						
Tall dropseed	<i>Sporobolus asper</i>																			X
Green needlegrass	<i>Stipa viridula</i>												X		X					
James' saxifrage	<i>Telesonix jamesii</i> sensu lato																		X	
Wovenspore lichen	<i>Texosporium sancti-jacobi</i>						X													
Purple meadow-rue	<i>Thalictrum dasycarpum</i>															X			X	

***Allium anceps* Kellogg— twinleaf onion, Kellogg's onion**

Liliaceae (Lily family)

General Description—Perennial forbs with broadly egg-shaped underground bulbs having a thick, yellowish, cellular-patterned coat. Bulbs give rise to a flattened, minutely scabrous-margined stem about 10–15 cm tall; each with a pair of sickle-shaped, scabrous-margined leaves 4–6 mm wide and up to twice as long as the scape. The leaves fall off the plant at maturity. Stems are terminated by an umbel containing 15–25 pinkish-colored flowers that have a diffuse green midrib. The slender, lance-linear-shaped tepals are 6–10 mm long and attached to the umbel by pedicels roughly three times as long as the tepals.

Field Identification Tips—The flattened stems; pair of relatively narrow, more-or-less sickle-shaped leaves; slender, lance-linear-shaped tepals; and stamens equaling or shorter than the tepals provide a combination of field characteristics to help distinguish *Allium anceps*.

Phenology—Flowering begins in the spring, sometimes by early April, and continues into June.

Similar Species—About ten other onion species overlap the range of *Allium anceps* in Idaho. It is most likely to be confused with several that also possess a pair of sickle-shaped leaves, including *A. lemmonii* (Lemmon's onion), *A. tolmiei* (Tolmie's

onion), and *A. parvum* (small onion). *Allium anceps* has slender tepals mostly more than 4 times as long as wide, compared to tepals mostly less than 4 times as long as wide for the other three species. One or more differences in bulb coat, leaf length and width, tepal and midrib color, and stamen length characters can also be used to separate *A. anceps* from these similar species.

Habitat—Heavy soils of volcanic origin in or around seasonally wet playas, swales, and other low places, or thin, rocky soil in the sagebrush zone. Sites are usually flat to gently sloping, and sparsely vegetated.

Global Distribution—Widespread in Nevada, extending into northeastern California, southeastern Oregon, and southern Idaho.

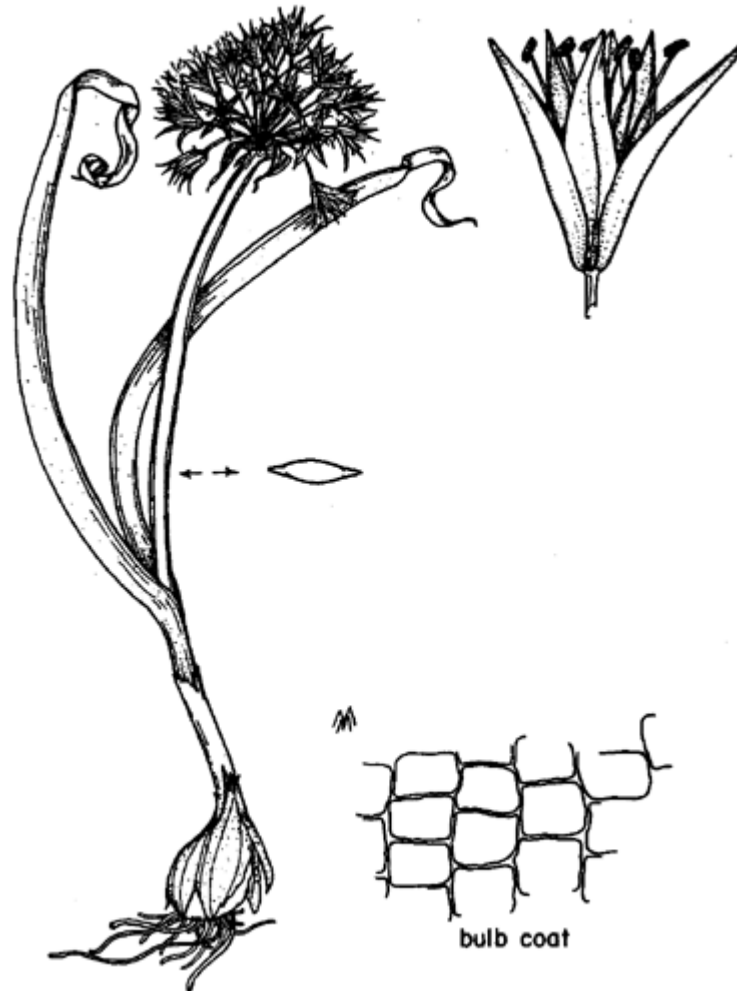
Idaho Distribution—Most known Idaho populations are in Twin Falls County. One occurrence is also known from Jerome County north of the Snake River. Populations in Owyhee and Cassia counties should also be expected. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/allanc_dis.cfm.)

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Photo © Robert K. Moseley
Allium anceps (twinleaf onion, Kellogg's onion) habitat



Allium anceps
twinleaf onion, Kellogg's onion

Illustration by Melissa Marshall. Reprinted with permission from Intermountain Flora: Vascular plants of the Intermountain West, U.S.A., by A. Cronquist, A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren, Vol. 6, p. 520, copyright 1977, The New York Botanical Garden.

***Astragalus aquilonius*
(Barneby) Barneby—
Lemhi milkvetch**

Fabaceae (Pea, Legume family)

General Description—A taprooted, herbaceous, short-lived perennial with numerous, decumbent or trailing stems up to

about 35 cm long and often purplish-tinged. The herbage is greenish-ashy in color due to short, fine hairs. The compound leaves consist of 9–23 oval, oblong, or oblanceolate, rounded to apically notched leaflets 5–16 mm long. The inflorescence is a loose raceme of 4–15 greenish-white flowers, each about 1 cm long. The keel petal is often purplish tipped, while the calyx has white and gray-brown,

more or less straight, appressed hairs. The one-celled fruit pods are 2.5–4 cm long by 1.3–1.7 cm in diameter, sessile, inflated, ellipsoid, membranous, green and not mottled, and glabrous to minutely hairy.

Field Identification Tips—Lemhi milkvetch is the only *Astragalus* species in east-central Idaho with a large, bladderly, unilocular fruit pod. Robust plants with numerous stems can have a low, rounded shape. The purplish-tinged stems and greenish-gray color of the herbage also help distinguish this species.

Phenology—Plants in flower from mid- to late May into July. Fruits may still be present into September.

Similar Species—The range of Lemhi milkvetch partly overlaps and is most likely to be confused with *A. amblytropis* (Challis milkvetch) because of its similar habit and greatly swollen fruit pod. Challis milkvetch differs, however, by having a two-chambered fruit.

Habitat—On dry, gentle to often steep and unstable slopes, talus, washes, alluvial debris, and flats. It occurs on various, but often southerly aspects having gravelly and sandy, to ashy and occasionally clayey soils. The surrounding shrub-steppe vegetation is dominated by *Artemisia tridentata* ssp. *wyomingensis*, *Atriplex confertiflora*, *Pseudoroegneria spicata*, *Elymus elymoides*, *Poa secunda*, and *Leymus salinus* ssp.

salmonis. Along the Salmon River it is often associated with two other Challis region endemics, *Astragalus amblytropis* and *Oxytropis besseyi* var. *salmonensis*.

Global Distribution—Endemic to east-central Idaho, in Custer, Butte, and Lemhi counties.

Idaho Distribution—The main center of distribution for Lemhi milkvetch includes the lower slopes of the Salmon River valley from near Ellis to Clayton, and the East Fork Salmon River upstream to the vicinity of Herd Creek. Populations are also known from the southern end of the Lemhi Range, the Lemhi River valley around Lemhi, and scattered locations in the Pahsimeroi and Lost River valleys. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/astagu_dis.cfm.)

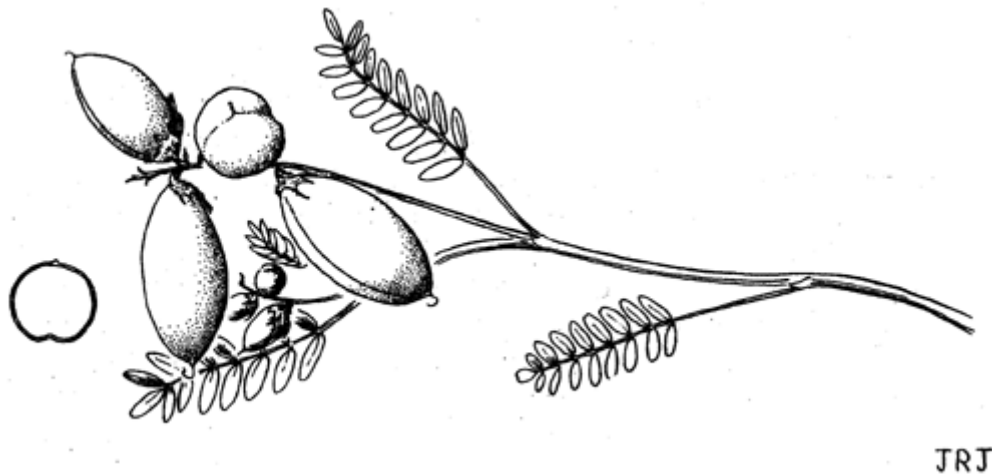
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Photo © Robert K. Moseley
Astragalus aquilonius
Lemhi milkvetch



Astragalus aquilonius
Lemhi milkvetch

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1961. Vascular plants of the Pacific Northwest. Part 3. University of Washington Press, Seattle. 614 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

***Astragalus bisulcatus*
(Hook.) A. Gray var.
bisulcatus—Two-grooved
milkvetch**

Fabaceae (Pea, Legume family)

General Description—A stout, erect, clump-forming, leafy, and thinly pubescent perennial herb 15–70 cm tall. The compound leaves have 15–35, more or less oblong leaflets, each between 5 and 30 mm long. The inflorescence is a dense raceme of whitish or purplish flowers. The banner is 11–17 mm long, and longer than the wings or keel petal. The calyx is 5–10 mm long, often red-purple, with thin white or black hairs, and the base swollen on one side. The pendulous, linear or narrowly oblong fruit pods have a short stipe, a thick papery texture, and are 10–20 mm long. The front face of the pod is openly grooved lengthwise along either side of the raised suture.

Field Identification Tips—Two-grooved milkvetch is recognized by its very leafy, clumpy habit, dense inflorescence of relatively large whitish to purplish flowers, basally pouched calyx, and pendulous, two-grooved fruit pod. Bagged plants and those drying in a plant press often give off a strong, disagreeable smell of selenium.

Phenology—Flowers May to August.

Similar Species—Two-grooved milkvetch is most likely to be confused with other robust, leafy milkvetches having many leaflets and many, relatively large flowers. *Astragalus canadensis* (Canada milkvetch) is most readily distinguished by its erect, sessile, more or less leathery-textured fruit pods. Additional distinguishing characteristics include its rhizomatous root system, pick-shaped pubescence, and greenish-white or yellowish-white-colored flowers. While the

Pods of *A. drummondii* (Drummond's milkvetch) are pendulous like two-grooved milkvetch, they differ in being bluntly three-angled in shape and having a longer stipe (5–11 mm long). In addition, the flowers tend to be larger (17–25 mm) and the foliage more hairy.

Habitat—Open grasslands, badlands, gullies, roadsides, and valley bottoms. In Idaho, populations occur in relatively moist sagebrush/grassland or creek bottom habitats, sometimes in degraded condition. Associated species include *Artemisia tridentata* ssp. *tridentata*, *A. tridentata* ssp. *wyomingensis*, *Rosa woodsii*, *Salix* spp., *Leymus cinereus*, *Pascopyrum smithii*, and *Poa pratensis*.

Global Distribution—Central Alberta to southwestern Manitoba, south to Kansas and New Mexico, and west to north-central Arizona, Utah, east-central Idaho, and southwestern Montana.

Idaho Distribution—Foothills of the southern Beaverhead and Centennial Mountain Ranges in Clark County, the Henrys Lake area in Fremont County, and the Lemhi River drainage in Lemhi County. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/astbis_dis.cfm.)

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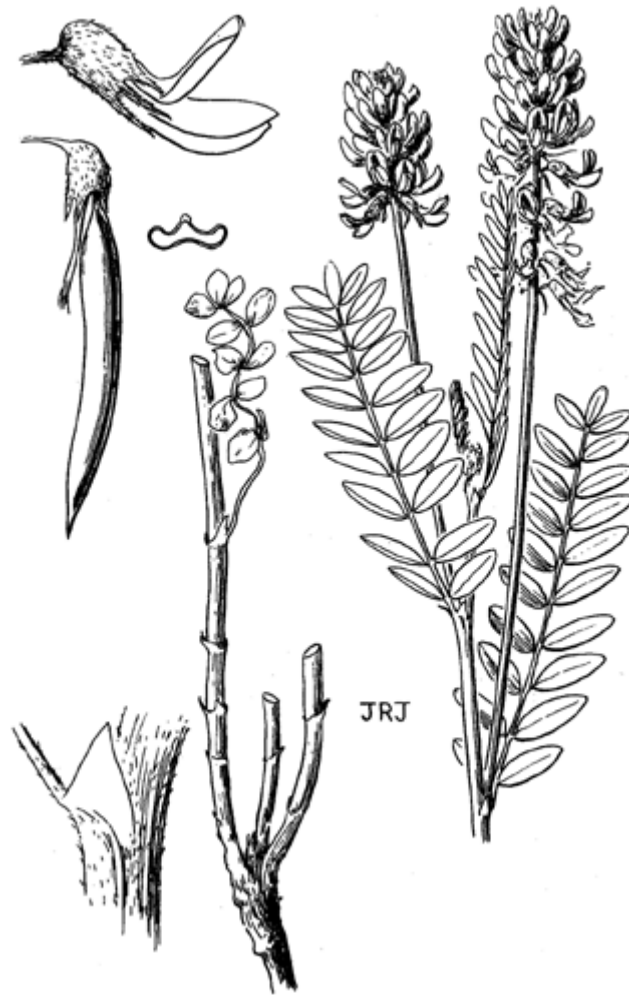
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University, Provo, UT. 1007 pp.



Photo © Robert K. Moseley
Astragalus bisulcatus bisulcatus
two-grooved milkvetch



Astragalus bisulcatus bisulcatus
two-grooved milkvetch

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1961. Vascular plants of the Pacific Northwest. Part 3. University of Washington Press, Seattle. 614 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

***Astragalus diversifolius*
Barneby—meadow
milkvetch**

Fabaceae (Pea, Legume family)

General Description—A diffuse or prostrate perennial forb with weak, slender, sparsely leafy, simple or branched stems radiating

from the root crown. Leaves are 2–5.5 cm long, with 1–5 linear, grasslike, or ovate leaflets 2–5 mm broad. The terminal leaflet is always the longest and continuous with the leaf stalk. The inflorescence is a loose raceme of 2–8 white, cream, or yellowish-white flowers. The flowers are often faintly purplish-tinged/tipped, with the banner petal being 7–13 mm long. The calyx is 3.5–6.5 mm long and has short, appressed, black or

white hairs. Fruit pods are oblong, straight or slightly curved, 10–17 mm long by 3–4 mm broad, with the thin green pod becoming papery and straw or gray-brown colored.

Field Identification Tips—The slender, often prostrate, sparsely leafy habit of meadow milkvetch, combined with a terminal leaflet larger than the lateral leaflets, makes this species relatively easy to identify. However, these same features can make it difficult to see in the field, especially if done flowering. The narrow leaflets mimic blades of grass and the whole plant becomes seemingly hidden in the vegetation.

Phenology—Plants begin to flower in June and peak during July. More fruits than flowers are observed by August.

Similar Species—Meadow milkvetch is most likely to be confused with other diffuse-looking, sparsely leafy *Astragalus* species occurring within its range. *Astragalus convallarius* (lesser rushy milkvetch) has narrow fruits over 20 mm long, very narrow leaflets, and occurs in drier habitats. *Astragalus ceramicus* (painted milkvetch) has inflated, reddish- to purplish-mottled pods and occurs in dry, sandy habitats. *Astragalus leptaleus* (Park milkvetch) occurs in several of the same east-central Idaho wetland systems as meadow milkvetch. It is readily distinguished by having leaves with 15–25 leaflets, smaller flowers, and an inflorescence that does not extend much above the middle of the plant.

Habitat—Moist soils in alkaline meadows with flat or hummocky topography supporting graminoid or medium height shrub vegetation. Associated species may include

Juncus balticus, *Poa secunda*, *Leymus cinereus*, *Spartina gracilis*, *Senecio debilis*, *Phlox kelsyi*, *Glaux maritima*, *Sarcobatus vermiculatus*, and *Potentilla fruticosa*.

Global Distribution—Widely separated populations are known from east-central Idaho, the southwestern edge of the Salt Lake Desert in western Juab and Tooele counties, Utah, and the Spring Valley area in southern White Pine County, Nevada. There is also a historical record for this species from the Green River Basin in western Wyoming.

Idaho Distribution—Most Idaho populations are located in Custer and Lemhi counties, in the intermountain valleys of the Big Lost, Little Lost, Pahsimeroi, and Lemhi rivers, and Birch Creek. The meadow milkvetch population reported from the upper Snake River Plain, near Springfield, in Bingham County, has probably been extirpated. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/astdiv_dis.cfm.)

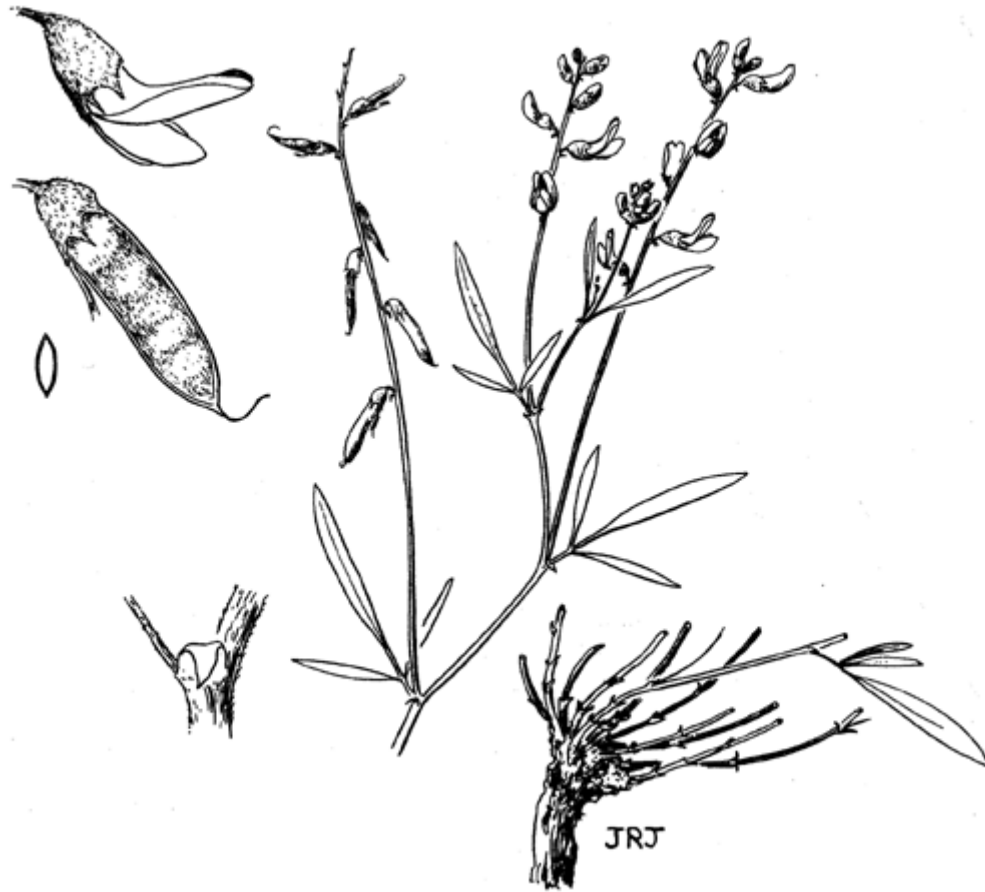
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Photo © Robert K. Moseley
Astragalus diversifolius
meadow milkvetch



Astragalus diversifolius
meadow milkvetch

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1961. Vascular plants of the Pacific Northwest. Part 3. University of Washington Press, Seattle. 614 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

Astragalus drummondii
Douglas ex. Hook.—
Drummond's milkvetch

Fabaceae (Pea, Legume family)

General Description—A stout, villous-hairy, perennial forb with several erect stems 25–55 cm tall. The compound leaves have 13–33 oblong-elliptic to obovate, obtuse or notched bicolored leaflets that are pale green beneath and bright green above; the larger ones 12–30

mm long. Racemes have 15–30, nodding, white to yellow-white flowers on stout, erect stems 4–14 cm long. Banner petals are 15–25 mm long and the keel petal lilac-tipped. The calyx is 7–13 mm long and commonly has black hairs. The stipitate, hanging fruit pods are 17–32 mm long by 3–6 mm wide and more or less linear in profile with three blunt angles. Pods are green and totally hairless, have a prominent brown suture, and become almost leathery in age.

Field Identification Tips—Drummond's milkvetch is recognized by its coarse habit, foliage with spreading hairs, large, whitish, nodding flowers, and pendulous, stipate, glabrous pods.

Phenology—Flowers in late spring, usually peaking in June and done by early to mid-July.

Similar Species—None of the several other *Astragalus* species that could co-occur in Idaho, such as *Astragalus miser* (weedy milkvetch), *A. convallarius* (lesser weedy milkvetch), *A. cibarius* (browse milkvetch), and *A. lentiginosus* (freckled milkvetch) should be confused with Drummond's milkvetch. Larger flowers, and several features of the fruit pod will distinguish Drummond's milkvetch from *A. bisulcatus* var. *bisulcatus* (two-grooved milkvetch).

Habitat—In Idaho, Drummond's milkvetch occurs in sagebrush-bunchgrass habitats on open, gentle to moderately steep, predominately south- to west-facing slopes with gravelly to rocky soils. Associated species include *Artemisia tridentata* ssp.

vaseyana, *Chrysothamnus* spp., *Tetradymia canescens*, *Festuca idahoensis*, and *Pseudoroegneria spicata*.

Global Distribution—Widespread over the high plains and Rocky Mountains from southern Canada, south to New Mexico, and entering the Intermountain region in portions of Utah and eastern Idaho. It is most common along the east slope of the Rockies and adjacent plains.

Idaho Distribution—Sagebrush plains and lower slopes along the southern Beaverhead and western Centennial ranges in northern and central Clark County. Also known from the eastern base of the Lemhi Range in the Birch Creek Valley, in the southwestern corner of Clark County. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/astdru_dis.cfm.)

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Barneby, R. C. 1989. Intermountain Flora. Vascular plants of the Intermountain West, U.S.A. Vol. 3, Part B, Fabales. The New York Botanical Garden, Bronx, NY. 279 pp.



Photo © Robert K. Moseley
Astragalus drummondii
Drummond's milkvetch



Astragalus drummondii
Drummond's milkvetch

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1961. Vascular plants of the Pacific Northwest. Part 3. University of Washington Press, Seattle. 614 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

***Astragalus gilviflorus* E.
Sheldon—plains
milkvetch, plains
orophaca**

Fabaceae (Pea, Legume family)

Synonyms—*Astragalus triphyllus* Pursh;
Orophaca triphylla (Eaton & Wright) Britton

General Description—A stemless, tufted perennial forming small mats up to about 15 cm in diameter, and foliage with silvery, lustrous, straight, appressed hairs. The compound leaves are comprised of 3, sessile, palmately arranged leaflets 5–30 mm long, and having a reverse lance- or reverse egg-shape narrowing at the point of attachment. The short inflorescence has 1–3 (mostly 2) erect, yellowish to whitish flowers tucked in

the leaf axils. Banner petals are 16–28 mm long. The calyx is narrowly cylindric and 9–20 mm long. Fruit pods are erect and commonly concealed among the persistent sepals and stipules. They are ovoid-elliptic in shape, hairy, one-celled, 6–10 mm long by 2.5–5 mm broad, and have thin fleshy valves that become leathery in age.

Field Identification Tips—The stemless, densely tufted habit, palmately tri-foliate leaves of steely gray-blue color, and relatively large yellowish to whitish flowers tucked within or barely exceeding the leaves readily identifies plains milkvetch in the field.

Phenology—Flowering in early May to about early June.

Similar Species—Although a number of other low-growing *Astragalus* species occur in east-central Idaho, none should be confused with plains milkvetch. *Astragalus calycosus* (Torrey’s milkvetch) may look superficially similar when flowers or fruits are not present, but it does not have palmately 3-foliate leaflets.

Habitat—Open, more or less sparsely vegetated, rocky, gentle to steeper limestone slopes with little soil development. It occurs on all aspects. Associated species include *Petrophytum caespitosum*, *Artemisia nova*, *A. frigida*, *Cercocarpus ledifolius*, *Tanacetum nuttallii*, *Penstemon* spp., *Hymenopappus filifolius* var. *idahoensis*, and *Arenaria kingii*.

Global Distribution—Widespread on the high plains from southern Alberta and Manitoba, south to Oklahoma, west to the Rocky Mountain foothills, and in the Intermountain Region in east-central Idaho and northeastern Utah.

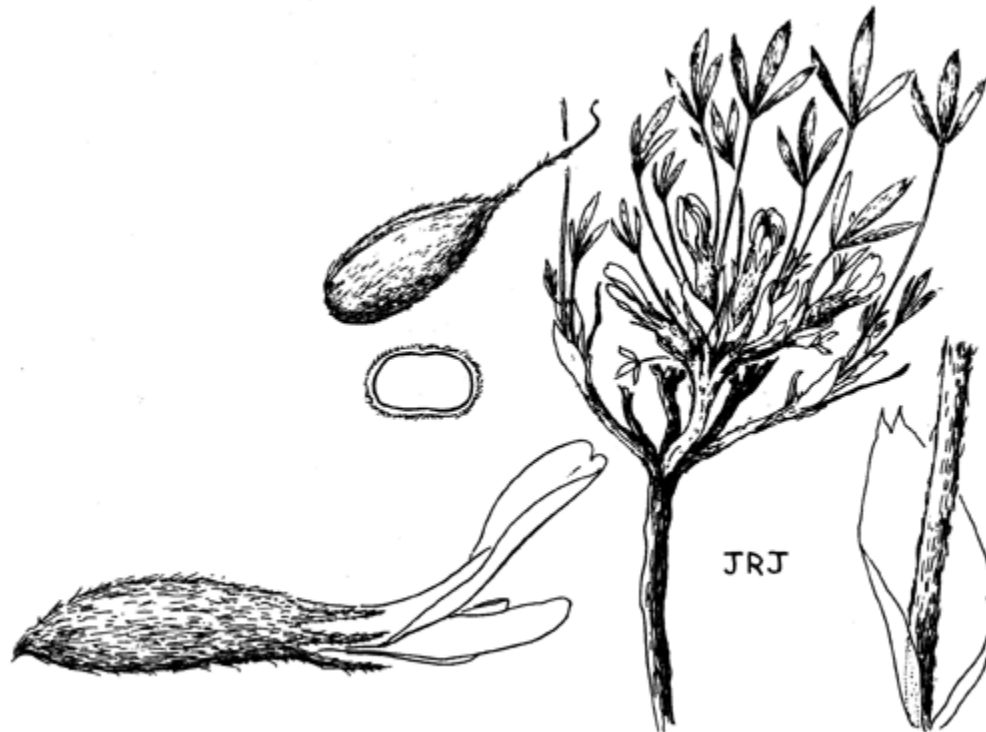
Idaho Distribution—West slope of the Beaverhead Range in and near the Lemhi River and Birch Creek valleys in Lemhi and Clark counties. Plains milkvetch has also been collected from near Henrys Lake in Fremont County. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/astgil_dis.cfm.)

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Photo © Robert K. Moseley
Astragalus gilviflorus
plains milkvetch; plains orophaca



Astragalus gilviflorus
plains milkvetch; plains orophaca

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1961. Vascular plants of the Pacific Northwest. Part 3. University of Washington Press, Seattle. 614 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

***Camissonia pterosperma* (S. Wats.) Raven—wing-seeded evening-primrose**

Onagraceae (Evening-primrose family)

General Description—A slender, simple or branched, diminutive annual herb up to about 15 cm tall. The herbage has few to many tiny spreading hairs and becomes glandular in the inflorescence. Stem leaves are entire, mostly lance-shaped, and up to about 1.5 cm long (occasionally longer) and 5 mm wide. Flowers are erect on short pedicels in the upper leaf axils. The petals are small, 1.5–3 mm long, white with a yellow base, aging to a pinkish color. Sepals are small and reflexed.

The fruit capsule is more or less straight, cylindric, shortly stalked, 1–2 cm long, and slightly to more often widely spreading by maturity. Seeds have a pair of conspicuous, incurved marginal wings.

Field Identification Tips—The slender, diminutive habit, entire, narrow leaves, small white flowers with a yellow base, and shortly-stalked, straight fruit capsules are good field characteristics. The white flowers with a yellow base and seeds having a pair of conspicuous, thick, incurved marginal wings are diagnostic.

Phenology—Flowers from approximately mid-May to mid-June.

Similar Species—There are several other annual *Camissonia* species in east-central Idaho. They all differ in one or more readily viewed field characteristics, including having toothed versus entire leaves; having mostly basal leaves versus leaves mostly along the stem; having sessile versus stalked fruit capsules; having bent/contorted versus straight fruit capsules; or having yellow versus white flowers. The elongated fruit capsule positioned below (inferior) the sepals distinguishes species of *Camissonia* from most other small annual forb species encountered in east-central Idaho.

Habitat—Dry, open slopes, ridges, and washes in the sagebrush and juniper zones. Most known Idaho populations occur on gravelly-silty soils, on southerly-facing limestone slopes. It is also known from volcanic-derived substrates in a few places. The vegetation is dominated by open *Juniperus osteosperma*, *Artemisia arbuscula*, or *Artemisia nova* communities. Other associated species in this open habitat include *Pseudoroegneria spicata*, *Poa secunda*, *Achnatherum hymenoides*, *Eriogonum* spp., *Phlox hoodii*, and *Mentzelia albicaulis*.

Global Distribution—Southeastern Oregon and adjacent very southwestern Idaho, south

through Nevada to Inyo County, California, northern Arizona, and portions of Utah; then disjunct in east-central Idaho.

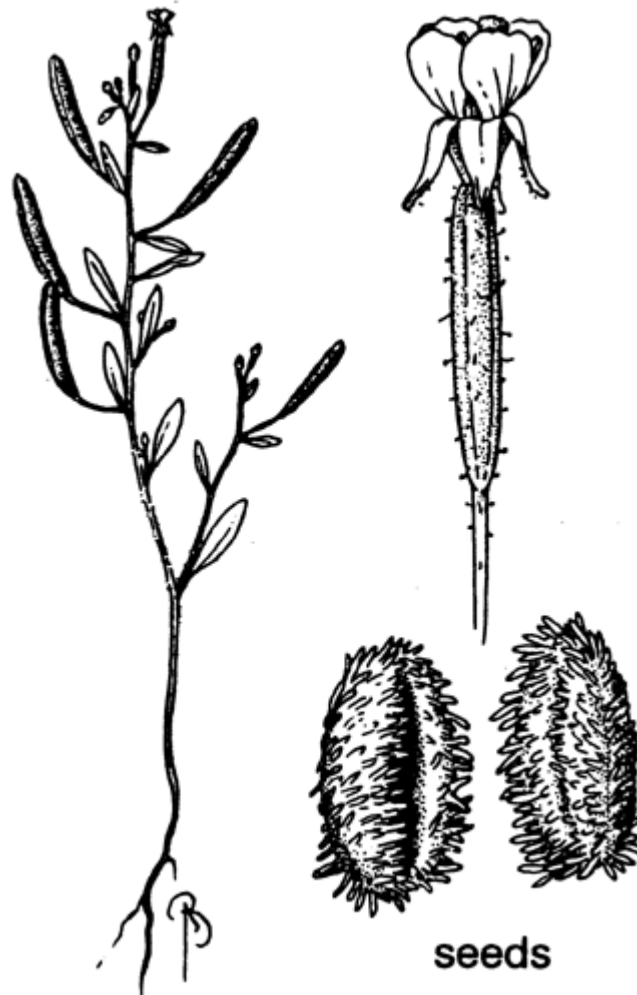
Idaho Distribution—Most Idaho populations of wing-seeded evening-primrose are known from the low, southern ends of the Lost River, Lemhi, and Beaverhead ranges in Butte and Clark counties. It has also been collected from near the South Fork Owyhee River in Owyhee County, in very southwestern Idaho. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/camppte_dis.cfm.)

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Photo © Robert K. Moseley
Camissonia pterosperma
wing-seeded evening-primrose



Camissonia pterosperma
wing-seeded evening-primrose

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***Carex livida* (Wahlenb.)
Willd.—pale sedge**

Cyperaceae (Sedge family)

General Description—Grass-like perennial growing in small clumps with flowering stems up to 20 cm tall arising from long-slender rhizomes. Leaves are deeply

channeled, 1–4 mm wide, clustered on the lower third of the stem, and have a glaucous blue-green color. The inflorescence consists of 2–3, or sometimes 4, loosely clustered spikes. The narrow terminal spike is usually wholly staminate. The lateral spikes are pistillate and nearly sessile. Flowers have 3 stigmas, and the oval-shaped scales subtending the perigynia have a green

midvein stripe, brown marginal stripes, and membranous edges. The perigynia are 2–4 mm long, pale green, elliptic or ovate in outline, and have a minutely bumpy surface.

Field Identification Tips—The pale blue–green, stiff, channeled, more or less falcate–shape leaves are quite distinctive in the field.

Phenology—Fruit matures in late June–August.

Similar Species—*Carex aquatilis* has long-stalked lateral spikes and flowers with two stigmas. *Carex limosa* is rhizomatous and has three stigmas, but has drooping lateral spikes on slender stalks. *Carex buxbaumii* has 3 stigmas and bluish-green foliage, but differs in having pistillate flowers at the tip of the upper spike and long-awned scales.

Habitat—Bogs and fens, swampy woods, or sometimes on mineral substrates adjacent to slow moving streams; from low to moderately high elevations.

Global Distribution—Circumboreal; in the western part of North America it reaches from southern Alaska south to northwestern California, Oregon, Washington, Idaho, Montana, Wyoming, Colorado, and Utah.

Idaho Distribution—Known from four widely separated areas in Idaho. It occurs in the Panhandle region; the Sawtooth Valley in the central mountains; the upper Lemhi River in east-central Idaho; and the Greater Yellowstone region near the state's eastern border. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/carliv_dis.cfm.)

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Photo © Robert Moseley
Carex livida
pale sedge



Carex livida
pale sedge

Hitchcock, C. L., A. Cronquist, and M. Ownbey. 1969. Vascular plants of the Pacific Northwest. Part 1. University of Washington Press, Seattle. 914 pp. Illustration by Jeanne Janish. Reprinted by permission of the University of Washington Press.

Carex tumulicola **Mackenzie—foothill sedge**

Cyperaceae (Sedge family)

General Description—A grass-like perennial forming loose tufts up to about 80 cm tall. Leaves are flat, 1–3 mm wide, elongate, but shorter than the stems, and not all clustered at the very base of the plant. Spikes several, small, few-flowered, with male flowers above the female flowers, and loosely aggregated into an oblong- or cylindric-shaped head 1.5–4 cm long. Bracts are usually well developed and with the lower ones generally (but not always) surpass their subtended spike. The greenish-straw to pale coppery perigynia are narrowly to broadly egg-shaped, 3.5–5 mm long, and have 2 stigmas. Scales are straw to brownish in color with whitish margins, fairly broad, tending to be shortly awn-tipped, and equaling or surpassing the more or less appressed perigynia.

Field Identification Tips—Foothill sedge occurs in relatively dry habitats. Useful field characteristics include its loosely tufted habit, small, few-flowered inflorescences with heads having male flowers above the female, and generally well developed bract surpassing the lower spike. Positive identification requires use of a technical key and hand lens or microscope.

Phenology—June and July.

Similar Species—Many other sedge species resemble foothill sedge in general appearance. It is most likely to be confused with other

tufted, upland habitat sedges that have male flowers above the female in the inflorescence. *Carex hoodii* (Hood's sedge) has spikes that are more tightly clustered and more markedly bicolored. *Carex vallicola* (valley sedge) does not get over about 40 cm tall, and has pale scales usually shorter than the perigynia. *Carex occidentalis* (western sedge), like these other two sedges, does not have well-developed subtending bracts that surpass the lower spikes.

Habitat—Open, often grassy slopes and dry meadows.

Global Distribution—Mainly distributed west of the Cascade Mountains, from southern Washington to central California, and up the Columbia River to western Klickitat County. Disjunct populations have been reported in southwestern and eastern Idaho.

Idaho Distribution—Owyhee County in southwestern Idaho, and historical collections from Bannock and Power counties in the eastern part of the state. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/cartum_dis.cfm.)

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Carex tumulicola
foothill sedge

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1969. Vascular plants of the Pacific Northwest. Part 1. University of Washington Press, Seattle. 914 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

***Castilleja christii*—Christ's Indian paintbrush**

Scrophulariaceae (Figwort family)

General Description—Christ's Indian paintbrush is a perennial forb 15 to 30 cm (6 to 12 inches) tall consisting of several stems clustered together. Herbage can be smooth or with bristle-like hairs, at least some of which

is gland-tipped near the inflorescence. Leaves are lance-shaped and usually lobed. The inflorescence is yellow to yellow-orange in color and with gland-tipped hairs. The corolla (concealed by the colorful bracts) is 20 to 30 mm (about 0.75 to 1.25 inches) long, with the upper, hooded portion (galea) being about 8–11 mm long.

Technical Description—Perennial herb, 1.5–3 dm tall; stems erect to ascending, usually

unbranched, several to a cluster; herbage glabrous to hispid with some of the hairs gland-tipped near the inflorescence; leaves 2.5 (6) cm long, narrowly to broadly lanceolate, with 1 (2) pair of lateral lobes above, sometimes all entire; inflorescence glandular-villous, yellow to yellow-orange, the bracts lanceolate to ovate, with 1 or 2 pairs of narrow lateral lobes; calyx 17–22 (24) mm long, the primary lobes more deeply cleft in front, 9–12 (13) mm, than behind, 7–11 mm, the segments 2–6.5 (8.5) mm long, lanceolate to narrowly lanceolate, acute to obtuse; corolla 20–20 mm long, the galea 8–11 mm long, the lower lip much reduced with incurved teeth, the tube 12–19 mm long; capsule 10–14 mm long (Cronquist et al. 1984).

Diagnostic Characteristics—Diagnostic characteristics include the yellow to yellow-orange colored inflorescence with gland-tipped hairs, the galea being at least 8 mm long, the calyx being slightly more deeply cleft in front than in the back, and the lanceolate-shaped leaves with usually one pair of narrow lateral segments.

Infraspecific Taxa—There are no infraspecific taxa for *Castilleja christii*.

Similar-appearing Taxa—*Castilleja christii* is the only yellow to yellow-orange flowered paintbrush on the Mount Harrison summit. It is also the only paintbrush occurring in the moist snowbed and graminoid communities around the summit. Three other species of *Castilleja* occur on and around Mount Harrison and can be distinguished using the following combination of characteristics (Moseley 1993):

Calyx decidedly more deeply cleft in front (7–22 mm) than in back (2–8 mm). Calyx conspicuous, bearing most of the red coloration of the inflorescence. Occurs on the lower-elevation big sagebrush slopes of

Mount Harrison, occasionally extending higher on south-facing slopes. *C. linariifolia*.

Calyx more deeply cleft in back than in front. The bracts bearing most of the attractive coloration of the inflorescence and partly concealing the relatively inconspicuously-colored flowers. Low, unbranched plant on exposed ridgelines and shallow soils with low sagebrush (*Artemisia arbuscula*). Inflorescence pale yellow to whitish, occasionally purple-tinged. *C. angustifolia* var. *flavescens*.

Calyx slightly more deeply cleft in front than in back. Bracts bearing most of the color and concealing the relatively inconspicuously-colored flowers. Leaves, at least the upper, with 1 or more pair of long, narrow lateral segments. Inflorescence yellow to yellow-orange. Occurs in moist, gently sloping communities, usually not directly associated with sagebrush. *C. christii*.

Calyx more deeply cleft in front than in back. Bracts provide coloration and conceal the relatively inconspicuously-colored flowers. Leaves all entire, generally shiny-green, rarely the uppermost deeply 3-parted. Inflorescence scarlet. Generally in deep soils in conifer and aspen stands, although occasionally in swales within big sagebrush communities. *C. miniata*.

Identification of this Taxon in Idaho—At Mount Harrison, no other species of *Castilleja* has a yellow to yellow-orange colored inflorescence with gland-tipped hairs.

Global—*Castilleja christii* is known only from the type location at Mount Harrison, at the northern end of the Albion Mountains in Cassia County, Idaho. It occurs entirely on U.S. Forest Service land. The single population extends over approximately 200 acres and consists of an estimated 10,000 individuals. The southern limit of the

population begins approximately 250 feet north of the summit lookout and continues north for about 0.75 mile. The east-west extent of the population is somewhat over one mile in width. The population is entirely managed by the U.S. Forest Service, Burley Ranger District, Sawtooth National Forest. Roughly 23% of the population (90 acres) occurs in the proposed Mount Harrison Research Natural Area. The population appears to be in excellent vigor and all size classes are represented.

The largest direct loss of paintbrush habitat can be attributed to the construction of several roads, and may amount to as much as 20 acres. The main road to the lookout atop Mt. Harrison (Howell Canyon Road) roughly bisects the population of *C. christii* and is maintained annually. Several other unofficial dirt roads branch off near the summit, and traverse through habitat occupied by *C. christii*. In addition to the roads, an underground vault, buried power cable, and fire lookout tower are located at the summit of Mount Harrison. The large underground vault was constructed by the military during the 1960's. The area adjacent to the vault was disturbed during construction and is currently used for random parking near the lookout. No *C. christii* presently occupies this area. During 1969–1970, an underground power cable was installed from a point near the lookout, north to a microwave site on a 9033-foot peak near Lake Cleveland. Installation of the cable went through part of the *C. christii* population. The species appears to have re-established on the site disturbed by placement of the cable. The Forest Service reconstructed the fire lookout during 1977. *Castilleja christii* does not occur around the lookout. Major human activities in the Mount Harrison area include recreation and operations associated with the fire lookout. Recreational activities are seasonally important and account for a large influx of human activity during the snow-free summer and fall months.

Several Classes of Threats Assessed—The present or threatened destruction, modification, or curtailment of its habitat or range. The Forest Service restricts vehicle traffic to established roads, although there is ample evidence this is ignored and vehicles traverse the paintbrush population away from the roads. Use of the summit as a hangglider launch site has increased rapidly in the past few years. To access hang-glider launch sites at Harrison Peak and Peak 9033, several two-track, unimproved roads lead through portions of the *C. christii* population. Currently, parking at the summit occurs at random over approximately a 0.5 acre area near the lookout. This is outside the limits of the *C. christii* population. The greatest direct threat to remaining habitat is from vehicles that leave the existing roads. Much of this activity probably results from late-lying snowbanks blocking access to the lookout and the electronic sites on Peak 9033. By driving out across the relatively gentle slopes to get around the drifts, vehicles create large erosion channels and small gullies in the plant's habitat. The Howell Canyon Road is scheduled for improvements, including paving to the lookout atop Mount Harrison. Direct and indirect impacts associated with road construction and staging are likely because plants occur right next to the existing road in some places. Road maintenance activities could also potentially impact portions of the population. Installation of a new underground power cable in 1995 went through a small amount of *C. christii* habitat. Placement of the new cable is scheduled for 1995.

Overutilization for Commercial, Recreational, Scientific, or Educational purposes—Although plant collection may increase if the access road is paved, overutilization is not anticipated to be a major threat to the *C. christii* population.

Disease or Predation—The summit plateau of Mount Harrison, including the entire area occupied by *C. christii* is currently closed to livestock grazing. Because of this, livestock grazing is not considered a threat at this time.

Inadequacy of Existing Regulatory Mechanisms—Presently, existing regulatory mechanisms are inadequate to control unauthorized off-road vehicle use and hang-gliding activities that may be impacting *C. christii* habitat.

Other Natural or Manmade Factors Affecting Its Continued Existence—Limited hiking takes place from near the lookout as a cutoff to the Skyline Trail, west of, and approximately 800 feet below the lookout. There is no designated trailhead at the summit. Hikers walking near the summit may impact portions of the population by trampling plants.

Idaho—The Association for Biodiversity Information rank for *Castilleja christii* is G1/S1. A global (G) rank of 1 is for taxa critically imperiled because of extreme rarity or because of some factor of its biology making it especially vulnerable to extinction. Because this species is endemic to Idaho, the state (S) rank equals the global rank. *Castilleja christii* is on the Idaho Native Plant Society's globally rare list with a priority of 8 (taxa facing imminent threats of low magnitude).

Distribution

Global—*Castilleja christii* is endemic to Mount Harrison in the northern portion of the Albion Range, Cassia County, Idaho. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/caschr_dis.cfm.)

Idaho—See Global Distribution comments. (See also

http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/caschr_dis.cfm.)

Habitat

Elevation (Global)—8,600 to 9,200

Elevation (Idaho)—8,600 to 9,200

Global—*Castilleja christii* occurs primarily on gentle, northerly-facing slopes. Plants are found in three distinct communities:

Snowbed—areas of the latest-lying snowbanks. The community is forb dominated, with *Solidago multiradiata*, *Aster foliaceus*, and *Cymopterus davisii* being the most prominent. *Castilleja christii* is present in low densities in this community.

Graminoid—*Festuca idahoensis*, *Agropyron caninum*, and *Elymus trachycaulus* dominate this community. *Artemisia tridentata* ssp. *vaseyana* is absent. The paintbrush reaches its highest density in this community.

Artemisia tridentata ssp. *vaseyana*/*Festuca idahoensis* habitat type: much of the area covered by this community on Mount Harrison is patterned ground. Density of *C. christii* is inversely related to the density of sagebrush. It generally occurs only in openings in the sagebrush and within the nearly shrubless swales of the patterned ground. Soils are relatively deep and gravelly. The dominant soils in the area are Typic Cryoborolls, loamy skeletal.

Idaho—See Global Habitat comments.

Ecology

Global—No specific information is known regarding the autecology of *C. christii*. The one known population occurs in an area where deep snows accumulate, and in some places may last the summer in some years. Apparently, the Mount Harrison area was

heavily grazed by sheep years ago, but what affects, if any, this had on the paintbrush population is unknown. The density of paintbrush is inversely related to the density of mountain big sagebrush, and usually occurs in openings in the sagebrush. This may indicate a level of shade intolerance, or perhaps some other kind of interaction. *Castilleja christii* achieves its highest density in the snowbed and graminoid communities where there is no sagebrush. Within sagebrush stands, the paintbrush only occurs in openings between the shrubs (Moseley 1993). *Castilleja christii* occurs almost exclusively on gentle, northerly-facing slopes. These sites tend to be fed by late-lying snow during the early part of the growing season, and likely remain moist well into August most years. Considerable pocket gopher activity takes place within the paintbrush's habitat. Species of *Castilleja* are hemiparasitic. It is not known which species or group of species *C. christii* may form such a hemiparasitic relationship.

Idaho—See Global Ecology comments.

Reproduction

Global—*Castilleja christii* reproduces by seed. Nothing is known about seed dispersal or seed bank dynamics. Flowering begins in early July, and mature seeds are apparently not present until late in the month. No specific pollinators have been documented. Seed germination studies conducted by the Denver Botanical Garden indicate *C. christii* has a strong dormancy. It is speculated seeds may require prolonged (three months or longer) cool and moist conditions to germinate. Approximately 3000 seeds are in seed storage at the National Seed Storage Laboratory in Fort Collins, Colorado.

Idaho—See Global comments on reproduction.

Phenology (Idaho)—Growth begins slightly before or soon after the snow melts in early July. Peak flowering occurs from mid-July to mid-August depending on the year. Fruits begin to mature soon afterward and probably dehisce by mid-September.

Management

Global—The one known population of *Castilleja christii* occurs entirely on U. S. Forest Service land. Due to its restricted range and specific habitat requirements, in combination with increasing recreational pressure and access and facility development proposals, any further destruction of habitat could potentially affect the long-term viability of *C. christii*. To address these concerns, a Conservation Agreement involving the U. S. Fish and Wildlife Service and the Sawtooth National Forest has been completed and approved (U. S. Fish and Wildlife Service 1995). The Conservation Agreement includes 21 proposed conservation actions for which the U. S. Forest Service are responsible, and 3 for which the U. S. Fish and Wildlife Service are responsible. Approximately 23% of the paintbrush population occurs in the proposed Mount Harrison Research Natural Area (RNA).

Establishment of the RNA is one of the proposed conservation actions listed in the Conservation Agreement. Other proposed conservation measures include establishment of a monitoring program, conducting field inventories, cooperating with the Denver Botanical Garden to maintain an off-site seed storage program, continuation of the livestock grazing closure in the area, complete a mineral withdrawal for the area covered by the paintbrush population, development of an interpretive program, and support studies researching the species' biology and ecology. Additional measures address problems related to roads, planned developments, and access. Finally, several administrative measures have

been identified. *Castilleja christii* is sympatric with another rare local endemic, Davis' wavewing (*Cymopterus davisii*). Shasta daisy (*Machaeranthera shastensis latifolia*) is another rare plant known from the area. The proposed conservation actions for *C. christii* will also benefit these other rare plants.

Idaho—See Global Management comments.

Inventory

General Comments (Idaho)—There have been a number of surveys for *Castilleja christii* in the Albion and adjacent mountain ranges over the years. The most comprehensive was conducted by Moseley (1993).

Inventory Needs (Idaho)—High elevation potential habitats in the Albion Range have been thoroughly surveyed in the past. However, one of the conservation activities proposed in the Conservation Agreement between the U. S. Fish and Wildlife Service and the Sawtooth National Forest is that inventories of potential habitat be conducted as funding becomes available.

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***Chrysothamnus parryi* ssp. *montanus*—centennial rabbitbrush**

Asteraceae (Aster family)

General Description—*Chrysothamnus parryi* ssp. *montanus* is a low growing, branching shrub with stems mostly covered by compacted, feltlike hairs (not always easy to see). It has linear leaves 0.5–1.5 inches long that are somewhat sticky to the touch. The inflorescence has one or a few heads and is overtopped by the uppermost stem leaves. Each head is about 0.5 inch long and usually contains 8–10 yellow disk flowers, but no ray flowers. The bracts forming the base of each head are lance-shaped with hairs spaced along the margins and long pointed green tips. They overlay each other like shingles on a roof. The

seeds have numerous long, thin, stiff hairs at the top.

Technical Description—Intricately branched, low, spreading shrubs, 1–2 (3) dm tall; leaves green, alternate, entire, linear, 2–3.5 cm long, 1–2 mm wide, viscidulous, upper ones surpassing the few-headed cymose inflorescence; heads 10–11.5 mm long, involucral bracts (11) 13–17 (18), viscidulous, more or less in vertical rows, outer bracts lanceolate-ovate with ciliate margins and long acuminate, herbaceous tips, inner ones broadly lanceolate-elliptic with acuminate tips; disk flowers (4) 5–11 (12), yellow, corollas 9–10 mm long, lobes 1.4–1.7 mm long, broadly lanceolate, styles variable with stigmatic lines much shorter to slightly longer than the style appendages (27–52% of total style branch length); achenes 8 mm long, pubescent; n = 9 (Anderson 1978).

Diagnostic Characteristics—*Chrysothamnus parryi* ssp. *montanus* is a low shrub with white stems, linear, glabrous leaves, the inflorescence overtopped by the uppermost leaves, and involucral bracts aligned in vertical ranks. This set of morphological characters combined with its high-elevation habitat distinguishes it from other similar species.

Infraspecific Taxa—*Chrysothamnus parryi* ssp. *salmonensis*.

Similar-appearing Taxa—There are several similar looking species that are sympatric, or occur in the vicinity with *Chrysothamnus parryi* ssp. *montanus*. *Chrysothamnus viscidiflorus* and *C. nauseosus* are common and widespread species of rabbitbrush. The former has wider leaves and twigs that are not white. The latter has white stems and narrow leaves, but the leaves are also white-hairy and the inflorescence is borne well above the uppermost leaves. Additionally, both species tend to be taller than the 10 to 30 cm height of *Chrysothamnus parryi* ssp. *montanus*. *Haplopappus suffruticosus* is common in rocky, high elevation habitats, but its stems are not white, it has wider leaves, and has heads with ray flowers.

Identification of this Taxon in Idaho—*Chrysothamnus parryi* ssp. *montanus* is a low shrub with white stems, linear, glabrous leaves, inflorescences overtopped by the uppermost stem leaves, and involucre bracts aligned in vertical ranks. This set of morphological characters combined with its rocky, high elevation habitat distinguishes it from similar species.

Global Comments

Idaho Comments—*Chrysothamnus parryi* ssp. *montanus* was not described until 1978 (Anderson 1978). Previous to this date, it was referenced as *Chrysothamnus parryi* var. *b* in Flora of the Pacific Northwest (Hitchcock and Cronquist 1973).

Status

Global—*Chrysothamnus parryi* ssp. *montanus* is a local endemic comprised of approximately 3,700 individuals in four occurrences, and confined to less than 2,000 acres in the Red Conglomerate Peaks area along the Continental Divide in Clark County, Idaho, and Beaverhead County Montana. Four occurrences are known for Idaho and support

approximately 3,500 plants. One occurrence extends across the Continental Divide into adjacent Montana. The Montana portion of the occurrence contains an estimated 200 additional plants. All known populations are on public land administered by the U. S. Forest Service, the Targhee National Forest, Dubois Ranger District, and the Beaverhead National Forest, Dillon Ranger District.

The habitat is remote and there are no apparent threats at this time. Livestock are grazed on the slopes of the Red Conglomerate Peaks area, but their use of the species' rocky ridge habitat seems minimal. There are no roads penetrating the high subalpine ridges, and off-road vehicle use in the area seem unlikely to be a major problem. The area is used by hunters in the fall, but there are few maintained trails. No mining activity is known from the area. However, the small population sizes and local distribution pattern make the species vulnerable to any disturbances in the area. All management plans for the Red Conglomerate Peaks area should consider the possible effects on this plant. It has been recommended that the Forest Service consider establishing a long-term monitoring trend study (Lesica 1992).

Until the U.S. Fish and Wildlife Service recently revised their candidate system, *Chrysothamnus parryi* ssp. *montanus* was a Category 2 (C2) candidate for listing under the Endangered Species Act. Under the revised system it is no longer considered a federal candidate species. In 1993, it was recommended for Category 1 (C1) status at the Idaho Native Plant Society's annual Idaho rare plant conference. It is a U. S. Forest Service Region 4 sensitive species for the Targhee National Forest in Idaho, and a Region 1 sensitive species for the Beaverhead National Forest in Montana.

Chrysothamnus parryi ssp. *montanus* is listed by the Idaho Conservation Data Center and

the Montana Natural Heritage Program as critically imperiled globally (G5T1/S1), because of extreme rarity in both states.

Idaho—*Chrysothamnus parryi* ssp. *montanus* is on the Idaho Native Plant Society's list of globally rare taxa. It has a priority of 9, indicating threats are imminent, but of low magnitude.

Distribution

Global—*Chrysothamnus parryi* ssp. *montanus* is a narrow endemic known only from the Red Conglomerate Peaks area, near the Continental Divide, in the southern Beaverhead Range of Idaho and Montana.

Idaho—Restricted to the Red Conglomerate Peaks area of the southern Beaverhead Range. All known populations occur on the Idaho side of the Continental Divide, with one extending into adjacent Montana. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/chrpar_dis.cfm.)

Habitat

Elevation (Global)—8,800 to 10,000 feet

Elevation (Idaho)—8,800 to 10,000 feet

Global—*Chrysothamnus parryi* ssp. *montanus* occurs on high elevation slopes or windswept ridge crests with southerly exposures between 8,800 and 10,000 feet. It is restricted to rocky, calcareous substrates of the Beaverhead Conglomerate Formation. It occurs where bedrock is at or near the surface, resulting in minimal soil development. Adjacent sites characterized by deeper, more fully developed soils do not support *Chrysothamnus parryi* ssp. *montanus*. Populations are most extensive on rocky spur ridges descending from the Continental Divide. Plants can be locally common, but overall, occupied habitat covers limited acreage.

Beaverhead Conglomerate is the lithified bed of a large ancient river. The extent of this rock type is limited. Approximate boundaries in Idaho are from the head of Irving Creek, eastward to an area northwest of Paul Reservoir. Beaverhead Conglomerate rocks do not surface east of Monida Pass. The situation is similar for Montana, where the only high elevation outcrops are around Red Conglomerate Peaks, although lower elevation exposures are found along the Red Rock River in southern Beaverhead County. A nearly identical formation, the Sphinx Mountain Conglomerate, occurs around Sphinx Mountain in the central Madison Range southeast of Ennis. It outcrops at 9,000 feet to well above timberline.

The community in which *Chrysothamnus parryi* ssp. *montanus* occurs is unclassified. Associated vegetation is sparse and not dominated by graminoids. Associate species include *Chrysothamnus viscidiflorus* ssp. *lanceolatus*, *Haplopappus acaulis*, *H. suffruticosus*, *Erigeron caespitosus*, *Antennaria umbrinella*, *Astragalus kentrophyta*, *Phlox pulvinata*, *Ivesia gordonii*, *Petrophytum caespitosum*, *Draba oligosperma*, *Leucopoa kingii*, *Agropyron scribneri* and *Poa interior*.

Idaho—See Global Habitat comments.

Ecology

Global—There have been no studies investigating the autecology of *Chrysothamnus parryi* ssp. *montanus*. It occurs on high elevation slopes or windswept ridge crests with southerly exposures. It has not been observed on north-facing slopes, suggesting it requires the warmer conditions prevailing on the southerly aspects. Evapotranspiration is high and snow cover minimal on these exposed sites, dry sites. Seedlings would likely have to depend on spring snow or rain to become established.

Recruitment may therefore, be limited to years with reliable spring precipitation (Lesica 1992).

Plants are found in sparsely vegetated sites, suggesting abiotic interactions may be more important than competition in regulating recruitment and survival. However, these habitats may also be very dry, at least seasonally. At these times competition for water may be important.

The species is apparently substrate specific, occurring only on substrate of the Beaverhead Conglomerate formation where bedrock is at or close to the surface. However, it is unknown if edaphic factors play a principal role in controlling the distribution of *Chrysothamnus parryi* ssp. *montanus*, or what the environmental factors related to this substrate specificity may be.

The palatability of *Chrysothamnus parryi* ssp. *montanus* is unknown. Some other rabbitbrush species are palatable and grazed by wild animals. There is no information on the species' response to disturbances.

Idaho—See Global Ecology comments.

Reproduction

Global—Reproduction appears to be entirely by seed. The pollinators of *Chrysothamnus parryi* spp. *montanus* are not known. The species' windy, exposed habitat makes it likely that strong-flying pollinators such as bees may be important (Lesica 1992). The achenes of *Chrysothamnus parryi* ssp. *montanus* have numerous capillary bristles and are likely shed in late fall or early winter. The habitat is windy, so dispersal is likely via wind. Large animals such as bighorn sheep and mountain goats may also play a role.

Idaho—See Global Reproduction comments.

Phenology (Idaho)—*Chrysothamnus parryi* ssp. *montanus* was observed flowering in mid-August (Mancuso and Moseley 1990). It probably flowers throughout much of August and early September. Achenes are likely shed by late fall or early winter.

Management

Global—*Chrysothamnus parryi* ssp. *montanus* is a local endemic comprised of approximately 3,700 individuals in four occurrences, and confined to less than 2,000 acres in the Red Conglomerate Peaks area along the Continental Divide in Clark County, Idaho, and Beaverhead County Montana. Four occurrences are known for Idaho and support approximately 3,500 plants. One occurrence extends across the Continental Divide into adjacent Montana. The Montana portion of the occurrence contains an estimated 200 additional plants. All known populations are on public land administered by the U.S. Forest Service, the Targhee National Forest, Dubois Ranger District, and the Beaverhead National Forest, Dillon Ranger District.

Although there are no immediate threats to maintaining the existing populations of *Chrysothamnus parryi* ssp. *montanus*, its small population sizes and restricted distribution make the species vulnerable to any disturbances in the Red Conglomerate Peaks area. All management plans for this area should consider possible effects on this species. Lesica (1992) has recommended that wildlife numbers in the area be monitored, as a large increase could potentially have an adverse effect on *Chrysothamnus parryi* ssp. *montanus*. He also recommends the Forest Service establish a long-term trend monitoring study. This species is a Forest Service sensitive species for both Region 1 (includes the Beaverhead National Forest) and Region 4 (includes the Targhee National Forest).

Idaho—See Global Management comments.

Inventory

General Comments (Idaho)—A systematic field investigation for *Chrysothamnus parryi* ssp. *montanus* was conducted in Idaho in 1990 (Mancuso and Moseley 1990). The investigation was a cooperative Challenge Cost-share project involving the Idaho Conservation Data Center and Targhee National Forest. Specific areas searched included the southern Beaverhead Range from the head of Warm Creek, east along the Continental Divide and associated ridges, to Monida Pass, and in the Centennial Range, in the Taylor Mountain, and Jefferson to Sawtell peaks areas.

Field surveys have also been conducted in Montana (Lesica 1992), including the southern Beaverhead Range along the Continental Divide from the head of Little Beaver Creek west to the head of Sawmill Creek, and the southern slopes of the Lima Peaks. Some additional areas containing outcrops of the Beaverhead Conglomerate Formation or similar geology have been investigated in Montana. Specifically, along the Red Rock River in southern Beaverhead County, and around Sphinx Mountain in the central Madison Range.

Inventory Needs (Idaho)—No additional areas needing survey work have been identified for Idaho. Land Managers and field personnel on the Targhee and Beaverhead National Forests should be aware of this species and document any new discoveries.

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- Author: M. Mancuso
Updated: 96-04-29 Produced by The Nature Conservancy, the Natural Heritage Network, and the Idaho Conservation Data Center.



***Cuscuta denticulata*
Engelm.—desert dodder,
sepal-toothed dodder**

Cuscutaceae (Dodder family)

General Description—A rootless, leafless, twining, non-green, parasitic herb with slender, pale yellow stems that grows on various desert shrubs. Flowers are white, sessile or subsessile, single and scattered, or congested into small clusters. The corolla is 5-merous, with lobes about 1.5 mm long, rounded at the apex and irregularly finely toothed. The non-fleshy calyx has deeply divided lobes that are more or less circular in outline. They have irregularly finely-toothed margins, and become shiny-translucent and finely lined when dry. The stamens are shorter than the corolla lobes and have anthers about equaling the filaments. Scales between the stamens are well developed and finely toothed. The styles are capitate. Capsules are narrowly pear-shaped, usually one-seeded, and have a crested thickening around the base of the style.

Field Identification Tips—The genus *Cuscuta* is readily recognized by its rootless, twining, non-green habit. Field identification to species is difficult due to the small size of the flowers. Features of the stigma, stamens

and scales between the stamens are key to identifying species of *Cuscuta*.

Phenology—Flowers from July through August.

Similar Species—Dodders known to occur in eastern Idaho include *Cuscuta indecora* (bigseed alfalfa dodder), *C. californica* (chaparral dodder), *C. pentagona* (five-angled dodder), *C. approximata* (alfalfa dodder), and perhaps others. All resemble desert dodder at first glance, and most occur on a wide range of hosts.

Habitat—Occurs on various desert shrubs, especially *Artemisia* spp. and *Chrysothamnus* spp.

Global Distribution—California to Nevada, Arizona, and Baja California; with disjunct populations known from Washington and Idaho.

Idaho Distribution—Known from Hells Canyon in Idaho County and the Birch Creek Valley in Clark County. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/cusden_dis.cfm.)

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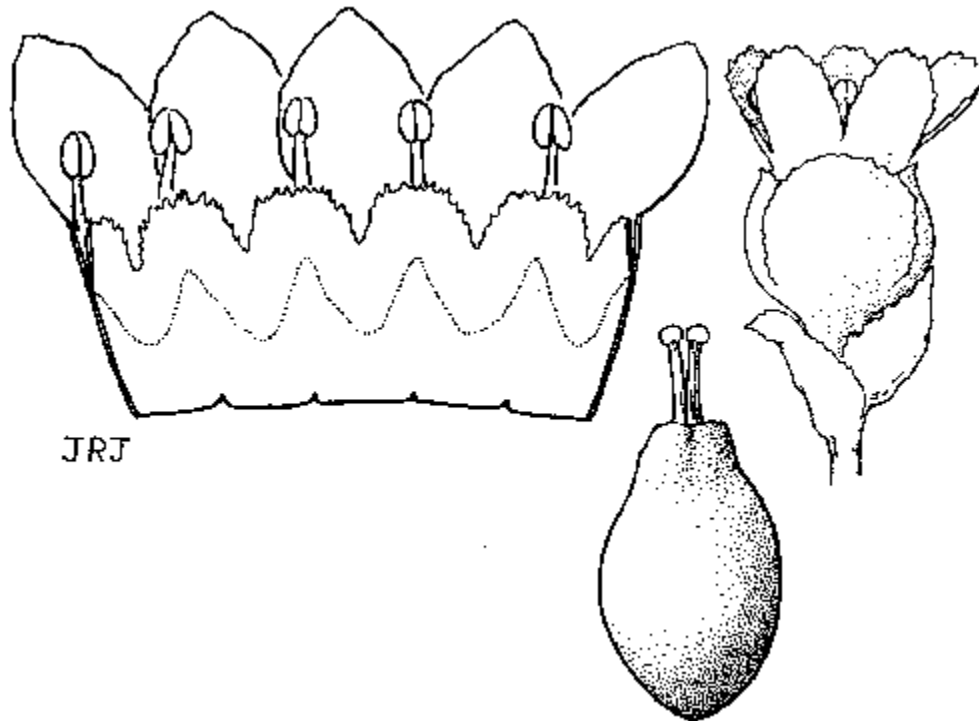
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Photo © Florence Caplow, WANHP
Cuscuta denticulata
desert dodder, sepal-toothed dodder



Cuscuta denticulata
desert dodder, sepal-toothed dodder

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1959. Vascular plants of the Pacific Northwest. Part 4. University of Washington Press, Seattle. 510 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

***Epipactis gigantea* Douglas ex Hook.—Giant helleborine**

Orchidaceae (Orchid family)

General Description—A leafy, glabrous, perennial herb up to 1.5 m tall, with 1 to several stems from a creeping rhizome. Leaves are numerous, alternate, sessile, and 5–20 cm long. The lower are oval, but the leaves become more lance-shaped further up the stem. Flowers are rather showy and borne singly in a long, narrow, open, mostly one-sided, leafy-bracted inflorescence at the top of the stem. Sepals and upper petals are 1.3–1.7 cm long, greenish-yellow or brownish in color

with purple veins. The lip petal is 1.5–2 cm long, greenish with purple veins, and divided into 3 unequal segments. The fruit is an elliptic, drooping capsule 2–2.5 cm long.

Field Identification Tips—A relatively large stature, numerous long clasping leaves, large brownish flowers, and drooping fruits combine to make giant helleborine a distinctive species.

Phenology—Flowers June to August.

Similar Species—Vegetative plants may be confused with some members of the orchid genus *Platanthera*, or more likely with *Maianthemum stellatum*, in the lily family, species that can co-occur with giant

helleborine. The prominently clasping leaf bases and taller habit of giant helleborine distinguishes it from *Maianthemum*, and its generally more numerous and larger leaves and taller habit from *Platanthera*.

Habitat—In general, giant helleborine occurs in moist areas along streambanks, lake margins, seeps and springs. In Idaho it is associated with thermal waters at higher elevations, or cold springs at lower elevations such as along the Snake River.

Global Distribution—From central Mexico northward to Texas and throughout the western United States to southern British Columbia.

Idaho Distribution—Widespread in Idaho: Bonner, Boundary, and Nez Perce counties in northern Idaho; Idaho, Adams, Valley, Boise, Custer, and Lemhi counties in central Idaho; Elmore, Camas, Gooding, Jerome, Twin Falls, and Owyhee counties in southern Idaho; and Clark and Madison counties in the eastern part of the state. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/epigig_dis.cfm.)

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Epipactis gigantea
giant helleborine

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1969. Vascular plants of the Pacific Northwest. Part 1. University of Washington Press, Seattle. 914 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.



Photo © Robert K. Moseley
Epipactis gigantea
 giant helleborine

***Eriogonum capistratum* Rev.
 var. *welshii* Rev.—
 Welsh's buckwheat**

Polygonaceae (Buckwheat family)

General Description—A low, mat-forming, perennial with blue-green colored foliage. Leaves are covered with dense, soft, white, wooly hairs. They are non-glandular, elliptic to spoon-like in shape, and 5–12 mm long on petioles 4–9 mm long. Flowering stems are leafless, 2–10 cm long, and covered with

dense, sometimes tangled, long, wooly hairs. The tight, ball-like inflorescence terminating the flowering stem is subtended by a bell-shaped, 5–7-toothed involucre covered with sparse to dense soft, wooly hairs. Flowers are golden-yellow, without hairs, 2–3 mm long, have a greenish to reddish-brown mid-rib, and become rosy-yellow upon maturity.

Field Identification Tips—Welsh's buckwheat is distinguished by its low, matted habit, bluish-green leaves covered by white tomentum, and head-like inflorescence of

yellow to golden flowers on densely hairy flowering stems.

Phenology—Flowering peaks in late June to early July most years.

Similar Species—*Eriogonum mancum* (imperfect buckwheat) can be readily distinguished by its cream to pinkish colored tepals when flowers are present. Without flowers it is distinguished by leaves having grayish wooly hairs, versus the white wooly tomentum of Welsh's buckwheat. However, this feature is not always easy to distinguish in the field. Care must be taken to distinguish *E. verrucosum* (graceful buckwheat) on volcanic substrates near the northern edge of Welsh's buckwheat range. *Eriogonum verrucosum* is identified by glabrous to only thinly hairy flowering stems and pustulose (with tiny blisters) flowers. In some areas, individuals of Welsh's buckwheat seem to have intermediate characteristics and intergrade with related species known from east-central Idaho. *Eriogonum capistratum* var. *capistratum* (hidden buckwheat) has glabrous or glandular flowering stems, but they are not covered with white, wooly hairs.

Habitat—Primarily on dry, windswept, sparsely vegetated sites characterized by

shallow, clay-rich soils. It is found on either calcareous (mainly limestone) or Challis Volcanics substrates, generally on convex-shaped, gently sloping (but sometimes flat or steeper) sites. Occurrences are known from between approximately 6,000 to 7,800 feet elevation. Welsh's buckwheat ranges from valley bottom alluvial fans and benches to foothill ridges and bluffs of the surrounding mountains.

Global Distribution—Endemic to east-central Idaho.

Idaho Distribution—Endemic to the valleys and foothills of the upper Big Lost, Little Lost, and Pahsimeroi rivers, and immediate vicinity, in Custer and adjacent portions of Lemhi and Butte counties in east-central Idaho. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/ericap_dis.cfm.)

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Photo © Chris Murphy
Eriogonum capistratum welshii
 Welsh's buckwheat

***Eriophorum viridicarinatum*
 (Engelm.) Fern—green
 keeled cotton-grass**

Cyperaceae (Sedge family)

General Description—Stems widely spaced from an extensive creeping rhizome, from 20 to 60(90) cm tall. The long, largely flat, sheathing basal and stem leaf blades are 2–6 mm wide. The stem is terminated by 2–8, somewhat nodding spikelets borne in an umbel-like inflorescence. Scales are blackish-green with a prominent pale midrib that reaches the tip of the scale. Numerous prominent, white perianth bristles greatly exceed the scales and achenes and give the appearance of a cotton ball attached to the top of the plant.

Field Identification Tips—The cotton-grasses are characterized by the long, whitish,

cottony perianth bristles that completely obscure the flower scales, bracts, and fruits. *Eriophorum viridicarinatum* often forms large colonies from creeping rhizomes.

Phenology—Flowers June through July.

Similar Species—*Eriophorum viridicarinatum* closely resembles *E. polystachion*, but has scales that are consistently blackish-green with a well-developed, notably paler midrib that tends to be expanded distally and reaches to the tip of the scale. *Eriophorum polystachion* has tawny to brownish or blackish-green scales with a slender midrib that is attenuated and does not reach the tip of the scale.

Habitat—Bogs, peatlands, and wet meadows.

Global Distribution—From Newfoundland to Alaska, south to New York, Michigan,

Colorado, Wyoming, Washington, Idaho, and Montana.

Idaho Distribution—Boundary and Bonner counties in the Panhandle region, and Valley, Fremont, and Teton counties to the south and east. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/erivir_dis.cfm.)

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Eriophorum viridicarinum
green keeled cotton-grass

Hitchcock, C.L., A. Cronquist, and M. Ownbey. 1969. Vascular plants of the Pacific Northwest. Part 1. University of Washington Press, Seattle. 914 pp. Reprinted by permission of the University of Washington Press.



Photo © Robert Bursik
Eriophorum viridicarinatum
 green keeled cotton-grass

***Ipomopsis polycladon* (Torr.)
 V. Grant—spreading
 ipomopsis,
 manybranched
 ipomopsis**

Polemoniaceae (Phlox family)

Synonym—*Gilia polycladon* Torr.
 (Spreading gilia)

General Description—A taprooted annual up to about 15 cm tall with several slender, rigid, ascending-spreading (not prostrate) branches

from the base. The herbage is glandular and hairy, with the stems more glandular, the leaves more hairy. Leaves are clustered at the base and again just below the flower heads, otherwise the stems are leafless or nearly so. Basal leaves are 1–3 cm long and have a few lobes or teeth. Those subtending the flower heads are similar or smaller and less cleft. The inflorescence is a dense cluster of small, white flowers terminating the branches. Corollas are 3–6 mm long and have small spreading lobes, while the calyx is 2–6 mm long and pointy-tipped.

Field Identification Tips—Spreading ipomopsis is recognized by its slender, stiff,

divaricate, subnaked, ascending-spreading stems branching from the base, and terminal, leafy-bracted flower heads. Additional characteristics include the lobed or toothed basal cluster of leaves, the glandular and hairy herbage, and dense head of small white flowers.

Phenology—Flowers April through June.

Similar Species—A few other desert annuals such as *Gilia leptomeria*, *Phacelia glandulifera*, or *Navarretia* spp. can look superficially similar.

Habitat—Dry, open areas in desert shrub communities. In southwestern Idaho, spreading ipomopsis occurs in *Artemisia tridentata* ssp. *wyomingensis* and desert shrub communities. It occurs on silt, sand, and clay soils, or on cindery or gravelly exposures that tend to be flat to gently sloping. Associated species include *A. tridentata* ssp. *wyomingensis*, *Atriplex confertifolia*, *Chrysothamnus* spp., *Tetradymia glabrata*, *Grayia spinosa*, *Achnatherum hymenoides*, *Bromus tectorum*, *Stanleya pinnata*, *Mentzelia albicaulis*, and *Phlox* spp. In eastern Idaho, spreading ipomopsis is usually associated with rocky *Artemisia nova* slopes on volcanic substrates. Associated species at

eastern Idaho sites include *A. nova*, *Leymus salinus*, and *Pseudoroegneria spicata*.

Global Distribution—Mexico, northward to California, west Texas, New Mexico, Arizona, western Colorado and Wyoming, most of Utah and Nevada, southern Idaho and adjacent Oregon.

Idaho Distribution—Populations are known from Ada, Elmore, and Owyhee counties in southwestern Idaho, and Butte and Power counties in the eastern part of the state. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/ipopol_dis.cfm.)

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Photo © Duane Atwood
Ipomopsis polycladon
spreading ipomopsis, manybranched ipomopsis



Ipomopsis polycladon
spreading ipomopsis, manybranched ipomopsis

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1959. Vascular plants of the Pacific Northwest. Part 4. University of Washington Press, Seattle. 510 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

***Muhlenbergia racemosa* (Michx.) Britton, Sterns, & Puggenb.—green muhly**

Poaceae (Grass family)

General Description—A stiffly erect perennial grass, 25–100 cm tall, from long, creeping, scaly rhizomes. The flat leaf blades are more or less evenly distributed along the culm and 5–15 cm long by 2–7 mm broad. Internodes are glabrous. The membranous ligules are up to about 1.5 mm long. The inflorescence is a narrow, spike-like panicle 4–17 cm long with densely clustered, light green, 1-flowered spikelets. The subequal glumes are 3–7 mm long and taper into a short awn. Lemmas are 2–4 mm long, pubescent along the lower half, and either awnless or with a short awn tip. Anthers are small, up to 0.8 mm long.

Field Identification Tips—The relatively tall, rhizomatous habit, spike-like inflorescence, 1-flowered, light green-colored spikelets, and short-awned glumes are useful field characteristics. Positive identification requires using a technical key and measuring technical morphological characteristics.

Phenology—Flowers July to September.

Similar Species—Several perennial *Muhlenbergia* species with spike-like inflorescences that occur in moist habitats could be confused with *M. racemosa*. *Muhlenbergia glomerata* (marsh muhly) closely resembles *M. racemosa*, and the two have been merged in some treatments. *Muhlenbergia glomerata* differs in its finely puberulent internodes, shorter ligules (0.2–0.6

mm), and slightly longer anthers (about 1 mm long). In addition, *M. glomerata* typically occupies wetter habitats such as streambanks, wet meadows, and lakeshores. *Muhlenbergia andina* (foxtail muhly) differs in a number of technical characters. The easiest one to see in the field is the dense, silky callus hairs about as long as the lemma. *Muhlenbergia mexicana* (Mexican muhly) has puberulent internodes, shorter glumes (up to about 3.5 mm long), and slightly spreading branches in the inflorescence.

Habitat—Drying meadows, rocky slopes, along irrigation ditches, and often in cultivated and other disturbed sites.

Global Distribution—Alberta to Ontario, south throughout much of the United States, except for the southeast and parts of the northeast. Uncommon in the Intermountain Region.

Idaho Distribution—The disposition of several Idaho populations is unresolved. Reports of this species are known from Bonner and Boundary counties in northern Idaho, and Bannock, Caribou, Fremont, and Teton counties in the eastern part of the state. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/muhrac_dis.cfm.)

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Muhlenbergia racemosa
green muhly

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1969. Vascular plants of the Pacific Northwest. Part 1. University of Washington Press, Seattle. 914 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

***Oenothera psammophila*
Nels. & Macbr.—St.
Anthony evening-
primrose, St. Anthony
sand-lily**

Onagraceae (Evening-primrose family)

Synonyms—*Oenothera caespitosa* Nutt. var. *psammophila* (Nels. & Macbr.) Munz

General Description—A glabrous, herbaceous perennial from a thick taproot 10–30 cm tall. Stems can become woody and buried in the drifting sand and give rise to numerous branches that then emerge from the sand. The multiple stems and branches can give plants a clumped or bunchy appearance spreading up to about 60 cm wide. Leaves are

usually 7–15 cm long and 1–3 cm wide, reverse lance-shaped, and entire or with wavy teeth along the margins. Flowers are borne singly in the leaf axils. Petals are bi-lobed at the summit, 2.5–4.5 cm long, and white, but turn pink or reddish-purple with age. The sepals are reflexed and 2–3 cm long, while the floral tube is 4–6 cm long. The sessile, ascending or erect fruit capsules are cylindric in outline, strongly angled, 3–5 cm long, and become rather woody at maturity, with the open capsules sometimes remaining attached to the stem throughout the winter.

Field Identification Tips—St. Anthony evening-primrose is recognized by its clumped, hairless habit, large white flowers that fade pinkish to reddish, and sessile capsules twisted and curved near the top that lack distinctive rows of warty projections. The distinctive sandy, inter-dunal habitat is also a good tip.

Phenology—Flowers June and July.

Similar Species—St. Anthony evening-primrose is most likely to be confused with one of the varieties of *Oenothera caespitosa* (evening-primrose) that occur in the St. Anthony area. *Oenothera caespitosa* var. *marginata* has straight capsules on short pedicels with distinctive wart-like projections in ridges or rows. In addition, plants are usually obviously hairy, with more deeply toothed leaves, and floral tubes usually over 7 cm long. *Oenothera caespitosa* var. *caespitosa* is often (but not always) shortly pubescent to one degree or another, and has leaves all in a basal cluster. It also has fruit capsules that are not twisted and only slightly curved at the top. *Oenothera pallida* (pale evening-primrose) is a rhizomatous perennial that sometimes co-occurs with St. Anthony

evening-primrose. It generally has a more erect habit, poorly developed or no basal leaves, usually smaller flowers, and more or less spreading, sometimes rather contorted fruit capsules.

Habitat—The trailing margins of migrating sand dunes in inter-dunal areas having sand-filled cracks over basalt outcrops and developing primary plant communities. St. Anthony evening-primrose is apparently limited to areas where the sand is less than approximately 50 cm deep. Associated species include *Leymus flavescens*, *Achnatherum hymenoides*, *Psoralea lanceolata*, *Ipomopsis congesta*, *Oenothera pallida*, and *Lygodesmia juncea*. Plants do not occur on the bodies of sand dunes, nor in surrounding sagebrush-steppe habitats.

Global Distribution—Endemic to the St. Anthony Sand Dune complex in eastern Idaho.

Idaho Distribution—The St. Anthony Sand Dune complex in southwestern Fremont County. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/oenpsa_dis.cfm.)

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U.S. Fish and Wildlife Service Photo
Oenothera psammophila
St. Anthony evening primrose; St. Anthony sand-lily



Oenothera psammophila

St. Anthony evening primrose; St. Anthony sand-lily

Illustration by Robin A. Jess. Reprinted with permission from Intermountain Flora: Vascular plants of the Intermountain West, U.S.A., by A. Cronquist, N.H. Holmgren, and P.K. Holmgren, Vol. 3A Subclass Rosidae (except Fabales), p. 211, copyright 1997, The New York Botanical Garden.

***Piptatherum micranthum*
(Trin. & Rupr.)
Barkworth—small-
flowered ricegrass**

Poaceae (Grass family)

Synonym—*Oryzopsis micrantha* (Trin. & Rupr.) Thurb.

General Description—A strongly tufted perennial grass 30–70 cm tall. Leaf blades are flat or slightly inrolled, 1–2 mm wide, while sheaths are open and smooth to slightly pubescent with fine, short hairs. Ligules are small, up to about 1 mm long and finely hairy along the edges. The inflorescence is a narrow

panicle 7–15 cm long having short, ascending or slightly spreading branches. Glumes are equal, papery, transparent, sharply pointed, and about 3–4 mm long. Lemmas are hairless or occasionally have fine hairs and have a straight, stiff awn 4–8 mm long. They are also shiny and become hard and brownish in color. The callus is also hairless. Anthers are about 1 mm long.

Field Identification Tips—Small-flowered ricegrass is recognized by its tufted habit, thin leaves, narrow panicle with ascending or slightly spreading branches, glabrous callus, and lemmas becoming shiny, brownish, and hardened as they mature and having a straight, relatively long awn.

Phenology—Flowers June to early August.

Similar Species—Small-flowered ricegrass could be confused with *Piptatherum exiguum* (*Oryzopsis exigua*). This species differs in its spike-like, appressed inflorescence and obviously bent awn of the lemma. Some species of *Achnatherum* (*Stipa* in part) can also look similar, but differ in having lemmas with longer (usually >15 mm), often bent, and sometimes pubescent awns, and a hairy callus.

Habitat—Dry, open, often sandy soil or rocky ridge areas from the sagebrush foothills to open forests at middle elevations. The known Idaho population occurs in cracks and on ledges in a limestone cliff alcove. It has no associates at this site.

Global Distribution—British Columbia to Saskatchewan, south to eastern California and Texas.

Idaho Distribution—Known from the Birch Creek Valley south of Blue Dome in Clark County. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/pipmic_dis.cfm.)

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Photo © Robert K. Moseley
Piptatherum micranthum
small-flowered ricegrass



Piptatherum micranthum
small-flowered ricegrass

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1969. Vascular plants of the Pacific Northwest. Part 1. University of Washington Press, Seattle. 914 pp. Illustration by Jeanne Janish. Reprinted with permission of the University of Washington Press.

***Primula alcalina* A. Cholewa
& D. Henderson—Alkali
primrose**

Primulaceae (Primrose family)

General Description—A perennial herb from a flat basal rosette of light green, crinkly leaves, each 1–4 cm long. Young leaves have a white mealy coating that disappears as the leaves age. The leaf blades are elliptic and

gradually narrow at the base to a winged petiole. Flowering stems are leafless and range between 5–30 cm tall. The inflorescence is a tight cluster of 3–10 erect flowers terminating the leafless stem. Flowers are white with a yellow center; the petals fused into a tube for their lower half, then flaring into 5 lobes, each about 1 cm long and clearly notched at the apex. The calyx is bell-shaped, with a somewhat white mealy coating. The involucre bracts at the base of

the inflorescence also have a somewhat white mealy coating.

Field Identification Tips—Alkali primrose is distinguished by its tight rosette of crinkly leaves, and solitary, leafless flower stalk usually around 15 cm tall terminated by a tight umbel of white flowers. The white mealy bloom covering young leaves is absent from older, mature leaves.

Phenology—Flowers in May and early June. Fruits develop through June, July, and August. The basal rosettes, with their distinctive wavy leaves remain green at least until the end of August. The leaves and flowering stem enlarge over the growing season, and by the time the capsules are ripe, may be several times their length compared to when first flowering.

Similar Species—*Primula incana* (Jones' primrose) is a widespread species rare in Idaho. It occurs in wetland habitats, but differs from alkali primrose in having lavender-colored flowers and mature leaves covered with a white, mealy powder. There are also technical differences in the flowers to distinguish the occasional white (albino) Jones' primrose plant that may be found. Other *Primula* species known for Idaho do not occur in wet, alkaline meadow habitats. The basal rosettes of alkali primrose and another member of the primrose family, *Dodecatheon pulchellum* (few-flowered shooting star), are similar in size and shape. However, the *Dodecatheon* leaves are not white-mealy at any stage, nor do they have crenulate margins.

Habitat—Alkali primrose occurs in wet, spring-fed, alkaline, intermontane valley meadow systems. The alluvial soils are fine-textured, light-colored, and derived from predominantly calcareous outwash. Plants occur in the lowest topographic position in the meadows, where the subirrigated soil is

saturated throughout the growing season. Plants are found on low, relatively level benches immediately adjacent to creeks and spring heads, as well as on low benches with hummocky microtopography, where plants are restricted to the tops and sides of the hummocks. Alkali primrose is not known from creeks having large seasonal or annual flows, or channel scouring from floods. Graminoids dominate the wet meadow habitats supporting alkali primrose, including *Eleocharis pauciflora*, *Carex scirpoidea*, *C. simulata*, *Kobresia simpliciuscula*, and *Juncus balticus*. Associated forbs are diverse, but have relatively low cover, and include *Dodecatheon pulchellum*, *Triglochin maritimum*, and *Thalictrum alpinum*. Hummocks are sometimes shared with shrubs such as *Betula glandulosa*, *Potentilla fruticosa*, and several *Salix* species.

Global Distribution—Narrowly endemic to east-central Idaho and immediately adjacent southwestern Montana.

Idaho Distribution—Known from a series of wet, spring-fed, alkaline meadows in the large intermontane valleys of east-central Idaho, in Lemhi, Butte, and Custer counties. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/prialc_dis.cfm).

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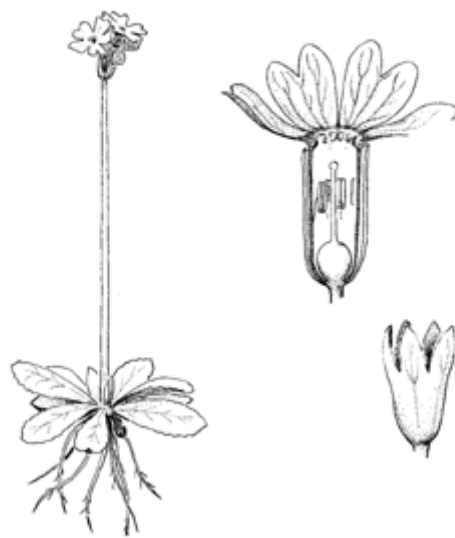
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species from Idaho. *Brittonia* 36(1): 59–62.
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Photo © Robert K. Moseley
Primula alcalina (alkali primrose) habitat



Primula alcalina
alkali primrose

***Rhynchospora alba* (L.) Vahl—white beakrush**

Cyperaceae (Sedge family)

General Description—A grass-like perennial, 15–50 cm tall that grows in densely tufted clumps. The thin stems are triangular and solid. It has several leaves, the lowest often more or less reduced to scales, the others slender and no more than about 1 mm wide. The inflorescence has 1–3 compact head-like clusters that are whitish in appearance, especially at anthesis. They are mostly 5–15 mm wide, with the terminal cluster of spikelets larger than the others. Achenes are 1.5–2 mm long and capped by an elongate, narrow tubercle. They are subtended by 10–12 well developed, minutely barbellate perianth bristles.

Field Identification Tips—The inflorescence's whitish appearance is a good field character.

Phenology—Flowers in July-August.

Similar Species—The whitish, head-like inflorescence, fruits with bristles, and the lack of a perigynia distinguish *R. alba* from all sedge (*Carex*) species.

Habitat—Bogs, fens, and other very wet places at moderate and low elevations.

Global Distribution—Interruptedly circumboreal, but not at the highest latitudes. In North America it ranges from

Newfoundland to North Carolina, inland to the Great Lakes region. The range is continuous across southern Canada to the Pacific, where it occurs from the Alaskan panhandle to central California. It is chiefly found west of the Cascade-Sierran summits, but also inland in northern Idaho.

Idaho Distribution—Boundary, Bonner, and Kootenai counties in the Panhandle region, and at Warm Lake in central Valley County. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/rhyalb_dis.cfm.)

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Photo © Robert Moseley
Rhynchospora alba
white beakrush



Rhynchospora alba
white beakrush

Hitchcock, C.L., A. Cronquist, and M. Ownbey. 1969. Vascular plants of the Pacific Northwest. Part 1. University of Washington Press, Seattle. 914 pp. Illustration by Jeanne Janish. Reprinted by permission of the University of Washington Press.

Salix candida* Fluegge ex Willd.—hoary willow*Salicaceae (Willow family)**

General Description—A freely-branched, low- to medium-sized shrub, 0.2–1.5 m tall. Twigs of the season are thinly to moderately tomentose on early season growth, becoming very dense on late season growth. Some of the pubescence usually persists into the second year. Leaves are mostly oblanceolate to narrowly oblong, the larger ones about 5–8 cm long and 0.7–1.5 cm wide, and with entire and inrolled margins. The lower leaf surfaces are covered with a dense, white, felt-like tomentum comprised of fine, tangled hairs; the upper surface glabrous or only thinly pubescent. The catkins are nearly sessile, the staminate ones about 1–2 cm long, and the pistillate ones mostly 1–3 cm long. The ovaries and capsules are pubescent and borne on short stipes. The persistent floral bracts are pale to dark brown.

Field Identification Tips—Readily distinguished by its relatively short stature and dense, white, felt-like tomentum on the lower leaf surfaces and twigs.

Phenology—Flowers in May–June. Its distinguishing vegetative characters allow this species to be identified throughout the summer.

Similar Species—*Salix brachycarpa* which is similar in stature, floral morphology, and habitat can resemble *S. candida*, especially early in the season. However, *S. candida* has notably longer and narrower leaves that are more densely wooly-white beneath and have revolute margins. *Salix wolfii* has shorter leaves with silvery, appressed hairs on both top and bottom surfaces.

Habitat—Bogs, fens, marshes, pond edges, and seepage areas.

Global Distribution—From Alaska to Labrador, south to New Jersey, Iowa, North and South Dakota, Washington, Idaho, Montana, Wyoming, and Colorado.

Idaho Distribution—Boundary and Bonner counties in the Panhandle region, and Butte, Custer, Lemhi, Fremont, Teton, and Caribou counties in the east-central and eastern parts of the state. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/salcan_dis.cfm.)

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Photo © Robert Moseley
Salix candida
hoary willow



Salix candida
hoary willow

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1964. Vascular plants of the Pacific Northwest. Part 2. University of Washington Press, Seattle. 597 pp. Illustration by Jeanne Janish. Reprinted by permission of the University of Washington Press.

***Scheuchzeria palustris* L.— pod grass**

Scheuchzeriaceae (Scheuchzeria family)

General Description—Pod grass is a trailing, strongly rhizomatous rush-like plant, 20–40 cm tall. Each erect stem has 3 or 4 linear, stiff, alternate leaves that are gradually reduced upward and arranged in a 2-ranked

fashion. Leaves are round in cross-section, and broadly sheathing at the base with a prominent ligule 2–10 mm long at the juncture of the sheath and blade. The inflorescence is a few-to several-flowered raceme. The obscure flowers produce three compressed fruits arranged in a spreading, triangular cluster.

Illustration—See

http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/schpal_illus.cfm.

Field Identification Tips—The entire plant has a greenish-brown appearance. The broadly sheathing leaf bases and prominent ligule help distinguish this species.

Phenology—Flowers in May and June, but can be identified in the field throughout the summer.

Similar Species—Possible to confuse with sedge (*Carex*) or rush (*Juncus*) species until closer examination reveals many differences, most notably in the fruits. It could also be confused with an arrow-grass (*Triglochin*), which has mostly basal leaves and a different kind of fruit.

Habitat—In bogs, where it is usually associated with *Sphagnum*, or on lake margins, where often with *Carex* spp.

Global Distribution—Southern Alaska to Labrador and Newfoundland, south in British Columbia and Washington to northern California, and to Idaho, North Dakota, Indiana, Iowa, and New Jersey. It is also found in Eurasia.

Idaho Distribution—Known from Boundary, Bonner, and Kootenai counties in the Panhandle region. Also known from Valley County, and the Yellowstone National Park area. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/schpal_dis.cfm.)

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Photo © Joe Duft
Scheuchzeria palustris
pod grass



Scheuchzeria palustris
pod grass

Hitchcock, C.L., A. Cronquist, and M. Ownbey. 1969. Vascular plants of the Pacific Northwest. Part 1. University of Washington Press, Seattle. 914 pp. Illustration by Jeanne Janish. Reprinted by permission of the University of Washington Press.

***Scirpus rollandii* Fern.—
Rolland's bulrush, dwarf
bulrush, small clubrush**

Cyperaceae (Sedge family)

Synonyms—*Scirpus pumilus* Vahl.; *Scirpus pumilus* Vahl. ssp. *rollandii* (Fern.) Raymond; *Trichophorum rollandii* (Fern.) Hultn.; *Trichophorum pumilum* (Vahl.) Schinz & Thellung

General Description—A glabrous, grass-like perennial with loosely tufted, slender stems 5–12 cm tall and arising from slender rhizomes clothed in the remains of dead culms and persistent leaf bases. The leaves have slender blades 5–15 mm long and up to 1 mm broad above, but consist only of shorter sheaths near the base. The inflorescence is a small, solitary spikelet of 3–6 flowers borne on the stem tip and subtended by a brown, blunt-tipped bract. Each flower consists of a brown scale with thin, whitish margins

subtending 3 stamens and an ovary with 3 stigmas. The scales fall off as the ovaries mature into smooth, blackish achenes (fruits) 1-2 mm long.

Field Identification Tips—Rolland's bulrush can be recognized by its small, loosely tufted, slender, stems, small leaves, and minute, solitary, terminal spikelet. After the achenes mature plants look like a tiny stick with a few tiny black eggs glued on top. Rolland's bulrush is an inconspicuous plant easily overlooked in its graminoid-dominated habitat.

Phenology—Flowers July, August and early September.

Similar Species—Most *Scirpus* species in Idaho have more than one flowering spike, as well as one or more elongated bracts below the inflorescence. However, two species have small, solitary, terminal spikelets similar to Rolland's bulrush. *Scirpus caespitosus* is a larger plant that forms distinctive tussocks and in Idaho appears to be restricted to peatland habitats. *Scirpus hudsonianus* has triangular stems and conspicuous, elongated perianth bristles. In comparison, Rolland's bulrush has more rounded stems and no perianth bristles. *Eleocharis* species (spike-rushes) have solitary, terminal spikelets and can also look similar. They can be distinguished by lacking leaf blades and technical differences in the flower such as thickened style bases which appear as a cap-like feature on the achenes. *Kobresia simpliciuscula* has multiple terminal spikelets and is commonly taller and more leafy than Rolland's bulrush.

Habitat—Rich fens; wet calcareous soils. Associated species at Idaho populations include *Eleocharis pauciflora*, *Kobresia simpliciuscula*, *Deschampsia cespitosa*, *Triglochin maritima*, and *Primula alcalina*.

Global Distribution—Circumboreal; in North America extending from the Yukon to Quebec and southward to Montana, Idaho, Wyoming, Colorado, and in California.

Idaho Distribution—Known from the upper Little Lost River Valley in Custer County, and Birch Creek in Clark County. (See also http://fishandgame.idaho.gov/tech/CDC/spp_accounts_plants/scirol_dis.cfm.)

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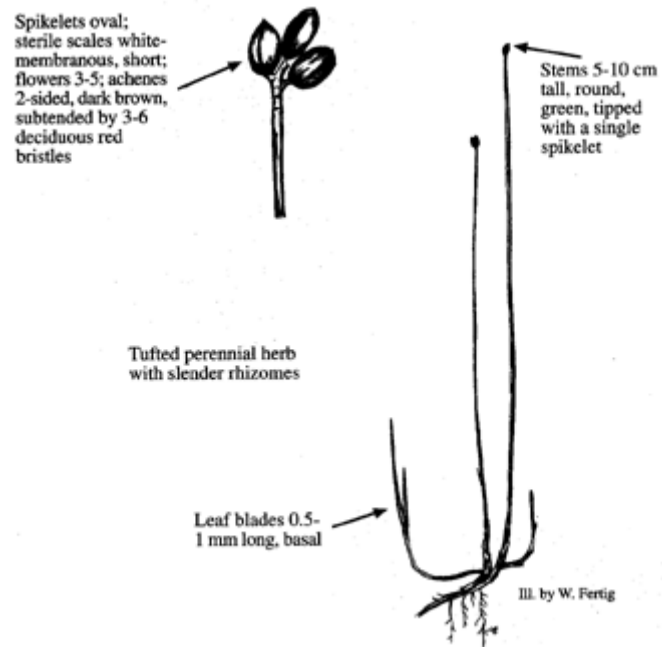
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Photo © Robert K. Moseley

Scirpus rollandii

Rolland's bulrush; dwarf bulrush; small clubrush



Scirpus rollandii

Rolland's bulrush; dwarf bulrush; small clubrush

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APPENDIX 1-4—DAMS WITHIN THE UPPER SNAKE PROVINCE.

Table 1. Inventory of Dams in the Upper Snake province. (Source: Idaho Department of Water Administration (IDWA). 1971. Inventory of Dams in the State of Idaho, August 1970. 97 pp.)

GHB= Greys–Hoback watershed; GVT= Gros Ventre watershed; PAL=Palisades watershed; SAL=Salt watershed; SHW=Snake Headwaters watershed; AMF=American Falls watershed; BFT=Blackfoot watershed; GSE=Goose watershed; IFA= Idaho Falls watershed; LHF=Lower Henrys Fork watershed; Portneuf watershed; RFT=Raft watershed; TET=Teton watershed; UHF=Upper Henrys Fork watershed; LWT=Lake Walcott watershed; WIL=Willow watershed; BCM=Beaver-Camas watershed; BCK=Birch Creek watershed; Big Lost River watershed; Little Lost River watershed; Medicine Lodge watershed.

Purpose: A=aesthetics; B=mining; C=commercial; D=domestic; E=erosion control; E=erosion control; F=flood control; G=wildlife propagation; H=fish propagation; I=irrigation; J=stock water and irrigation; K=domestic and stock and irrigation; L=domestic and irrigation; M=municipal supply; N=industrial; O=other; P=power; Q=fire protection; R=recreation; S=stock water; T=mine tailings. Auxdam.

Size Category: 1 = >40 feet or stores >4,000 acre-feet; 2 = 20-40 feet or stores 100-4,000 acre-feet; 3 = Height <20 feet or stores <100 acre-feet.

BASIN	State	HUC ABB	Dam Name	Fed Agency	Owner Name	Size Category	Purposes	Year Completed	River or Stream	Max. Storage	Normal Storage	Storage-Max or*	Normal	Surface Area
UpMidS UpSn	ID	USR	Milner		Milner Dam Inc	1	I	1905	Snake River	36300	0	36300		4000
UpMidS UpSn	ID	USR	Murtaugh Lake		Twin Falls Canal Co	1	I	1905	Snake River (Os)	7720	0	7720		827
UpMidS UpSn	ID	USR	Wilson Lake		North Side Canal Co	1	I	1909	Snake River (Os)	4600	0	4600		504
UpMidS UpSn	ID	USR	Shoshone Falls		Idaho Power Co	2	P	1927	Snake River	750	0	750		120
UpMidS UpSn	ID	USR	Twin Falls		Idaho Power Co	2	P	1935	Snake River	1000	0	1000		96
UpMidS UpSn	ID	USR	Dry Creek		Dry Creek Strong Ditch Inc	3	E	1975	Dry Creek (Os)	5	0	5		1

Upper Snake Provincial Assessment

BASIN	State	HUC ABB	Dam Name	Fed Agency	Owner Name	Size Category	Purposes	Year Completed	River or Stream	Max. Storage	Normal Storage	Storage-Max or*	Normal	Surface Area
UpSnake	ID	LHF	Grassy Lake	USBR		1	I	1939	Grassy Creek	16200	15500	16200		310
UpSnake	ID	LHF	Grassy Lake	USBR		1	I	1939	Grassy Creek	16200	15500	16200		310
UpSnake	ID	BFT	Conda Partnership		Nu-West Industries Inc	1	T	1978	Tr-Bear River (Os)	1250	0	1250		59
UpSnake	ID	AMF	American Falls	USBR	U.S. Bureau Of Reclamation	1	IFP	1978	Snake River	1671300	0	1671300		56055
UpSnake	ID	LHF	Ashton		PacifiCorp	1	P	1913	Henrys Fork	9800	0	9800		404
UpSnake	ID	BFT	Blackfoot		U.S. Bureau Of Indian Affairs	1	L	1911	Blackfoot River	350000	0	350000		18000
UpSnake	ID	AMF	Gem State		City Of Idaho Falls	1	IPR	1988	Snake River	5000	0	5000		305
UpSnake	ID	WIL	Grays Lake-Clarks Cut		U.S. Bureau Of Indian Affairs	1	AUXDAM	1988	Tr-Meadow Creek	0	0	0		27000
UpSnake	ID	WIL	Grays Lake-N End Outlet		U.S. Bureau Of Indian Affairs	1	IG	1924	Grays Lake Outlet	40000	0	40000		27000
UpSnake	ID	UHF	Henrys Lake		North Fork Reservoir Co	1	L	1923	Henrys Fork	58700	0	58700		6050
UpSnake	ID	UHF	Island Park	USBR	U.S. Bureau Of Reclamation	1	L	1938	Henrys Fork	127646	0	127646		7794
UpSnake	ID	LWT	Minidoka (Lake Walcott)	USBR	U.S. Bureau Of Reclamation	1	IP	1906	Snake River	210000	0	210000		11850
UpSnake	ID	GSE	Oakley		Oakley Canal Co	1	I	1916	Goose Creek	76000	0	76000		1350
UpSnake	ID	PTF	Portneuf		Portneuf-Marsh Valley Canal Co	1	L	1912	Portneuf River	23695	0	23695		1593
UpSnake	ID	WIL	Ririe	USBR	U.S. Bureau Of Reclamation	1	IF	1976	Willow Creek	100500	0	100500		1560
UpSnake	ID	RFT	Sublett		Sublett Irrigation Co	1	I	1914	Sublett Creek	2742	0	2742		113
UpSnake	ID	LHF	Bergman Lake			2	I	1953	Indian Creek	373	201	373		37
UpSnake	ID	LHF	Indian Lake			2	I	1954	Indian Lake Basin	2034	904	2034		252
UpSnake	ID	LHF	Arcadia Lower		Arcadia Canal And Reservoir Co.	2	I	1912	Sand Creek	882	0	882		68
UpSnake	ID	LHF	Arcadia Upper		Arcadia Canal And Reservoir Co	2	I	1912	Sand Creek (Control Inflow)	300	0	300		40

Upper Snake Provincial Assessment

BASIN	State	HUC ABB	Dam Name	Fed Agency	Owner Name	Size Category	Purposes	Year Completed	River or Stream	Max. Storage	Normal Storage	Storage-Max or*	Normal	Surface Area
UpSnake	ID	BFT	Blackfoot Equalizing		U.S. Bureau Of Indian Affairs	2	O	1937	Blackfoot River	1500	0	1500		640
UpSnake	ID	LHF	Blue Creek No 3		Idaho Fish And Game Department	2	H	1965	Blue Creek	168	0	168		39
UpSnake	ID	LHF	Blue Creek No 4		Idaho Fish And Game Department	2	H	1960	Blue Creek	390	0	390		78
UpSnake	ID	LHF	Cross Cut Diversion		Fremont-Madison Irrig Dist	2	I	1938	Henrys Fork	250	0	250		35
UpSnake	ID	LWT	Dewey		Skaggs 6S Ranch	2	I	1913	Marsh Creek	478	0	478		78
UpSnake	ID	WIL	Elkington		Elkington Brothers	2	I	1994	Squaw Creek	90	0	90		6
UpSnake	ID	UHF	Golden Lake		Idaho Dept Parks And Recreation	2	R	1915	Thurmon Creek	112	0	112		41
UpSnake	ID	WIL	Green Valley Ranch		Green Valley Ranch Inc	2	I	1986	Birch Creek	25	0	25		5
UpSnake	ID	PTF	Hawkins		Marsh Center Irrigation Co	2	I	1870	Hawkins Creek	880	0	880		54
UpSnake	ID	UHF	Icehouse Creek East		Brent Matsuura	2	H	1914	Icehouse Creek (Os)	200	0	200		64
UpSnake	ID	LWT	Lamb-Weston		Lamb-Weston Inc	2	N	1974	Tr-Snake River	153	0	153		15
UpSnake	ID	WIL	Little Valley		Gentile Valley Land & Cattle Co	2	J	1897	Little Valley Creek	1000	0	1000		265
UpSnake	ID	IFA	Power Dam No 1 Upper		City Of Idaho Falls	2	P	1982	Snake River	800	0	800		300
UpSnake	ID	IFA	Power Dam No 2 Upper		City Of Idaho Falls	2	AUXDAM	1982		0	0	0		300
UpSnake	ID	IFA	Power Dam No 3		City Of Idaho Falls	2	P	1982	Snake River	400	0	400		125
UpSnake	ID	IFA	Power Dam No 4 Lower		City Of Idaho Falls	2	P	1982	Snake River	800	0	800		125
UpSnake	ID	UHF	Sheridan		Mike Webster	2	J	1873	Sheridan, Dry Creeks (Os)	3398	0	3398		415

Upper Snake Provincial Assessment

BASIN	State	HUC ABB	Dam Name	Fed Agency	Owner Name	Size Category	Purposes	Year Completed	River or Stream	Max. Storage	Normal Storage	Storage-Max or*	Normal	Surface Area
UpSnake	ID	UHF	Silver Lake		Idaho Dept Parks And Recreation	2	R	1915	Thurmon Creek	340	0	340		135
UpSnake	ID	AMF	Simplot Effluent Irrig		J R Simplot Co	2	I	1981	Tr-Ft Hall Canal,Effluent	860	0	860		38
UpSnake	ID	PTF	Twenty Four Mile		Chesterfield Canal And Res Co	2	L	1928	Twenty Four Mile Creek	700	0	700		44
UpSnake	ID	AMF	Twin Buttes No 1		Idaho Department Of Lands	2	S	1974	Lava Draw	180	0	180		44
UpSnake	ID	BFT	Unit 3 Haulroad		Rhone-Poulenc Chemical	2	O	1979	Tr-Angus Creek	40	0	40		14
UpSnake	ID	LHF	Bergman Lake			2	I	1953	Indian Creek	373	201	373		37
UpSnake	ID	LHF	Indian Lake			2	I	1954	Indian Lake Basin	2034	904	2034		252
UpSnake	ID	BFT	Blackfoot China Hat		U.S. Bureau Of Indian Affairs	3	AUXDAM	1925		0	0	0		18000
UpSnake	ID	UHF	Egbert Dike		Kevin Egbert	3	AUXDAM	0		0	0	0		9
UpSnake	ID	UHF	Icehouse Creek West		Brent Matsuura	3	AUXDAM	0		0	0	0		64
UpSnake	ID	BFT	Angus Creek		Rhone-Poulenc Chemical	3	B	1972	Angus Creek	20	0	20		3
UpSnake	ID	TET	B And R Farms		B And R Farms	3	I	1982	Tr-Spring Creek	9	0	9		2
UpSnake	ID	LHF	Blue Creek No 1		Idaho Fish And Game Department	3	H	1977	Blue Creek	56	0	56		16
UpSnake	ID	LHF	Blue Creek No 2		Idaho Fish And Game Department	3	H	1969	Blue Creek (Os)	77	0	77		18
UpSnake	ID	LHF	Blue Creek Upper		Idaho Fish And Game Department	3	L	1920	Blue Creek	67	0	67		12
UpSnake	ID	LWT	Champagne Mine Det No 1		Idaho Gold Corp	3	B	1989	Champagne Creek (Os)	21	0	21		2
UpSnake	ID	LWT	Champagne Mine Det No 2		Idaho Gold Corp	3	B	1989	Champagne Creek (Os)	22	0	22		2
UpSnake	ID	UHF	Cherry		Frank Summers	3	I	1980	Blue Creek	93	0	93		19

Upper Snake Provincial Assessment

BASIN	State	HUC ABB	Dam Name	Fed Agency	Owner Name	Size Category	Purposes	Year Completed	River or Stream	Max. Storage	Normal Storage	Storage-Max or*	Normal	Surface Area
UpSnake	ID	UHF	Egbert		Kevin Egbert	3	I	1982	Spring Creek	68	0	68		9
UpSnake	ID	BFT	Enders		Olive Enders	3	L	1910	Cutoff Canyon Creek	60	0	60		25
UpSnake	ID	TET	Felt		Fall River Rural Electric Coop	3	P	1921	Teton River	40	0	40		10
UpSnake	ID	RFT	Gunnell		Lelan P Gunnell	3	I	1949	Six Mile Creek	15	0	15		2
UpSnake	ID	LWT	Hayes Lower		Bob Knudsen Jr	3	I	1964	Hess Spring Creek	19	0	19		2
UpSnake	ID	UHF	Henrys Fork Ranch		Henrys Fork Ranch	3	R	1987	Tr-Henrys Fork	90	0	90		10
UpSnake	ID	UHF	Howell Lower		Frank Vandersloot	3	I	1976	Strong Creek	25	0	25		6
UpSnake	ID	UHF	Howell Upper		Frank Vandersloot	3	IH	1962	Strong Creek	30	0	30		5
UpSnake	ID	BFT	Indian Creek Lower		Phil Yost	3	I	1977	Chicken Creek	15	0	15		4
UpSnake	ID	BFT	Indian Creek Upper		Phil Yost	3	I	1975	Chicken Creek	48	0	48		5
UpSnake	ID	UHF	Jacobs		F Mitchell Jacobs	3	HRS	1935	Sheep Creek	75	0	75		20
UpSnake	ID	LWT	J-Canal Reregulating		Craig Larson	3	0	1994	Tr-Snake River	42	0	42		8
UpSnake	ID	LWT	Lake Cleveland		Denaughel, Montgomery, Anderson	3	IR	1914	Land Creek	99	0	99		24
UpSnake	ID	PTF	Lava Ranch		Lava Ranch Property Owners Assn	3	SH	1960	Deer Creek	15	0	15		2
UpSnake	ID	LHF	Mikesell Lower		Glen Moon And Lynn Bowman	3	I	1940	Spring Creek	70	0	70		20
UpSnake	ID	LHF	Mikesell Upper		Glen Moon & Lynn Bowman	3	I	1945	Spring Creek	80	0	80		16
UpSnake	ID	UHF	Osborne Fish Pond		Idaho Dept Parks And Recreation	3	JG	1915	Tr-Henrys Fork	85	0	85		27
UpSnake	ID	PTF	Perkins		C V Cattle Co	3	I	1972	Tr-Portneuf River (Os)	99	0	99		26

Upper Snake Provincial Assessment

BASIN	State	HUC ABB	Dam Name	Fed Agency	Owner Name	Size Category	Purposes	Year Completed	River or Stream	Max. Storage	Normal Storage	Storage-Max or*	Normal	Surface Area
UpSnake	ID	RFT	Sessions		Jeff Sessions	3	I	1994	Round Mountain Creek	12	0	12		2
UpSnake	ID	LWT	Smyer East		Bennie Smyer	3	J	1988	Summit Creek	25	0	25		25
UpSnake	ID	LWT	Smyer West		Bennie Smyer	3	J	1989	Pine-Anton Creeks	15	0	15		4
UpSnake	ID	PTF	Thompson		Thayne Thompson	3	I	1958	Yago Creek (Os)	8	0	8		2
UpSnake	ID	LWT	Udy Brothers		Udy Brothers	3	I	1960	Tr-Rock Creek	10	0	10		2
UpSnake	ID	IFA	Webster (Leatham)		K Merle Jeppesen	3	I	1976	Lyons Creek	55	0	55		6
UpSnake	ID	RFT	Whitaker		Art Whitaker	3	S	1987	Eightmile Creek	8	0	8		2
UpSnake	ID	PTF	Wiregrass		Marsh Center Irrigation Co	3	I	1943	Wiregrass Creek	71	0	71		6
UpSnakeClo	ID	BLR	Mackay		Big Lost River Irrigation Dist	1	J	1918	Big Lost River	44500	0	44500		1341
UpSnakeClo	ID	LLR	Summit		Triple T Summit Ranch	2	I	1921	Pass And Big Gulch Creeks	600	0	600		100
UpSnake Closed	ID	BCM	Hagenbarth		David And James Hagenbarth	3	I	1986	Tr-Crooked Creek	60	0	60		8
UpSnake Closed	ID	BLR	Lehman Creek		Ronold Van Hagen	3	I	1925	Lehman Creek	54	0	54		6
UpSnake Closed	ID	BCM	Paul		Upper Snake River Cattle Assn	3	L	1911	East Modoc Creek	50	0	50		6
UpSnake HW	WY	SHW	Jackson Lake	USBR		1	ICRF	1911	Snake River	873000	847000	873000		25530
UpSnake HW	WY	SHW	Jackson Lake	USBR		1	ICRF	1911	Snake River	873000	847000	873000		25530
UpSnake HW	WY	SAL	Afton Electric	FSR		2	H	1938	Swift Creek	69	48	69		5

Upper Snake Provincial Assessment

BASIN	State	HUC ABB	Dam Name	Fed Agency	Owner Name	Size Category	Purposes	Year Completed	River or Stream	Max. Storage	Normal Storage	Storage-Max or*	Normal	Surface Area
UpSnake HW	WY	SAL	Cottonwood Lake	FSR		2	FI	1918	Cottonwood Creek	240	70	240		32
UpSnake HW	WY	SAL	Strawberry Creek	FSR		2	H	1951	Strawberry Creek	0	10	10	*normal	3
UpSnake HW	WY	SAL	Upper Swift Creek	FSR		2	H	1940	Swift Creek	0	22	22	*normal	2
UpSnake HW	WY	SAL	Afton Electric	FSR		3	H	1938	Swift Creek	69	48	69		5
UpSnake HW	WY	SAL	Cottonwood Lake	FSR		3	FI	1918	Cottonwood Creek	240	70	240		32
UpSnake HW	WY	SHW	Leidy Lake			3	F	1983	Leidy Creek	0	65	65	*normal	14
UpSnake HW	WY	SHW	Porter	FSR		3	IP	1951	Wallace Creek	62	52	62		7
UpSnake HW	WY	SAL	Strawberry Creek	FSR		3	H	1951	Strawberry Creek	0	10	10	*normal	3
UpSnake HW	WY	SAL	Teal	USDA		3	F	1992	Salt River	0	80	80	*normal	32
UpSnake HW	WY	SAL	Upper Swift Creek	FSR		3	H	1940	Swift Creek	22	22	22	*normal	2
UpSnake HW	WY	SHW	Leidy Lake			3	F	1983	Leidy Creek	0	65	65	*normal	14
UpSnake HW	WY	SHW	Porter	FSR		3	IP	1951	Wallace Creek	62	52	62		7
UpSnake HW	WY	SAL	Teal	USDA		3	F	1992	Salt River	0	80	80	*normal	32
UpSnake HW	ID	SAL	Smoky Canyon		J R Simplot Co	1	T	1983	Roberts Creek	2500	0	2500		83
UpSnake HW	ID	SAL	Smoky Canyon No 2		J R Simplot Co	1	T	1991	Tygee Creek	20450	0	20450		480
UpSnake HW	ID	PAL	Palisades	USBR	U.S. Bureau Of Reclamation	1	IFP	1957	Snake River	1401000	0	1401000		16150

Upper Snake Provincial Assessment

BASIN	State	HUC ABB	Dam Name	Fed Agency	Owner Name	Size Category	Purposes	Year Completed	River or Stream	Max. Storage	Normal Storage	Storage-Max or*	Normal	Surface Area
UpSnake HW	WY	GHB	Flat Creek Ranch			2	F	1967	Flat Creek	0	151	151	*normal	46
UpSnake HW	WY	GHB	Jackson Wastewater Treatment Plant			2	DO	1980	Snake River Offstream	0	260	260	*normal	20
UpSnake HW	WY	SHW	Tracy Lake	FSR		2	R	1928	Randolph Creek	646	420	646		47
UpSnake HW	WY	SHW	Uhl	NPS		2	IF	1948	Spread Creek	756	423	756		83
UpSnake HW	WY	GHB	Jackson Wastewater Treatment Plant			2	DO	1980	Snake River Offstream	0	260	260	*normal	20
UpSnake HW	WY	SHW	Tracy Lake	FSR		2	R	1928	Randolph Creek	646	420	646		47
UpSnake HW	WY	SHW	Uhl	NPS		2	IF	1948	Spread Creek	756	423	756		83
UpSnake HW	ID	PAL	Antelope Creek		Foster Land And Cattle Co	3	I	1991	Antelope Creek	40	0	40		10
UpSnake HW	ID	SAL	Clark		Ross Clark	3	H	1983	Tr-Crow Creek	20	0	20		2
UpSnake HW	ID	SAL	Clark Middle		Ross Clark	3	H	1960	Tr-Crow Creek	10	0	10		1
UpSnake HW	ID	SAL	Clark Upper		Ross Clark	3	H	1990	Tr-Crow Creek	7	0	7		1
UpSnake HW	ID	SAL	Stewart Ranch		Stewart Bros Crow Creek Ranch	3	IR	1965	Tr-Crow Creek	50	0	50		10
UpSnake HW	WY	GHB	Flat Creek Ranch			3	F	1967	Flat Creek	0	151	151	*normal	46

APPENDIX 1-5—WATER QUALITY LIMITED STREAMS WITHIN THE UPPER SNAKE PROVINCE

Table 1. Idaho's 1998 303(d) list. This list is required by the Clean Water Act, where States are required to submit this list to the U.S. Environmental Protection Agency. The list represents a comprehensive status of water quality in the Upper Snake province. Streams, rivers, lakes and reservoirs are evaluated for this list. HUC=Hydrologic Unit Code; WQLSEG=Water Quality Limited Segment Number; BACT=Bacteria; CO=Dissolved Oxygen; FLOWAL=Flow alteration ; HABALT=Habitat alteration MET=Metals (Hg); NH3=Ammonia; NUTR=nutrients; O-G=Oil or gas; ORG=Organic; PEST=Pesticides; SAL=Salinity; SED=Sediment; TEMP=Temperature; UNKN=Unknown.

Basin	HUC	Name	TMDL Schedule	Length (m)	Status	Threat	BACT	DO	FLOWAL	HABALT	MET	NH3	NUTR	O_G	ORG	PEST	SAL	SED	TEMP	UNKN
Upper Snake Subbasin																			Total Length (m) 2,319,998	
UpSnake	USR	Dry Creek	1999	16389	Current 303(d)		X		X									X	X	
UpSnake	USR	Milner Lake	1999	3991	Current 303(d)			X	X				X	X				X		
UpSnake	USR	Shoshone Falls Reservoir	1999	4054	Current 303(d)			X	X									X		
UpSnake	USR	Snake River	1999	32483	Current 303(d)		X	X	X			X						X	X	
UpSnake	USR	West Fork Dry Creek	1999	10042	Current 303(d)		X	X	X				X					X		
UpSnake	AMF	American Falls Reservoir	2003	77564	Current 303(d)			X					X					X		
UpSnake	AMF	Bannock Creek	2003	82844	Current 303(d)		X						X					X		
UpSnake	AMF	Knox Creek	2006	18223	1998 303(d) Additions															X
UpSnake	AMF	McTucker Creek	2003	3609	Current 303(d)													X		
UpSnake	AMF	Moonshine Creek	2003	2184	Current 303(d)													X		
UpSnake	AMF	Rattlesnake Creek	2003	23568	Current 303(d)													X		
UpSnake	AMF	Snake River	1999	89119	Current 303(d)	X		X	X				X					X		
UpSnake	AMF	West Fork Bannock Creek	2003	5871	Current 303(d)													X		
UpSnake	BFT	Angus Creek	1999	12930	Current 303(d)													X		
UpSnake	BFT	Bacon Creek	1999	4825	Current 303(d)													X		

Upper Snake Provincial Assessment

Basin	HUC	Name	TMDL Schedule	Length (m)	Status	Threat	BACT	DO	FLOWAL	HABALT	MET	NH3	NUTR	O_G	ORG	PEST	SAL	SED	TEMP	UNKN
UpSnake	BFT	Blackfoot River	1999	169830	Current 303(d)	X			X				X		X			X		
UpSnake	BFT	Brush Creek	2006	24636	1998 303(d) Additions															X
UpSnake	BFT	Corral Creek	1999	29846	Current 303(d)													X		
UpSnake	BFT	Diamond Creek	1999	32349	Current 303(d)													X		
UpSnake	BFT	Dry Valley Creek	1999	17961	Current 303(d)													X		
UpSnake	BFT	Grizzly Creek	2006	11987	1998 303(d) Additions															X
UpSnake	BFT	Lanes Creek	1999	16728	Current 303(d)													X		
UpSnake	BFT	Maybe Creek	2006	4583	1998 303(d) Additions															X
UpSnake	BFT	Meadow Creek	1999	49744	Current 303(d)													X		
UpSnake	BFT	Sheep Creek	1999	12711	Current 303(d)													X		
UpSnake	BFT	Slug Creek	1999	37992	Current 303(d)													X		
UpSnake	BFT	Trail Creek	1999	13035	Current 303(d)													X		
UpSnake	BFT	Wolverine Creek	1999	10228	Current 303(d)								X					X		
UpSnake	GSE	Beaverdam Creek	2006	8644	1998 303(d) Additions															X
UpSnake	GSE	Big Cottonwood Creek	2006	21086	1998 303(d) Additions															X
UpSnake	GSE	Birch Creek	2002	24102	Current 303(d)		X	X										X		
UpSnake	GSE	Blue Hill Creek	2006	9195	1998 303(d) Additions															X
UpSnake	GSE	Cold Creek	2006	13298	1998 303(d) Additions															X
UpSnake	GSE	Goose Creek	2002	24649	Current 303(d)		X	X	X				X					X	X	
UpSnake	GSE	Lower Goose Creek Reservoir	2002	10179	Current 303(d)			X	X				X					X		
UpSnake	GSE	Trapper Creek	2002	12328	Current 303(d)		X	X	X									X		

Upper Snake Provincial Assessment

Basin	HUC	Name	TMDL Schedule	Length (m)	Status	Threat	BACT	DO	FLOWAL	HABALT	MET	NH3	NUTR	O_G	ORG	PEST	SAL	SED	TEMP	UNKN
UpSnake	IFA	Birch Creek	2006	17074	1998 303(d) Additions															X
UpSnake	IFA	North Fork Willow Creek	2002	16422	Current 303(d)													X		
UpSnake	IFA	Snake River	2002	3785	Current 303(d)	X			X											
UpSnake	IFA	South Fork Willow Creek	2002	15757	Current 303(d)													X		
UpSnake	IFA	Willow Creek	2002	16786	Current 303(d)													X		
UpSnake	LHF	GRASSY CR		730							X									
UpSnake	LHF	North Fork Teton River	1999	8570	Current 303(d)								X					X		
UpSnake	LWT	East Fork Rock Creek	1999	8576	Current 303(d)													X		
UpSnake	LWT	Marsh Creek	2006	32137	1998 303(d) Additions															X
UpSnake	LWT	Milner Lake	1999	56939	Current 303(d)			X	X				X	X				X		
UpSnake	LWT	Raft River	2002	1386	Current 303(d)		X	X	X			X	X					X		
UpSnake	LWT	Rock Creek	1999	21005	Current 303(d)													X		
UpSnake	LWT	Snake River	1999	49779	Current 303(d)			X								X		X		
UpSnake	LWT	South Fork Rock Creek	2006	50825	1998 303(d) Additions															X
UpSnake	PTF	American Falls Reservoir	2003	5037	Current 303(d)			X					X					X		
UpSnake	PTF	Arkansas Creek	2006	8693	1998 303(d) Additions															X
UpSnake	PTF	Birch Creek	1998	10413	Current 303(d)								X					X		
UpSnake	PTF	Cherry Creek	1998	11948	Current 303(d)								X					X		
UpSnake	PTF	Garden Creek	1998	12120	Current 303(d)								X					X		
UpSnake	PTF	Hawkins Creek	1998	24233	Current 303(d)								X					X		
UpSnake	PTF	Hawkins Reservoir	1998	1192	Current 303(d)			X					X							

Upper Snake Provincial Assessment

Basin	HUC	Name	TMDL Schedule	Length (m)	Status	Threat	BACT	DO	FLOWAL	HABALT	MET	NH3	NUTR	O_G	ORG	PEST	SAL	SED	TEMP	UNKN
UpSnake	PTF	Indian Creek	2006	5577	1998 303(d) Additions															X
UpSnake	PTF	Marsh Creek	1998	78025	Current 303(d)								X					X		
UpSnake	PTF	Pocatello Creek	1998	7938	Current 303(d)													X		
UpSnake	PTF	Portneuf River	1998	169116	Current 303(d)	X	X		X				X	X				X		
UpSnake	PTF	Rapid Creek	1998	10038	Current 303(d)													X		
UpSnake	PTF	Twentyfourmile Creek	1998	20836	Current 303(d)													X		
UpSnake	RFT	Cassia Creek	2002	20570	Current 303(d)	X				X								X		
UpSnake	RFT	Fall Creek	2006	3685	1998 303(d) Additions															X
UpSnake	RFT	Raft River	2002	122804	Current 303(d)		X	X	X			X	X				X	X	X	
UpSnake	RFT	Sublett Creek	2006	13324	1998 303(d) Additions		X	X	X				X					X		
UpSnake	RFT	Sublett Reservoir	2002	1977	Current 303(d)			X	X				X					X		
UpSnake	TET	Badger Creek	1999	13752	1998 303(d) Additions													X		
UpSnake	TET	Darby Creek	1999	5596	Current 303(d)				X									X		
UpSnake	TET	Fox Creek	1999	14766	Current 303(d)				X									X	X	
UpSnake	TET	Horseshoe Creek	1999	11332	Current 303(d)				X											
UpSnake	TET	Moody Creek	1999	40792	Current 303(d)								X							
UpSnake	TET	North Fork Teton River	1999	28300	Current 303(d)								X					X		
UpSnake	TET	North Leigh Creek	2006	7885	1998 303(d) Additions															X
UpSnake	TET	Packsaddle Creek	1999	15938	Current 303(d)				X									X		
UpSnake	TET	South Leigh Creek	1999	18304	Current 303(d)													X		
UpSnake	TET	Spring Creek	1999	20377	Current 303(d)				X									X	X	
UpSnake	TET	Teton River	1999	52997	Current 303(d)					X			X					X		

Upper Snake Provincial Assessment

Basin	HUC	Name	TMDL Schedule	Length (m)	Status	Threat	BACT	DO	FLOWAL	HABALT	MET	NH3	NUTR	O_G	ORG	PEST	SAL	SED	TEMP	UNKN
UpSnake	UHF	Sheridan Creek	2006	25139	1998 303(d) Additions													X		
UpSnake	WIL	Birch Creek	2002	11333	Current 303(d)													X		
UpSnake	WIL	Brockman Creek	2002	20426	Current 303(d)								X					X		
UpSnake	WIL	Buck Creek	2006	4178	1998 303(d) Additions															X
UpSnake	WIL	Corral Creek	2002	6897	Current 303(d)													X	X	
UpSnake	WIL	Crane Creek	2002	24499	Current 303(d)													X		
UpSnake	WIL	Grays Lake Outlet	2002	9620	Current 303(d)								X					X		
UpSnake	WIL	Hell Creek	2002	22476	Current 303(d)								X					X		
UpSnake	WIL	Homer Creek	2002	31767	Current 303(d)													X		
UpSnake	WIL	Lava Creek	2002	11372	Current 303(d)													X	X	
UpSnake	WIL	Long Valley Creek	2002	10597	Current 303(d)													X	X	
UpSnake	WIL	Meadow Creek	2002	17047	Current 303(d)													X		
UpSnake	WIL	Mill Creek	2002	10293	Current 303(d)													X	X	
UpSnake	WIL	Ririe Reservoir	2002	18887	Current 303(d)													X		
UpSnake	WIL	Sawmill Creek	2002	4946	Current 303(d)													X	X	
UpSnake	WIL	Sellars Creek	2002	6789	Current 303(d)				X									X	X	
UpSnake	WIL	Seventy Creek	2002	4914	Current 303(d)				X									X	X	
UpSnake	WIL	Tex Creek	2002	13432	Current 303(d)													X		
UpSnake	WIL	Willow Creek	2002	65243	Current 303(d)													X		
Closed Basin Subbasin																		Total Length (m) 544,218		
UpSnake Clo	BCK	Birch Creek	2004	27100	Current 303(d)				X	X			X					X		
UpSnake Clo	BCM	Beaver Creek	2004	52178	Current 303(d)				X	X			X					X	X	
UpSnake Clo	BCM	Camas Creek	2004	85169	Current 303(d)				X	X			X					X	X	
UpSnake Clo	BCM	Cow Creek	2006	7798	1998 303(d) Additions															X

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Basin	HUC	Name	TMDL Schedule	Length (m)	Status	Threat	BACT	DO	FLOWAL	HABALT	MET	NH3	NUTR	O_G	ORG	PEST	SAL	SED	TEMP	UNKN
UpSnake Clo	BLR	Antelope Creek	2003	26003	Current 303(d)				X									X	X	
UpSnake Clo	BLR	Big Lost River	2003	54396	Current 303(d)			X	X				X					X	X	
UpSnake Clo	BLR	East Fork Big Lost River	2003	46158	Current 303(d)					X								X	X	
UpSnake Clo	BLR	Little Boone Creek	2006	3820	1998 303(d) Additions															X
UpSnake Clo	BLR	Spring Creek	2003	27542	Current 303(d)			X	X				X					X	X	
UpSnake Clo	BLR	Twin Bridges Creek	2003	14632	Current 303(d)								X					X		
UpSnake Clo	BLR	Warm Springs Creek	2006	13899	1998 303(d) Additions															X
UpSnake Clo	LLR	Little Lost River	2006	51333	1998 303(d) Additions														X	X
UpSnake Clo	LLR	Sawmill Creek	1999	19938	Current 303(d)													X	X	
UpSnake Clo	LLR	Wet Creek	1999	25543	Current 303(d)	X			X									X	X	
UpSnake Clo	MDL	Camas Creek	2004	3040	Current 303(d)								X					X		
UpSnake Clo	MDL	Edie Creek	2004	12454	Current 303(d)					X			X					X		
UpSnake Clo	MDL	Fritz Creek	2004	4646	Current 303(d)								X						X	
UpSnake Clo	MDL	Irving Creek	2004	11165	Current 303(d)					X			X					X		
UpSnake Clo	MDL	Medicine Lodge Creek	2004	26080	Current 303(d)				X									X	X	
UpSnake Clo	MDL	Warm Springs Creek	2004	31324	Current 303(d)								X					X		

Upper Snake Provincial Assessment

Basin	HUC	Name	TMDL Schedule	Length (m)	Status	Threat	BACT	DO	FLOWAL	HABALT	MET	NH3	NUTR	O_G	ORG	PEST	SAL	SED	TEMP	UNKN
Upper Snake Headwaters																		Total Length (m) 278,964		
UpSnake HW	GHB	Cache Creek		14415							X							X		
UpSnake HW	GHB	Horse Creek		2740						X										
UpSnake HW	GHB	Little Granite Creek		11936														X		
UpSnake HW	GHB	Snake River		37571						X										
UpSnake HW	GVT	Gros Ventre River		26662						X								X		
UpSnake HW	PAL	Antelope Creek	2000	18516	Current 303(d)	X												X		
UpSnake HW	PAL	Bear Creek	2006	19318	1998 303(d) Additions															X
UpSnake HW	PAL	Camp Creek	2006	7347	1998 303(d) Additions															X
UpSnake HW	PAL	Elk Creek	2006	5299	1998 303(d) Additions															X
UpSnake HW	PAL	Fall Creek	2006	19597	1998 303(d) Additions															X
UpSnake HW	PAL	Little Elk Creek	2006	7292	1998 303(d) Additions															X
UpSnake HW	PAL	North Fork Indian Creek	2006	1733	1998 303(d) Additions															X
UpSnake HW	PAL	Sheep Creek	2006	8653	1998 303(d) Additions															X
UpSnake HW	PAL	Snake River		654						X										
UpSnake HW	PAL	Snake River	2000	65694	Current 303(d)	X			X											

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Basin	HUC	Name	TMDL Schedule	Length (m)	Status	Threat	BACT	DO	FLOWAL	HABALT	MET	NH3	NUTR	O_G	ORG	PEST	SAL	SED	TEMP	UNKN
UpSnake HW	SAL	Boulder Creek	2006	10510	1998 303(d) Additions															X
UpSnake HW	SHW	Pacific Creek		21027						X								X		
Grand Total				3143180																

APPENDIX 1-6—NOXIOUS WEEDS

Table 1. Plant species considered to be noxious weeds in the Upper Snake Province. Data provided by Idaho State Department of Agriculture (2003), and Teton County Weed Control (Teton County, WY [2003]).

Common Name	Watershed																					
	AMF	BCK	BCM	BFT	BLR	GHB	GSE	GVT	IFA	LHF	LLR	LWT	MDL	PAL	PTF	RFT	SAL	SHW	TET	UHF	USR	WIL
Absinthe wormwood	X	X	X	X	X		X			X	X	X	X	X	X	X	X		X	X	X	
Bittersweet nightshade						X												X				
Black henbane	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X				
Black medic						X												X				
Bull thistle						X		X										X	X			
Canada thistle	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Cheatgrass																		X				
Common mullein						X		X										X	X			
Common tansy						X		X										X	X			
Common timothy						X		X										X				
Dalmatian toadflax	X		X			X		X	X	X					X		X	X	X	X	X	
Diffuse knapweed	X				X		X			X		X				X		X			X	
Dyer's woad	X		X	X		X	X	X		X		X			X	X	X	X		X	X	
False madwort																		X				
Field bindweed	X			X	X	X		X		X		X			X	X	X	X	X		X	
Field scabiosa						X																
Hawkweed						X													X			
Houndstongue						X		X										X	X			
Kentucky bluegrass																		X				
Leafy spurge	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X
Mayweed														X								
Mule-ears																						X
Musk thistle	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Orange hawkweed																		X				
Other	X	X	X	X		X		X	X			X	X		X	X		X			X	
Perennial pepperweed	X			X		X	X	X	X						X	X		X			X	
Perennial sowthistle		X							X										X			
Poison hemlock	X			X						X		X	X		X		X		X	X	X	

Common Name	Watershed																					
	AMF	BCK	BCM	BFT	BLR	GHB	GSE	GVT	IFA	LHF	LLR	LWT	MDL	PAL	PTF	RFT	SAL	SHW	TET	UHF	USR	WIL
Russian olive						X																
Scentless corn chamomile						X		X										X	X			
Scotch thistle	X		X	X	X	X	X					X			X	X					X	
Smooth brome						X		X										X				
Sowthistle						X		X										X	X			
Spotted knapweed	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
St. Johnswort						X				X								X	X	X		
Sulphur cinquefoil	X					X		X										X	X			
Unknown		X	X					X										X				
Western salsify																		X				
Whitetop	X	X		X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	
Yellow hawkweed																		X				
Yellow sweetclover						X		X										X				
Yellow toadflax	X	X	X	X		X		X	X	X					X		X	X	X	X		X

APPENDIX 2-1—DATA LIMITATIONS

This assessment included the compilation and analysis of many hundreds of individual data sets from a great number of sources; totaling approximately 10 GB of storage in reduced form. While a great number of data sets were compiled, only some were used in the assessments, while others were not. These determinations were made to illustrate what the authors felt was necessary and reasonable to include in the assessment, while minimizing superfluous data.

The following is a statement of the limitations of some of the spatial data used for analysis in this assessment. It should be noted that this statement may not be entirely complete, however an attempt was made to address all major sources of spatial data such that results from these analyses could be considered holistically. This statement includes the following topics:

- Current Vegetation
- Historic Vegetation
- Invasive Vegetation
- Vegetative Fragmentation
- Disturbance
- Altered Hydrology
- Altered Fire Regime
- Grazing
- Points of Diversion
- Geology
- Ownership
- Fish Distributions
- South West Idaho Eco-Group Data
- Urban Rural Development Class (Urban Sprawl)

Analysis of all spatial products was done utilizing Environmental Research Systems Institute (ESRI) ArcView, ArcMap, and ArcInfo software. It is notable that some coverages were continuous (e.g., vegetation) while others were not spatially continuous

(e.g., grazing allotments). The analyses included intersecting and joining spatial layers and cross-tabulating attributes. Areas for polygons were calculated using the XTOOLS extension in ESRI ArcView, and the majority of tabular reports were generated in Microsoft Excel in pivot tables.

1 Current Vegetation Cover

Two data sets describing the current distribution of vegetation categories in the region were available for analysis. The first was a layer produced by ICBEMP, and the second produced by the GAP project. The ICBEMP layer did provide a seamless current vegetation coverage for the region, however after comparative analysis and data exploration, the authors of this project felt the GAP products were more representative, and thus were used in place of ICBEMP when available.

It is essential to consider that, as with any remotely derived product, there is a certain degree of uncertainty within the GAP product. In GAP, spatial and spectral resolutions, temporal constraints, cloud cover, and geometric correction accentuate this uncertainty. Thus, while it is imperative to include basal vegetation for spatial analysis, the GAP data should not be considered an ideal data set from which major decisions should be based. Instead, it should serve as a guideline for development of future projects, which in turn will improve our understanding of vegetative systems. It is important to note that GAP data was used to define the quantity of focal habitats and vegetative species distributions for this assessment.

Very little has been done to serve as a regional accuracy assessment for the GAP derived vegetation layer. In the late 1990's,

field crews from the Bureau of Land Management and Pacific Northwest National Laboratories collected 1,168 field vegetation survey points and performed a first-cut accuracy assessment of the classification of GAP II vegetation in the state of Idaho (Table 1). The results demonstrate that GAP II performs respectably, producing accuracies commonly between 40% and 70%. Unfortunately, there is not a sufficient number

of data points to reliably estimate the accuracy of all classes. Analysis of the data presented in Table 1 produces the accuracy summary presented in Table 2. It is notable that the Riparian classification produced an accuracy of zero percent; however, there was only one data point for comparison. It is also of note that this data point was grass, which may or may not be associated with a riparian system.

Table 1. Confidence levels for reference and classified habitat types using GAP II. Overall, 58%; khat 0.403. This table is an calculated product derived from related information provided by the BLM and is presumably very similar to original data.

		Classified						
		Shrub	Conifer	Aspen	Juniper Pinyon	Grass	Riparian	Other
Reference	Shrub	344	62	7	5	23	3	2
	Conifer	37	231	36	0	0	0	0
	Aspen	57	50	28	1	2	1	0
	Juniper Pinyon	25	4	0	38	0	0	0
	Grass	91	3	5	3	32	0	11
	Riparian	0	0	0	0	1	0	0
	Other	40	4	0	7	14	0	1
Totals		594	354	76	54	72	4	14
		1168						

Table 2. Producer's accuracies for specified vegetation categories.

Cover Type	Producers Accuracy
Shrub	58%
Conifer	65%
Aspen	37%
Juniper/Pinyon Pine	70%
Grass	44%
Riparian	0%
Other	7%

The overall accuracy (58%) is the sum of all correct classifications divided by the count of

all classifications tested. This calculation provides a broad analysis of the quality of the

data set, but does not represent the quality of any one class. The Producer's accuracies illustrated in Table 2 are the estimated accuracies by class. While it is notable that there is considerable variance between class accuracies, it is also of note that there is also considerable difference between the numbers of field-validated plots (Table 1), which introduces a bias. As sample sizes increase, the certainty that the variance of the sample actually represents the variance of the data set increases. Congalton (1991) indicate that a minimum of 100 field samples per class is necessary to produce a meaningful result for geographically large data sets.

The final calculation is that of Khat, which is a measure of the probability that the resulting overall accuracy is due only to random variability (applied as a Kappa test of independence). A Khat value of 1 implies that there is no possibility that the calculations were due to chance, while a Khat value of 0 dictates that there is great probability of chance classification. The Khat value of the GAP II classification is 0.403, which is notably low and may reduce confidence in the classification.

For the state of Idaho, GAP II vegetation classifications were used. GAP II is a refinement of the original GAP vegetation classification, with finer spatial scale and assumedly higher accuracies. Where necessary, GAP classifications for other states in the region were used (Wyoming, Utah, and Nevada). Unfortunately, the different state projects did not always collaborate on processing methods and classifications systems, which resulted in products with different spatial scales and different names for the same vegetative categories. The boundaries between states are also commonly expressed as abrupt changes in vegetative structure. Additionally, state boundaries do not always line up according to how different states performed their analyses. At times this

resulted in large gaps of missing data between states. Where this occurred, the ICBEMP classification for current vegetation was utilized to fill these holes.

1.1 Data Documentation

Attribute_Accuracy_Report:

Accuracy is estimated at 67.27% (range 53.89% to 93.39%) for northern Idaho based on a scene by scene fuzzy set analysis. For southern Idaho, accuracy is estimated at 69.3% (range 63.6% to 79.3%) based on total percent correct over 9 regions.

Regarding inappropriate uses, it is far easier to identify appropriate uses than inappropriate ones. However, there is a "fuzzy line" that is eventually crossed when the differences in resolution of the data, size of geographic area being analyzed, and precision of the answer required for the question are no longer compatible. Following are several examples:

- Using the data as a "content" map for small areas (less than thousands of hectares), typically requiring mapping resolution at 1:24,000 scale and using aerial photographs or ground surveys.
- Combining GAP data with other data finer than 1:100,000 scale to produce new hybrid maps or answer queries resulting in precise measurements.
- Generating specific areal measurements from the data finer than the nearest thousand hectares. (Minimum mapping unit size and accuracy affect this precision.)
- Establishing exact boundaries for regulation or acquisition.
- Establishing definite occurrence or nonoccurrence of any feature for an exact geographic area. (For land cover, the

percent accuracy will provide a measure of probability.)

- Determining abundance, health, or condition of any feature.
- Establishing a measure of accuracy of any other data by comparison with GAP data.
- Altering the data in any way and redistributing them as a GAP data product.
- Using the data without acquiring and reviewing the metadata and this report.

2 Historic Vegetation Cover

To estimate the relative degree of vegetative change (resulting from habitat or ecosystem fragmentation, urbanization, natural morphology, etc.), it was necessary to analyze a layer of historical natural vegetation cover. The layer used for this analysis was the Kuchler's Potential Natural Vegetation Polygon layer, maintained at ICBEMP. Unfortunately, there is no way to test the accuracy of a layer describing potential natural vegetation. It is assumed that this coverage is a broad overview of what an idealistic vegetative state might be like without any anthropogenic influence. The scale of these data is much larger than the scale of the GAP data used for the distribution of current vegetation. Unfortunately, the availability of regional, contiguous data sets describing potential natural vegetation is very limited, and Kuchler's classification was the best option found for spatial and temporal analysis of vegetation changes.

2.1 Data Documentation

Originator: U.S. Forest Service

Publication Date: 03/15/1995

Title: Kuchler's Potential Natural Vegetation
–Polygon

Abstract: Kuchler's Potential Natural Vegetation–Polygon (1964)

Purpose: Used for analysis in Scientific Assessment of the ICBEMP.

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC) or possibly the subwatershed (6th field HUC) level. The individual listed as contact person can answer questions concerning appropriate use of data.

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3 Invasive Vegetation

This assessment utilizes invasive species from the Idaho State Department of Agriculture and a variety of local agencies in Wyoming. While the Idaho data are statewide and contiguous, there are several limitations. Foremost is that the data were compiled by ISDA but collected by individual county weed control offices, presumably using different mapping techniques. Visual evaluation of this data set demonstrates strong biases in weed distributions as delineated by county boundaries.

The known distributions of invasive species in the State of Idaho is mapped only by dominant invasive by PLSS section. This implies that while a given section may have an abundant population of a particular invasive community, it may also have significant distributions of a second community that is not represented by this data set. Alternatively, presence of a particular invasive species may be over emphasized through the same bias.

Invasive weeds from Wyoming are not by PLSS section, but rather are represented by GPS polygons. While this distribution is more accurate for the weeds that are mapped, it omits weeds that are not inventoried using GPS that are known to exist.

These limitations effectively prohibit the use of the data for area calculations or for relative impacts. They are useful to the extent that they demonstrate known occurrences of weeds, but they are by no means representative of the actual distribution of noxious weeds in any areas.

4 Vegetative Fragmentation

Vegetative fragmentation in the scope of this assessment is defined as the relative degree of fragmentation within a vegetative community, regardless of cause. The fragmentation factor utilized in this assessment was derived as part of the ICBEMP assessment.

4.1 Data Documentation

Originator: Interior Columbia Basin
Ecosystem Management Project

Title: Similarity/Fragmentation Index for
Succession/Disturbance and Vegetation
Composition/Structure (ASMNT)

Other Citation Details:
/emp/crdbdb/crb/h6char/sim.dbf

Online Linkage:
<http://www.icbemp.gov/spatial/landchar/>

Abstract

Similarity index of subwatershed succession/disturbance regime and vegetation composition/structure to historical range of variability pattern. The inverse of this similarity index provides an index of fragmentation. This is a broad-scale index classifying subwatersheds into classes of similarity to the historical landscape regime based on the system developed and described

in the landscape assessment. The index is assigned to subwatersheds for the current conditions as a similarity comparison to the historical regime.

Purpose

Used for Supplemental Draft EIS and Integrated Risk Assessment analysis. At the broad-scale, summary of the classes of this variable can be used to identify how much area may be similar to the historical regime or the inverse can be used to estimate departure from the historical regime. In addition, this variable could be summarized at a 4th code HUC level to identify and assess subbasins in a similar manner. These broad-scale data should not be used to target specific subwatershed similarity or departure, since the classification is relative and has a potential error of 20%. Since classes are relative to each other, these data should be used in this context and not as an absolute calculation of conditions. For example, if one subwatershed has a given classification and the adjacent subwatershed has a different classification, the interpretation is that the one subwatershed has much higher probability of its assigned class than the other. Another way to consider this interpretation is that the absolute amount of a given class is unknown at this scale, but these data indicate that one subwatershed has much higher probability than the other of the assigned class.

This index ranks subwatersheds (6th field HUC) from 0 (lowest) to 10 (highest) based on similarity of the succession/disturbance regime, vegetation composition/structure, and landscape pattern to the historical range of variability pattern. Regional and landscape similarities of historical and current vegetation conditions, and succession/disturbance regimes are discussed on page 420 of Hann *et al.* (1997). Multiple input variables and calculations were used to classify this variable into a similarity to the

historical regime. Definition and prediction of this variable is described in Hann *et al.* (1997).

Use Constraints

SIM is a single index calculated for each subwatershed based on the current or future broad- and mid-scale integrated departure from a 400-year pre-EuroAmerican settlement estimate of variation. The index calculation included integration of several variables that are listed in the Capture Methods section. Any summary of these subwatershed data to a finer stratification, such as potential vegetation group (PVG), will contain some error since multiple PVGs occur in any one subwatershed. This variable can be used to assess, identify, or correlate the general similarity or departure from the historical regime. This variable should not be used to summarize refined stratifications or small area absolute amounts similarity or departure, because of the inclusions and the generic nature of this classification.

These data were intended for use at the broad-scale, generally to summarize regional conditions, prioritize subbasins (4th field HUC), or identify large groups of subwatersheds (6th field HUC) that would contain a predominance of the conditions for the class. Data should not be used to target conditions for specific subwatersheds, because of accuracy limitations. The individual listed as the Contact Person can answer questions concerning appropriate use of data.

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Logical Consistency Report

The attributes in this data set are derived from a rule set linked to the intermediate input variables. Because these intermediate input variables are predicted, any one resulting subwatershed variable class has approximately 15 to 25% chance of error into an adjacent class and 5 to 15% chance of error to non-adjacent classes. When classes are summarized at the Basin or groups of subbasins scale, confidence in the class area summary is approximately plus or minus 10%. When classes are summarized at the subbasin scale, confidence in the class area summary is approximately plus or minus 20%. This can be improved to plus or minus 10% by grouping classes into a coarser (3 class; low, moderate, high) classification, which will improve accuracy. The classes are only applicable and accurate when considered in a relative sense to each other.

This variable should not be used to summarize absolute inferences. Confidence in correct classification of any one subwatershed compared to ground truth is estimated to be 65% (2 out of 3 chances of being right). Confidence in composition of the different classes summarized across the basin is estimated at 90% (9 out of 10 chances of being right), 85% for a group of subbasins, 80% for subwatersheds within a subbasin, and 70% for a smaller group (10 to 20) of subwatersheds.

5 Forest Management Activity

For the scope of this assessment, disturbance is defined as the change of a system from its natural state. This is important to consider for a subbasin assessment. The disturbance layer utilized in subbasin planning was derived from the ICBEMP project, and included many attributes. Of these attributes, the authors

selected to only use Forest Management Activity.

Logically it would have been preferable to use GPS or higher resolution field data collections to more accurately represent timber harvest. Large logistical barriers were encountered, however, when attempting to coordinate with several government and private sector agencies as to the extent and type of timber management activities at the subbasin scale within the timeframe of this assessment. Therefore, the ICBEMP layer was utilized as the best available regional estimate of timber management activity through the subbasin.

5.1 Data Documentation

Abstract

Current Disturbance and Activities—The current time period generally reflects the current year (1999) plus or minus 5 years (i.e., 1994–2004). Developed from data and models using administrative unit data from the past 10 years as one input. Reflects the disturbance from 1988 to 1997 (10-year average). Current disturbance and activities include 10 variables of which most are expressed in relative low, moderate, and high classes. The data for these 10 variables for Forest Service and BLM lands came from administrative unit reports and wildfire reports, while data for other lands came from general resource reports and extrapolation of assumptions. Activities are planned treatments, while disturbances include unplanned effects. Planned activities include: livestock grazing measured in relative classes of animal unit months (AUMs) and range allotment restoration and maintenance (RST), which is measured in relative classes of area affected; timber and woodland harvest (HRV) and thinning (THN) measured in relative classes of area treated, while wood product volume (VOL) is measured in an approximate estimate of millions of board feet; and

prescribed fire and fuel management (PRS) and prescribed natural fire (PNF), both also measured in relative classes of area treated. Two summary activity variables are provided: forest and woodland management activity (FMA) is a summary of HRV and THN, while fire activity (FAD) is a summary of PRS and PNF. The one unplanned disturbance variable is the amount of wildland fire (wildfire, WLF).

Purpose

The intent of current disturbance and activity data is to provide baseline information useful to understanding current activity and disturbance levels at the broad-scale. Future predictions of this information can be used at the broad-scale to evaluate scenarios or alternatives. The 10 disturbance and activity variables can be used to address an understanding of the relative location and relative amounts of management treatments and disturbance that are occurring currently and how those may change in the future under different scenarios or alternatives.

Use Constraints

All of the disturbance and activity variables are expressed as relative classes, except volume, which is expressed in millions of board feet. The classes are based on relativized indexes generated from actual data on acres of activity or disturbance. Consequently, the classes are only useful in a relative sense, i.e., comparing different areas or summarizing conditions within or across the whole area.

These data were intended for use at the broad-scale, generally to summarize regional levels of activities and disturbance, prioritize or plan subbasin (4th field HUC) outcomes for a given level of activity or disturbance. The individual listed as the Contact Person can

answer questions concerning appropriate use of data

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Attribute Accuracy Report:

The attributes in this data set are derived from a rule set linked to the input of treatment and disturbance acre or volume data. The reported treatment and disturbance data was only spatially specific to the administrative unit. Consequently, this reported data was spatially redistributed through modeling and assumptions to a finer scale. Because of the general nature of the reported data and the extrapolation approach, any one resulting subbasin variable class has approximately 15 to 25% chance of error into an adjacent class and 5 to 15% chance of error to nonadjacent classes. When classes are summarized at the Basin or groups of subbasins scale, confidence in the class area summary is approximately plus or minus 10%. When classes are summarized at the subbasin scale, confidence in the class area summary is approximately plus or minus 20%. The classes are only applicable and accurate when considered in a relative sense to each other. The estimated timber volume has plus or minus 10% accuracy at the basin or groups of subbasin scale, which declines to plus or minus 20% for just one subbasin.

This variable should not be used to summarize absolute inferences. Confidence in correct classification of any one subbasin compared to ground truth is estimated to be 65% (2 out of 3 chances of being right). Confidence in composition of the different classes summarized across the basin is estimated at 90% (9 out of 10 chances of being right), 85% for a group of subbasins, 80% for subwatersheds within a subbasin, and

70% for a smaller group (10 to 20) of subwatersheds.

6 Altered Hydrology

As part of this subbasin assessment, it is necessary to evaluate the relationships between humans and the effect that they have on hydrologic systems. This is a very large and sweeping concept that may be impacted by factors ranging from construction of dams to urban sprawl, road construction, and timber harvest. ICBEMP performed a multivariate analysis of this type and derived an estimate of the relative impact that anthropogenic activity has effected regions in the Columbia River Basin. In this assessment, we utilized this factor, called the Hydro Human Impact factor, in our analysis.

6.1 Data Documentation

Abstract

Hydrologic Impacts Index. The hydrologic impacts index reflects the cumulative impacts from human associated developments of cropland agriculture, mining, dams, and roads. This is a broad-scale index classifying subwatersheds into classes from very low to very high relative probability of amounts of these impacts. The index is assigned to subwatersheds based on the presence or absence of substantial amounts of cropland, mines, and dams, and from road density classification.

Purpose

Used for Supplemental Draft EIS and Integrated Risk Assessment analysis. Can be used to assess the cumulative impacts from cropland, mines, dams and roads on hydrologic systems. At the broad-scale, summary of the classes of this variable can be used to identify how much area may have relatively high or low amounts of impacts.. In

addition, this variable could be summarized at a 4th code HUC level to identify subbasins with levels of impact.. These broad-scale data should not be used to target specific subwatershed hydrologic or soil problems, since the very low to high type of classification is relative and has a potential error of 20%. Since classes are relative to each other, these data should be used in this context and not as an absolute calculation of conditions.

For example, if one subwatershed has a very high rating and the adjacent subwatershed has a low rating, the interpretation is that the one subwatershed has much higher probability of impact than the other. Another way to consider this interpretation is that the absolute amount of impact is unknown at this scale, but these data indicate that one subwatershed has much higher probability than the other.

These data were used for Supplemental Draft EIS and Integrated Risk Assessment analysis. The hydrologic impacts index was derived using 4 variables from the Watershed Characterization theme (ID #797, export name ATRINTRP): Cropland, Mines, Dams, and Road Class. See auxiliary metadata file (HII.PDF) to define the assignment process for the Dominant Impact variable and the Hydrologic Impact Index.

The rule set used to classify this variable into very low (L), low (L), moderate (M), or high (H) hydrologic impact index is based on logical relationships (Jenny 1980, Alexander 1988, Jensen *et al.* 1997, Megahan 1991, Rockwell 1998, Oregon State University 1993, U.S. Department of Agriculture 1993). These relationships assume that as the presence and amount of impacts of cropland, mines, dams, and roads increase the impact to hydrologic systems and soil processes accumulate through time.

The spatial distribution of the high and very high classes is concentrated in the areas of the Basin with cropland and high density roads or cropland. In contrast, the very low and low are concentrated in the areas of wilderness and roadless or rangeland with low road density. The moderate category tends to follow the areas with intermediate conditions.

Use Constraints

These data were intended for use at the broad-scale, generally to summarize regional conditions, prioritize subbasins (4th field HUC), or identify large groups of subwatersheds (6th field HUC) that would contain a predominance of the conditions for the class. Data should not be used to target conditions for specific subwatersheds, because of accuracy limitations. The individual listed as the Contact Person can answer questions concerning appropriate use of data.

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Attribute Accuracy Report

The attributes in this data set are derived from a rule set linked to the intermediate input variables. Because these intermediate input variables are predicted, any one resulting subwatershed variable class has approximately 15 to 25% chance of error into an adjacent class and 5 to 15% chance of error to non-adjacent classes. When classes are summarized at the Basin or groups of subbasins scale, confidence in the class area summary is approximately plus or minus 10%. When classes are summarized at the subbasin scale, confidence in the class area summary is approximately plus or minus 20%. This can be improved to plus or minus 10% by grouping classes into a coarser (3

class: low, moderate, high) classification, which will improve accuracy. The classes are only applicable and accurate when considered in a relative sense to each other.

This variable should not be used to summarize absolute inferences. Confidence in correct classification of any one subwatershed compared to ground truth is estimated to be 65% (2 out of 3 chances of being right). Confidence in composition of the different classes summarized across the basin is estimated at 90% (9 out of 10 chances of being right), 85% for a group of subbasins, 80% for subwatersheds within a subbasin, and 70% for a smaller group (10 to 20) of subwatersheds.

7 Altered Fire Regime

Ecosystems-at-risk (EAR) integrates ignition probability, fire weather hazard, and fire regime condition class (FRCC), based on the probability of severe fire effects. FRCC is a very large and complex data set that essentially represents how much damage might be done to any particular area in the event of a fire. Analysis of this type aids in the understanding of ecosystem health and sustainability, and when combined with data indicating how likely an area is to burn, assists in identifying areas in immanent danger of dramatic habitat changes.

7.1 Data Documentation

Entity and Attribute Overview

The fire regime condition class codes, short descriptions, and explanations follow:

Code	FRCC Description
1	Low departure—Fire regimes are within their historical range and the risk of losing key ecosystem components is low.

Code	FRCC Description
2	Moderate departure—At least one fire interval has been missed, or exotic species have altered native species composition (e.g., cheatgrass and blister rust). There is a moderate risk of losing key ecosystem components should a fire occur.
3	High departure—Several fire intervals have been missed, or exotic species have substantially altered native species composition (e.g., cheatgrass and blister rust). There is a high risk of losing key ecosystem components should a fire occur.
4	Moderate grass/shrub—Moderate departure in shrubland or grassland systems. At least one fire interval has been missed, or exotic species have substantially altered native species composition (e.g., cheatgrass and blister rust). There is moderate risk of losing key ecosystem components should a fire occur.
8	Agriculture
9	Rock/barren
10	Urban
11	Water
12	Snow/ice
13	No information

We used three condition classes to qualitatively rank the departure from the historical fire-regimes. To a large extent, fire-regime condition classes were derived from a comparison of the historical fire regime and the current fire severity. To derive condition class, we simply assessed the transition between our projected current fire severity and the historical fire regime of a given site. If the evidence suggested that fire severity had changed by at least one class, then we would conclude that the condition class has a value that exceeds Class 1. In other words, we would infer that the fire effects would be something other than the effects expected if

the structure and composition reflected the historical range of conditions. The greater the departure, the greater the probability that key components would be lost if a wildfire occurred.

Assumptions

We made many assumptions prior to developing the modeling rules to derive fire regime condition class:

1. The current fire severity, and consequently the condition class could only increase as a result of fire exclusion.
2. Condition Class 1 occurred if there had been no detectable change in fire severity between the historical fire regime and the current fire severity.
3. Although fire exclusion has likely resulted in an increase of the duff depth, and consequently future fires will probably be more severe, the resolution of our base data did not allow us to make inferences concerning duff depths.
4. Fire exclusion has not measurably changed fire severity of the communities within the MS3, SR1, and SR2 fire regimes. Our inability to detect change within these fire regimes is more of a function of an inappropriate scale - changes within these regimes (as well as MS2) are much better detected at a landscape scale, rather than at a stand scale. The attributes representing stand structure and composition in our database were not refined enough to detect change within these historical fire regimes.

We adjusted the FRC within tshe (western hemlock), abla4 (Subalpine Fir type 4), pial (whitebark pine), and laly (alpine larch) Potential Natural Vegetation (PNV) types to account for the potential effects of blister rust

on western white pine and whitebark pine. The adjustment made to FRCC was relative to canopy cover. For example, if canopy cover = 3 (roughly 40–70%), the FRCC was changed from low to moderate. If canopy cover = 4 (roughly >70%), then FRCC was changed from low to high. We also adjusted the FRCC when broadleaf cover types occurred in coniferous forest PNVs. Since fire would likely be beneficial to aspen, the FRCC was changed to low.

Purpose

These data were designed to characterize broad scale patterns of fire regime departures for use in regional and subregional assessments. The departure of the current condition from the historical base line serves as a proxy to the potential of severe fire effects. In applying the condition class concept, we assume that historical fire regimes represent the conditions under which the ecosystem components within fire-adapted ecosystems evolved and have been maintained over time. Thus, if we projected that fire intervals and/or fire severity has changed from the historical conditions, we would expect that fire size, intensity, and burn patterns would also be subsequently altered if a fire occurred. Furthermore, we assumed that if these basic fire characteristics have changed, then it is likely that there would be subsequent effects to those ecosystem components that had adapted to the historical fire regimes. As used here, fire regime condition classes reflect the probability that key ecosystem components may be lost should a fire occur. Furthermore, a key ecosystem component can represent virtually any attribute of an ecosystem (for example, soil productivity, water quality, floral and faunal species, large-diameter trees, snags, etc.).

General Limitations

These data were designed to characterize broad scale patterns of fire-regime departures for use in regional and subregional assessments. Any decisions based on these data should be supported with field verification, especially at scales finer than 1:100,000. Although the resolution of the FRCC theme is 90-meter cell size, the expected accuracy does not warrant their use for analyses of areas smaller than about 10,000 acres (for example, assessments that typically require 1:24,000 data).

FRCC is based upon information associated to stands, i.e., stand level information. Since fire processes operate at a landscape level, it seems logical that FRCC should be derived at a landscape level instead of a stand level. However, we need to run vegetation simulation models to derive historical range of variability, which would allow FRCC to be modeled at landscape levels.

The derivation of FRCC for grassland and shrubland settings is overly simplistic at this time. Currently, there is little empirical data concerning fire regimes in non-forested settings.

Source Data

http://www.fs.fed.us/r1/cohesive_strategy/datafr.htm

8 Grazing

Two spatial coverages characterizing grazing in the subbasin were utilized in this assessment. The first was a grazing allotment coverage acquired from the ICBEMP website, used to determine type of domestic grazing. It was used because it provided contiguous grazing information compiled from various sources. The grazing data from this coverage is limited in that some records may be old or

otherwise outdated, spatial accuracies are variable, and current allotment status is not always documented. These issues are not easily surmounted given the number of contributing source agencies and variability in data collection / record management. This layer was used to calculate percentages of areas grazed by animal type by watershed.

The second coverage used to evaluate grazing in the subbasin was an uncharacteristic grazing layer, also downloaded from the ICBEMP website. This layer is an indicator of the effect of grazing on a natural system, as compared to the predicted potential status of the natural system with only native ungulate grazing and browsing. This layer was used to generate the High, Moderate, and Low categories used in Appendix 3-1.

8.1 Data Documentation—Animal Type

Publication Date: 05/15/1995

Abstract: Range Allotments—Idaho

Purpose: Provide information on locations of grazing on federal lands, type of livestock, and seasonal use.

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as Contact Person can answer questions concerning appropriate use of data.

Contact Person: Becky Gravenmier

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Attribute Accuracy Report

Topology and attributes for this theme were manually checked by comparing plots of the

processed data against original materials. Attribute accuracy information for source materials were not collected since acquisition of source data pre-dated FGDC metadata standards.

Completeness Report

Capture Method: Received digital files or manuscripts. Projections usually UTM (zone 10, 11, 12) or State Plane. Scales 1:24,000 to 1:126,720. Tabular data received in database format or hardcopy. Agencies/field units consulted for edits/data as needed.

Not all agencies submitted data. Received data from: Boise NF, Caribou NF, Challis NF, Clearwater NF, Idaho Panhandle NF, Nez Perce NF, Payette NF, Salmon NF, Sawtooth NF, Targhee NF, Wallowa-Whitman NF, BLM-Boise, BLM-Burley, BLM-Coeur d'Alene, BLM-Idaho Falls, BLM-Salmon, BLM-Shoshone, USFWS, Nat'l Park Service. Allotment number links the spatial and tabular data. Pastures (smaller divisions) are included in some places, but the tabular data applies at the allotment level. In merging the coverages, precedence was given to the most accurate coverage. The merged coverage was edited (eliminating slivers, etc.) and then clipped to state and CRBA boundaries to create seven state coverages.

8.2 Data Documentation— Uncharacteristic Grazing

Originator: Interior Columbia Basin
Ecosystem Management Project

Title: Current Year Uncharacteristic
Livestock Grazing

Other Citation Details:
/emp/crbdb/crb/dst/bdbulg.dbf

Online Linkage:
<http://www.icbemp.gov/spatial/landchar/>

Time Period of Content: 5/1/1999

Status: Progress: Complete

Purpose

The objective is to understand the cycles and relationships of current native ungulate regimes as it affects vegetative communities, as compared to the characteristics of natural (historical) ungulate regimes of the Pre-European settlement without the influence of livestock grazing.

Abstract

Uncharacteristic livestock grazing has effects outside of the normal range of effects that occurred in the historical (natural) system. The normal range is considered to be within the 400 year historic range of variability minimum +25% and maximum -25%. The 400 year period includes the variation that is predicted to occur within the recent and current climate without influence of Euro-American settlement influence. The historical regime accounts in general for influences of native species adaptations and soil development for the past 10 to 15 thousand years since the last glacial period. Some native species adaptations have evolved over the last 1 to 3 million years in response to changing paleoecological climates and disturbances.

Current time period generally reflects the current year (1999) plus or minus 5 years (i.e., 1994–2004). Developed from data and models using administrative unit data from the past 10 years as one input. Reflects the disturbance from 1988 to 1997 (10-year average).

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as contact person (Becky Gravenmier) can

answer questions concerning appropriate use of data.

Attribute Definition

Description = Current Uncharacteristic Livestock Grazing Classification

VH: ≥ 0.900000001 to ≤ 1.0 .

Very high probability of uncharacteristic livestock grazing in the subwatershed.

H: > 0.549471265 to 0.0 .

High probability of extensive uncharacteristic livestock grazing effects in the subwatershed with considerable cumulative effects from high stocking levels in the early to mid 1900s. This level of uncharacteristic livestock grazing would likely result in negative effects to both upland and riparian systems, unless mitigated with distribution mgt. Spatial distribution highly correlated with the dry shrub PVGs.

M: ≥ 0.049981819 to < 0.549471264 .

Moderate probability of extensive uncharacteristic livestock grazing effects in the subwatershed. This level of uncharacteristic livestock grazing could result in negative effects, particularly on riparian systems in steep, complex terrain, unless mitigated with distribution mgt. Spatial distribution highly correlated with the dry shrub, cool shrub, and moist forest.

L: ≥ 0.000000002 to < 0.049981818 .

Low probability of uncharacteristic livestock grazing in the subwatershed. It is unlikely that this level of uncharacteristic livestock grazing would cause extensive effects, but in steep, complex terrain could result in negative impacts on riparian systems. Spatial distribution highly correlated with the dry forest, moist forest, and cool shrub PVGs.

N: < 0.000000001

Almost no probability of uncharacteristic livestock grazing in the subwatershed. Spatial distribution highly correlated with agricultural, urban lands, and moist forest.

9 Points of Diversion

The PODs summed in tables are actually water rights with surface water irrigation PODs associated with them. It consists of the Snake River Basin Adjudication recommended rights, the claims they are or will be processing, and any other licensed and permitted rights currently recognized. There can be more than one POD associated with a water right and vice versa, so the count is an estimate. Also, because the amount of water that can be diverted at any one time depends on available water and many other factors, no diversion rates or volumes have been given. Models are being developed for this, but these can only be verified and used in areas where there is a substantial effort at gauging the flow.

Points of diversion in across the basin may be in various states of adjudication. Until adjudicated, much of these data are as of date of the claim application in the late 1980s. Many POD locations are only accurate to the quarter-quarter or QQQ section. PODs for the state of Idaho are currently being adjudicated, and inventories are changing rapidly. It is notable that these points were acquired from IDWR in November 2003, and the database may have altered significantly since.

Diversion Rates

Also, because the amount of water that can be diverted at any one time depends on available water and many other factors, no diversion rates or volumes have been given. Models are being developed for this, but these can only be verified and used in areas where there is a

substantial effort at gauging the flow. *MIKE Basin Surface Water Budget Modeling*, as well as projects by USBR, IDWR, and DHI, Inc., are examples of quantifying the amount of available water being diverted. PHabSim is an additional software approach that evaluates the effects on aquatic species.

10 Geology

Major geological features are important at the subbasin scale whereas they influence stream and slope stability, topography, stream incision, vegetative structure, and other factors. While much of the areas encompassed in creation of this assessment is mapped at a high resolution for geologic features, these records are scattered amongst several academic and governmental organizations, and many are not in formats easily utilized. Therefore, a major lithology coverage maintained by ICBEMP was used for this assessment. This coverage was intended for large scale (> 1:1000000) analysis, however for this application it was the best available data source, and since not direct decisions will be made based on high discretization of this layer, its relatively coarse resolution is considered acceptable.

10.1 Data Documentation

Citation Information

Originator: U.S. Geological Survey

Publication Date: 11/03/1995

Title: Major Lithology

Other Citation Details:

/emp/crbv/crb/min/lithm

Online Linkage:

<http://www.icbemp.gov/spatial/min/>

Abstract

Classification of Geologic Map Units
According to their Major Lithology—The major lithologies classifications were used for

the component Scientific Assessment portion of the project. Both the biophysical and economic sections utilize information provided in this data set.

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as Contact Person can answer questions concerning appropriate use of data.

Contact Information

Contact Person: Bruce Johnson

Contact Organization: U.S. Geological Survey

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bjohnson@galileo.wr.usgs.gov

Native Data Set Environment: Computer

Operating System: SUN/ARC/INFO

Filename: /emp/crbv/crb/min/lithm, Native

File Size: 27.12 Mb, Export File Size:

50.22 Mb

Data Quality Information:

Topology and attributes for this theme were manually checked by comparing plots of the processed data against original materials. Attribute accuracy information for source materials were not collected since acquisition of source data pre-dated FGDC metadata standards.

State geologic maps digitized by scanning Washington, Idaho, and Montana from paper sources and Wyoming, Utah, Nevada, and California from stable base material made from publication mylars. Maps edgematched at state lines. Montana had an RMS error on transform of 965m, the rest had RMS errors<190m. Map units for each state were classified by expert team. Using the

classifications, the maps were dissolved, unioned, slivers eliminated at state lines, then dissolved again. Classifications were then modified considering other geologic knowledge.

11 Ownership

Political components to this subbasin assessment are important whereas they commonly reflect land use practices and, in the case of private vs. public lands, ownership impacts the ability for management agencies to access areas for inventory or remediation purposes. For this reason, ownership was considered in this analysis at a broad scale using regional land ownership categories maintained by ICBEMP.

11.1 Data Documentation

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as Contact Person can answer questions concerning appropriate use of data.

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Attribute Domain Values

Enumerated Domain Value: 0

Enumerated Domain Value Definition: NOT ATTRIBUTED

Enumerated Domain Value: 11

Enumerated Domain Value Definition: FOREST SERVICE

Enumerated Domain Value: 20

Enumerated Domain Value Definition: DEPT OF DEFENSE

Enumerated Domain Value: 90

Enumerated Domain Value Definition: TRIBAL LAND

Enumerated Domain Value: 1

Enumerated Domain Value Definition: PRIVATE

Enumerated Domain Value: 80

Enumerated Domain Value Definition: STATE LAND

Enumerated Domain Value: 12

Enumerated Domain Value Definition: AGRICULTURAL RESEARCH SERVICE

12 Fish Distributions

Yellowstone cutthroat trout data used for the assessment were electrofishing surveys by various agencies, primarily relying on recent investigations by IDFG through the Native Salmonid Assessment Project.

Estimation of fish distributions and populations is not a trivial science and has serious ramifications. It is important to note that, in this assessment, the best attempt possible was made to generate an objective and representative snapshot as to the current status of fish populations and distributions. There is obviously some degree of inherent error on both spatial and temporal scales, however it is felt that the analyses included in

this assessment are representative of the most current and best estimation of distribution and status. More specific comments are referenced in the assessment text, and the authors are available for comment on their approaches.

Where appropriate, fish densities were calculated at survey locations for Yellowstone cutthroat trout. Densities were drawn from the number of fish surveyed (electrofishing) divided by the reach length, and then normalized by subbasin. Because fish density distributions are often strongly skewed toward lower densities, normalization provides a method to statistically separate low from nominal and high densities. For this assessment, low fish densities are $\frac{1}{2}$ standard deviation below the mean, nominal densities are $-1/2$ to $1/2$ standard deviations from the mean, and high densities are greater than $\frac{1}{2}$ standard deviation above the mean of the normalized distribution. Normalization of data ideally forces distributions to mimic a Gaussian distribution, however due to the strong skew of fish densities, the resulting histogram is not normal in appearance. It is, however, more normal than it was before the transform and allows the data to be displayed more effectively.

13 Southwest Idaho Ecogroup Data

In 2001, the Southwest Idaho Ecogroup, made up of the Boise, Payette and Sawtooth National Forests, produced a series of ecoregional assessments for southwestern Idaho. As part of this assessment, they compiled a large amount of spatial data relative to subbasin planning and performed many high-quality analyses. While this was an excellent project, the study areas for their assessment and those for subbasin planning do not overlap, making it difficult to incorporate much of their product into

subbasin planning assessments. An attempt was made to use their data as a reference to either substantiate or negate the findings of the authors in this subbasin assessment. However, large-scale implementation of their findings was very difficult to address.

Water quality integrity and geomorphic integrity were two figures that did incorporate the SWIEG data by replacing Inland West Watershed Initiative (IWWI) calls with the SWIEG calls in the 6th field HUCs covered by SWIEG. Fire perimeters and years compiled by SWIEG were also used.

14 Urban Rural Development Class (Urban Sprawl)

An assessment of how urbanization and urban sprawl are affecting natural systems could be an integral part of subbasin planning. In an attempt to constrain the effects of urban areas and their proximity to natural resources, we analyzed the Urban Rural Development Class layer maintained by ICBEMP. This layer provides a very sweeping picture of the geographic and intensity effects of population centers on nearby systems. This layer is based on a variety of older data; it is notable that there is more current information available. However, this layer was the only known source that assessed impacts of this type on a basin scale. It was not used for detailed analysis.

14.1 Data Documentation

Originator: Interior Columbia Basin Ecosystem Management Project

Publication Date: 05/30/1997

Title: Urban / Rural Classes

Other Citation Details:

/emp/crbg/crb/demog/rurbclass

Online Linkage:

<http://www.icbemp.gov/spatial/demog/>

Abstract

Urban Rural Development Class. A classification of influence to lands within the ICBEMP from human-created developments.

Purpose: Used as one of the measures of human influence at the landscape level in the Scientific Assessment of the ICBEMP.

This theme is a general correlate for developments such as housing, roads, industry, utilities, and assorted human-created developments. Classes range from low influence to very high influence for all lands within the Basin.

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as Contact Person can answer questions concerning appropriate use of data.

Attribute Accuracy Report

This is a data set resulting from modeling or analysis. The accuracy of the attributes are dependent on the accuracy of source materials as well as the statistical accuracy of the modeling process. Attribute accuracy information for source materials were not collected since acquisition of source data predated FGDC metadata standards.

Logical Consistency Report

Not applicable to raster data.

Completeness Report

These data are as complete as the source data maps: Towns DCW-1:1M Point (export name BVBTOWNB) and Road Density Predicted (export name BGBRDDN).

Originator: Intermountain Fire Science Lab - Missoula, MT

Publication Date: 02/29/1996

Title: Road Density (Predicted)

Other Citation Details:

/emp/crbg/crb/culture/roaddens

Online Linkage:

<http://www.icbemp.gov/spatial/culture/>

Originator: Census Bureau

Publication Date: 09/18/1995

Title: Towns—100k (Point)

Other Citation Details:

/emp/subv/crb/demog/towns

Online Linkage:

<http://www.icbemp.gov/spatial/demog/>

Process Description

Reclass Urban Pop Wildland Interface very high to high and very low to low; take category of towns (Yakima, Tri Cities, Spokane, Missoula, Boise, Caldwell) & assign very high class to all areas w/in 60 miles of center w/predicted road density $\geq$ moderate.

Attribute Domain Values

Enumerated Domain Value: 2

Enumerated Domain Value Definition:
LOW—Influence from Human-Created Developments

Enumerated Domain Value: 3

Enumerated Domain Value Definition:
MODERATE—Influence from Human-Created Developments

Enumerated Domain Value: 5

Enumerated Domain Value Definition: VERY HIGH—Influence from Human-Created Developments

Enumerated Domain Value: 4

Enumerated Domain Value Definition:
HIGH—Influence from Human-Created
Developments

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APPENDIX 2-2—KEY ECOLOGICAL FUNCTIONS OF SPECIES

A Hierarchical Classification of KEFs and KECs

I Major Assumptions with the IBIS Data set

The Northwest Habitat Institute (NHI) Interactive Biodiversity Information System (IBIS), supplied the data set used in the assessment of the key ecological functions for the wildlife species in the Upper Snake province. The data set included information from basinwide wildlife habitat maps. Vegetation maps from all or parts of seven states (Idaho, Montana, Nevada, Oregon, Utah, Washington and Wyoming) in the Columbia River Basin were used by NHI to develop the wildlife habitat maps depicting current conditions. These maps were developed to serve as an initial basis for large-scale mapping or database investigations.

Consequently, the wildlife habitat maps used in this assessment provide only an initial depiction of the amounts of wildlife habitats that may exist within watersheds, but are not of sufficient resolution for depicting the site-specific location of habitats within each watershed. Thus, wildlife habitats that occur in patch sizes less than 250 acres (i.e., linear riparian habitat) are likely underrepresented in the assessment.

Further, there has been no formal validation of the basinwide current wildlife habitat maps. Because maps are only a representation of reality and cannot depict all the detail represented in nature, some generalization is unavoidable. It is also important to note that remotely sensed maps developed from photograph interpretation or satellite imagery also contain errors.

NHI also developed a historic map by combining products from two previous works: Interior Columbia Basin Ecosystem Management Project (ICBEMP 1997) and the Oregon Biodiversity Project (Defenders of Wildlife 1998). These two mapping efforts used very different methods. The ICBEMP historic data were mostly derived from a modeling exercise, and the Oregon Biodiversity Project map was created from using surveyor notes from the 1850 land survey. Thus, the historic map is a theoretical construct with a coarse (1-km² pixel size) level of resolution. Wildlife habitats that are small or linear in size or shape (i.e., riparian or herbaceous wetlands) are underrepresented in the historic condition maps. In addition, no validation of the historic map was completed, and because there are no recognized historical data sets presently available, validation is difficult. Hence, the historic map best depicts gross generalizations of gains or losses of specific wildlife habitats.

II Classification of the Key Ecological Functions (KEFs) of Wildlife

(Marcot and Vander Heyden 2001)

1. Trophic relationships

- 1.1. heterotrophic consumer (an organism that is unable to manufacture its own food and must feed on other organisms)
 - 1.1.1. primary consumer (herbivore; an organism that feeds primarily on plant material)
(also see below under Herbivory)

- 1.1.1.1. foliovore (leaf eater)
- 1.1.1.2. spermivore (seed eater)
- 1.1.1.3. browser (leaf, stem eater)
- 1.1.1.4. grazer (grass, forb eater)
- 1.1.1.5. frugivore (fruit eater)
- 1.1.1.6. sap feeder
- 1.1.1.7. root feeders
- 1.1.1.8. nectivore (nectar feeder)
- 1.1.1.9. fungivore (fungus feeder)
- 1.1.1.10. flower/bud/catkin feeder
- 1.1.1.11. aquatic herbivore
- 1.1.1.12. feeds in water on decomposing benthic substrate (benthic is the lowermost zone of a water body)
- 1.1.1.13. bark/cambium/bole feeder
- 1.1.2 secondary consumer (primary predator or primary carnivore; a carnivore that preys on other vertebrate or invertebrate animals, primarily herbivores)
 - 1.1.2.1 invertebrate eater
 - 1.1.2.1.1 terrestrial invertebrates
 - 1.1.2.1.2 aquatic macroinvertebrates (e.g., not plankton)
 - 1.1.2.1.3 freshwater or marine zooplankton
 - 1.1.2.2 vertebrate eater (consumer or predator of herbivorous or carnivorous vertebrates)
 - 1.1.2.2.1 piscivorous (fish eater)
 - 1.1.2.3 ovivorous (egg eater)
- 1.1.3 tertiary consumer (secondary predator or secondary carnivore; a carnivore that preys on other carnivores)
- 1.1.4 carrion feeder (feeds on dead animals)
- 1.1.5 cannibalistic (eats members of its own species)
- 1.1.6 coprophagous (feeds on fecal material)
- 1.1.7 feeds on human garbage/refuse
 - 1.1.7.1 aquatic (e.g., offal and bycatch of fishing boats)
 - 1.1.7.2 terrestrial (e.g., garbage cans, landfills)
- 1.2 prey relationship
 - 1.2.1 prey for secondary or tertiary consumer (primary or secondary predator)

2. Aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)
3. Organismal relationships
 - 3.1. controls or depresses insect population peaks
 - 3.2. controls terrestrial vertebrate populations (through predation or displacement)
 - 3.3. pollination vector
 - 3.4. transportation of viable seeds, spores, plants, or animals (through ingestion, caching, caught in hair or mud on feet, etc.)
 - 3.4.1. disperses fungi
 - 3.4.2. disperses lichens
 - 3.4.3. disperses bryophytes, including mosses
 - 3.4.4. disperses insects and other invertebrates (phoresis)
 - 3.4.5. disperses seeds/fruits (through ingestion or caching)
 - 3.4.6. disperses vascular plants
 - 3.5. creates feeding, roosting, denning, or nesting opportunities for other organisms
 - 3.5.1. creates feeding opportunities (other than direct prey relations)
 - 3.5.1.1. creates sapwells in trees
 - 3.5.2. creates roosting, denning, or nesting opportunities
 - 3.6. primary creation of structures (possibly used by other organisms)
 - 3.6.1. aerial structures (typically large raptor or squirrel stick or leaf nests in trees or on platforms, or barn swallow/cliff swallow nests)
 - 3.6.2. ground structures (above-ground, nonaquatic nests and ends and other substrates, such as woodrat middens, nesting mounds of swans, for example)
 - 3.6.3. aquatic structures (muskrat lodges, beaver dams)
 - 3.7. user of structures created by other species
 - 3.7.1. aerial structures (typically large raptor or squirrel stick or leaf nests in trees or on platforms, or barn swallow/cliff swallow nests)
 - 3.7.2. ground structures (above-ground, nonaquatic nests and ends and other substrates, such as woodrat middens, nesting mounds of swans, for example)
 - 3.7.3. aquatic structures (muskrat lodges, beaver dams)
 - 3.8. nest parasite
 - 3.8.1. interspecies parasite (commonly lays eggs in nests of other species)
 - 3.8.2. common interspecific host (parasitized by other species)
 - 3.9. primary cavity excavator in snags or live trees (organisms able to excavate their own cavities)

- 3.10. secondary cavity user (organisms that do not excavate their own cavities and depend on primary cavity excavators or natural cavities)
- 3.11. primary burrow excavator (fossorial or underground burrows)
 - 3.11.1. creates large burrows (rabbit-sized or larger)
 - 3.11.2. creates small burrows (less than rabbit-sized)
- 3.12. uses burrows dug by other species (secondary burrow user)
- 3.13. creates runways (possibly used by other species; runways typically are worn paths in dense vegetation)
- 3.14. uses runways created by other species
- 3.15. pirates food from other species
- 3.16. interspecific hybridization (species known to regularly interbreed)
- 4. Carrier, transmitter, or reservoir of vertebrate diseases
 - 4.1. diseases that affect humans
 - 4.2. diseases that affect domestic animals
 - 4.3. diseases that affect other wildlife species
- 5. Soil relationships
 - 5.1. physically affects (improves) soil structure, aeration (typically by digging)
 - 5.2. physically affects (degrades) soil structure, aeration (typically by trampling)
- 6. Wood structure relationships (either living or dead wood)
 - 6.1. physically fragments down wood
 - 6.2. physically fragments standing wood
- 7. Water relationships
 - 7.1. impounds water by creating diversions or dams
 - 7.2. creates ponds or wetlands through wallowing
- 8. Vegetation structure and composition relationships
 - 8.1. creates standing dead trees (snags)
 - 8.2. herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)
 - 8.3. herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)

III Defining Habitat Elements—Key Environmental Correlates (KECs)

(O'Neil *et al.* 2001)

Site-specific habitat elements are those components of the environment believed to most influence wildlife species distribution, abundance, fitness, and viability (definition adapted from Marcot *et al.* (1997) and Mayer and Laudenslayer (1988). In this context, habitat elements include natural attributes, both biological and physical (e.g., large trees, woody debris, cliffs, and soil characteristics) as well as anthropogenic features and their effects such as roads, buildings, and pollution. Including these fine-scale attributes of an animal's environment when describing the habitat associations for a particular species expands the concept and definition of habitat, a term widely used only to characterize the vegetative community or structural condition occupied by a species. Failing to assess and inventory habitat elements within these communities and conditions may lead to errors of commission; species may be presumed to occur when in actuality they do not. Habitat elements that influence a species negatively may preclude occupancy or breeding despite adequate floristic or structural conditions.

Traditionally defined, the term habitat is that set of environmental conditions, usually depicted as food, water, and cover, used and selected for by a given organism.

Despite this broad definition, many land management agencies use the term habitat to denote merely the vegetation conditions and/or structural or seral stages used by a particular species. However, many other environmental attributes or features influence and affect the population viability of wildlife species. Marcot *et al.* (1997) in their assessment of the terrestrial species of the Columbia River Basin emphasized the importance of examining all features that exert influence on wildlife by expanding the definition of habitat to encompass all environmental correlates, naming the entirety of these attributes key environmental correlates or KECs. All environmental scales, from broad floristic communities to fine-scale within-stand features, were included in their definition of a KEC. The word "key" in key environmental correlate refers to the high degree of influence (either positive or negative) the environmental correlates exert on the realized fitness of a given species. Nonetheless, when this information was determined, only direct relationships between the habitat element and a species were identified. Most of the habitat elements-species associations refer to mostly positive influences between the habitat elements and the species. Negative influence between habitat elements and the species may be viewed as environmental stressors; however, a comprehensive list of negative influences is not presented here.

The list of habitat elements and their definitions was derived from Marcot *et al.* 1997 and was refined and edited based on the published literature and expert review. The final list comprises 287 habitat elements, including naturally occurring biological and physical elements as well as elements created or caused by human actions. Definitions are provided to characterize each element and clarify the nature of its influence on wildlife species. The following are habitat elements definitions.

1. Forest, shrubland, and grassland habitat elements

Biotic, naturally occurring attributes of forest and shrubland communities; the information that follows is for mostly positive relationships.

- 1.1 Forest/woodland vegetative elements or substrates. Biotic components found within a forested context.
 - 1.1.1 Down wood. Includes downed logs, branches, and rootwads.
 - 1.1.1.1 Decay class. A system by which down wood is classified based on its deterioration.
 - 1.1.1.1.1 hard (class 1, 2). Little wood decay evident; bark and branches present; log resting on branches, not fully in contact with ground; includes classes 1 and 2 as described in Thomas 1979.
 - 1.1.1.1.2 moderate (class 3). Moderate decay present; some branches and bark missing or loose; most of log in contact with ground; includes class 3 as described in Thomas 1979.
 - 1.1.1.1.3 soft (class 4, 5). Well decayed logs; bark and branches missing; fully in contact with ground; includes classes 4 and 5 as described in Thomas 1979.
 - 1.1.1.2 Down wood in riparian areas. Includes down wood in the terrestrial portion of riparian zones in forest habitats. Does not refer to instream woody debris.
 - 1.1.1.3 Down wood in upland areas. Includes downed wood in upland areas of forest habitats.
 - 1.1.2 Litter. The upper layer of loose, organic (primarily vegetative) debris on the forest floor. Decomposition may have begun, but components still recognizable.
 - 1.1.3 Duff. The matted layer of organic debris beneath the litter layer. Decomposition more advanced than in litter layer; intergrades with uppermost humus layer of soil.
 - 1.1.4 Shrub layer. Refers to the shrub strata within forest stands.

Biotic components found within a shrubland or grassland context (these are positive influences only).

- 1.2.1 Herbaceous layer. Zone of understory nonwoody vegetation beneath shrub layer (nonforest context). May include forbs, grasses.
- 1.2.2 Fruits/seeds/nuts. Plant reproductive bodies that are used by animals.
- 1.2.3 Moss. Large group of green plants without flowers but with small leafy stems growing in clumps.
- 1.2.4 Cactus. Any of a large group of drought resistant plants with fleshy, usually jointed stems and leaves replaced by scales or spines.
- 1.2.5 Flowers. A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.

- 1.2.6 Shrubs. Plant with persistent woody stems and <16.5 feet tall; usually produces several basal shoots as opposed to a single bole.
 - 1.2.6.1 Shrub size. Refers to shrub height.
 - 1.2.6.1.1 small <2.0 feet
 - 1.2.6.1.2 medium 2.0–6.5 feet
 - 1.2.6.1.3 large 6.5–16.5 feet
 - 1.2.6.2 Percent shrub canopy cover. Percent of ground covered by vertical projection of shrub crown diameter.
 - 1.2.6.3 Shrub canopy layer. Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies.
 - 1.2.6.3.1 Subcanopy. The space below the predominant shrub crowns.
 - 1.2.6.3.2 Above canopy. The space above the predominant shrub crowns.
- 1.2.7 Fungi. Mushrooms, molds, yeasts, rusts, etc.
- 1.2.8 Forbs. Broad-leaved herbaceous plants. Does not include grasses, sedges, or rushes.
- 1.2.9 Bulbs/tubers. Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.
- 1.2.10 Grasses. Members of the Graminae family.
- 1.2.11 Cryptogamic crusts. Nonvascular plants that grow on the soil surface. Primarily lichens, mosses, and algae. Often found in arid or semiarid regions. May form soil surface pinnacles.
- 1.2.12 Trees (located in a shrubland/grassland context). Small groups of trees or isolated individuals.
 - 1.2.12.1 Snags. Standing dead trees.
 - 1.2.12.1.1 Decay class. System by which snags are classified based on their deterioration.
 - 1.2.12.1.1.1 hard. Little wood decay evident; bark, branches, top, present; recently dead; includes class 1.
 - 1.2.12.1.1.2 moderate. Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown 1985.
 - 1.2.12.1.1.3 soft. Well-decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown 1985.
 - 1.2.12.2 Snag size. Measured in dbh, as previously defined.
 - 1.2.12.2.1 shrub/seedling <1 inch dbh
 - 1.2.12.2.2 sapling/pole 1–9 inches dbh

1.2.12.2.3 small tree 10–14 inches dbh

1.2.12.2.4 medium tree 15–19 inches dbh

1.2.12.2.5 large tree 20–29 inches dbh

1.2.12.2.6 giant tree >30 inches dbh

1.2.12.3 Tree size. Measured in dbh, as previously defined.

1.2.12.3.1 shrub/seedling <1 inch dbh

1.2.12.3.2 sapling/pole 1–9 inches dbh

1.2.12.3.3 small tree 10–14 inches dbh

1.2.12.3.4 medium tree 15–19 inches dbh

1.2.12.3.5 large tree 20–29 inches dbh

1.2.12.3.6 giant tree >30 inches dbh

1.2.13 Edges. The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together.

2. Ecological habitat elements

Selected interspecies relationships within the biotic community; they include both positive and negative influences.

2.1 Exotic species. Any nonnative plant or animal, including cats, dogs, and cattle.

2.1.1 Plants. This field refers to the relationship between an exotic plant species and animal species.

2.1.2 Animals. This field refers to the relationship between an exotic animal species and the animal species.

2.1.2.1 Predation. The species queried is preyed upon by or preys upon an exotic species.

2.1.2.2 Direct displacement. The species queried is physically displaced by an exotic species, either by competition or actual disturbance.

2.1.2.3 Habitat structure change. The species queried is affected by habitat structural changes caused by an exotic species, for example, cattle grazing.

2.1.2.4 Other. Any other effects of an exotic species on a native species.

2.2 Insect population irruptions. The species directly benefits from insect population irruptions (i.e., benefits from the insects themselves, not the resulting tree mortality or loss of foliage).

2.2.1 Mountain pine beetle. The species directly benefits from mountain pine beetle eruptions.

2.2.2 Spruce budworm. The species directly benefits from spruce budworm irruptions.

2.2.3 Gypsy moth. The species directly benefits from gypsy moth irruptions.

- 2.3 Beaver/muskrat activity. The results of beaver activity including dams, lodges, and ponds, that are beneficial to other species.
- 2.4 Burrows. Aquatic or terrestrial cavities produced by burrowing animals that are beneficial to other species.

3. Nonvegetative, Abiotic, Terrestrial Habitat Elements

Nonliving components found within any ecosystem. Primarily positive influences with a few exceptions as indicated.

- 3.1 Rocks. Solid mineral deposits.
 - 3.1.1 Gravel. Particle size from 0.1–3.0 inches (0.2–7.6 cm) in diameter; gravel bars associated with streams and rivers are a separate category.
 - 3.1.2 Talus. Accumulations of rocks at the base of cliffs or steep slopes; rock/boulder sizes varied and determine what species can inhabit the spaces between them.
 - 3.1.3 Talus-like habitats. Refers to areas that contain many rocks and boulders but are not associated with cliffs or steep slopes.
- 3.2 Soils. Various soil characteristics.
 - 3.2.1 Soil depth. The distance from the top layer of the soil to the bedrock or hardpan below.
 - 3.2.2 Soil temperature. Any measure of soil temperature or range of temperatures that are key to the queried species.
 - 3.2.3 Soil moisture. The amount of water contained within the soil.
 - 3.2.4 Soil organic matter. The accumulation of decomposing plant and animal materials found within the soil.
 - 3.2.5 Soil texture. Refers to size distribution and amount of mineral particles (sand, silt, and clay) in the soil; examples are sandy clay, sandy loam, silty clay, etc.
- 3.3 Rock substrates. Various rock formations.
 - 3.3.1 Avalanche chute. An area where periodic snow or rock slides prevent the establishment of forest conditions; typically shrub and herb dominated (sitka alder, *Alnus sinuate*, and/or vine maple, *Acer circinatum*).
 - 3.3.2 Cliffs. A high, steep formation, usually of rock. Coastal cliffs are a separate category under Marine Habitat Elements.
 - 3.3.3 Caves. An underground chamber open to the surface with varied opening diameters and depths; includes cliff-face caves, intact lava tubes, coastal caves, and mine shafts.
 - 3.3.4 Rocky outcrops and ridges. Areas of exposed rock.
 - 3.3.5 Rock crevices. Refers to the joint spaces in cliffs, and fissures and openings between slab rock; crevices among rocks and boulders in talus fields are a separate category (talus).

3.3.6 Barren ground. Bare exposed soil with >40% of area not vegetated; includes mineral licks and bare agricultural fields; natural bare exposed rock is under the rocky outcrop category.

3.3.7 Playa (alkaline, saline). Shallow desert basins that are without natural drainage ways where water accumulates and evaporates seasonally.

3.4 Snow. Selected features of snow.

3.4.1 Snow depth. Any measure of the distance between the top layer of snow and the ground below.

3.4.2 Glaciers, snow field. Areas of permanent snow and ice.

4. Freshwater Riparian and Aquatic Bodies Habitat Elements

Includes selected forms and characteristics of any body of freshwater attributes. Ranges of continuous attributes that are key to the queried species, if known, will be in the comments.

4.1.1 Dissolved oxygen. Amount of oxygen passed into solution.

4.1.2 Water depth. Distance from the surface of the water to the bottom substrate.

4.1.3 Dissolved solids. A measure of dissolved minerals in water

4.1.4 Water pH. A measure of water acidity or alkalinity.

4.1.5 Water temperature. Water temperature range that is key to the queried species; if known, it is in the comments field.

4.1.6 Water velocity. Speed or momentum of water flow.

4.1.7 Water turbidity. Amount of roiled sediment within the water.

4.1.8 Free water. Water derived from any source.

4.1.9 Salinity and alkalinity. The presence of salts.

4.2 Rivers and streams. Various characteristics of streams and rivers.

4.2.1 Oxbows. A pond or wetland created when a river bend is cut off from the main channel of the river.

4.2.2 Order and class. Systems of stream classification.

4.2.2.1 Intermittent. Streams/rivers that contain nontidal flowing water for only part of the year; water may remain in isolated pools.

4.2.2.2 Upper perennial. Streams/rivers with a high gradient, fast water velocity, no tidal influence; some water flowing throughout the year, substrate consists of rock, cobbles, or gravel with occasional patches of sand; little floodplain development.

4.2.2.3 Lower perennial. Streams/rivers with a low gradient, slow water velocity, no tidal influence; some water flowing throughout the year, substrate consists mainly of sand and mud; floodplain is well developed.

- 4.2.3 Zone. System of water body classification based on the horizontal strata of the water column.
 - 4.2.3.1 Open water. Open water areas not closely associated with the shoreline or bottom.
 - 4.2.3.2 Submerged/benthic. Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within 3.2 feet (1 m) of the substrate.
 - 4.2.3.3 Shoreline. Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.
- 4.2.4 In-stream substrate. The bottom materials in a body of water.
 - 4.2.4.1 Rocks. Rocks >10 inches (256 mm) in diameter.
 - 4.2.4.2 Cobble/gravel. Rocks or pebbles, .1–10 inches (2.5–256 mm) in diameter, substrata may consist of cobbles, gravel, shell, and sand with no substratum type >70% cover.
 - 4.2.4.3 Sand/mud. Fine substrata <.01 inch (1mm) in diameter, little gravel present, may be mixed with organics.
- 4.2.5 Vegetation. Herbaceous plants.
 - 4.2.5.1 Submergent vegetation. Rooted aquatic plants that do not emerge above the water surface.
 - 4.2.5.2 Emergent vegetation. Rooted aquatic plants that emerge above the water surface.
 - 4.2.5.3 Floating mats. Unrooted plants that form vegetative masses on the surface of the water.
- 4.2.6 Coarse woody debris in streams and rivers. Any piece of woody material (debris piles, stumps, root wads, fallen trees) that intrudes into or lies within a river or stream.
- 4.2.7 Pools. Portions of the stream with reduced current velocity, often with water deeper than surrounding areas.
- 4.2.8 Riffles. Shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but where standing waves are absent.
- 4.2.9 Runs/glides. Areas of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.
- 4.2.10 Overhanging vegetation. Herbaceous plants that cascade over stream and river banks and are <3.2 feet (1 m) above the water surface.
- 4.2.11 Waterfalls. Steep descent of water within a stream or river.

4.2.12 Banks. Rising ground that borders a body of water.

4.2.13 Seeps or springs. A concentrated flow of ground water issuing from openings in the ground.

4.3 Ephemeral pools. Pools that contain water for only brief periods of time usually associated with periods of high precipitation.

4.4 Sand bars. Exposed areas of sand or mud substrate.

4.5 Gravel bars. Exposed areas of gravel substrate.

4.6 Lakes/ponds/reservoirs. Various characteristics of lakes, ponds, and reservoirs.

4.6.1 Zone. System of water body classification based on the horizontal strata of the water column.

4.6.1.1 Open water. Open water areas not closely associated with the shoreline or bottom substrates.

4.6.1.2 Submerged/benthic. Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.

4.6.1.3 Shoreline. Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.6.2 In-water substrate. The bottom materials in a body of water.

4.6.2.1 Rock. Rocks >10 inches (256 mm) in diameter.

4.6.2.2 Cobble/gravel. Rocks or pebbles, .1–10 inches (2.5–256 mm) in diameter, substrata may consist of cobbles, gravel, shell, and sand with no substratum type exceeding 70% cover.

4.6.2.3 Sand/mud. Fine substrata <.1 inch (2.5 mm) in diameter, little gravel present, may be mixed with organics.

4.6.3 Vegetation. Herbaceous plants.

4.6.3.1 Submergent vegetation. Rooted aquatic plants that do not emerge above the water surface.

4.6.3.2 Emergent vegetation. Rooted aquatic plants that emerge above the water surface.

4.6.3.3 Floating mats. Unrooted plants that form vegetative masses on the surface of the water.

4.6.4 Size. Refers to whether or not the species is differentially associated with water bodies based on their size.

4.6.4.1 Ponds. Bodies of water <5 acre (2 ha).

4.6.4.2 Lakes. Bodies of water >5 acre (2 ha).

- 4.7 Wetlands/marshes/wet meadows/bogs and swamps. Various components and characteristics related to any of these systems.
 - 4.7.1 Riverine wetlands. Wetlands found in association with rivers.
 - 4.7.2 Context When checked, indicates that the setting of the wetland, marsh, wet meadow, bog, or swamp is key to the queried species.
 - 4.7.2.1 Forest. Wetlands within a forest.
 - 4.7.2.2 Nonforest. Wetlands that are not surrounded by forest.
 - 4.7.3 Size. When checked, indicates that the queried species is differentially associated with a wetland, marsh, wet meadow, bog, or swamp based on the size of the water body.
 - 4.7.4 Marshes. Frequently or continually inundated wetlands characterized by emergent herbaceous vegetation (grasses, sedges, reeds) adapted to saturated soil conditions.
 - 4.7.5 Wet meadows. Grasslands with waterlogged soil near the surface but without standing water for most of the year.
- 4.8 Islands. A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water.
- 4.9 Seasonal flooding. Flooding that occurs periodically due to precipitation patterns.

5. Marine Habitat Elements

Selected biotic and abiotic components and characteristics of marine systems - water depth, and relationship to substrate.

- 5.1.1 Supratidal. The zone that extends landward from the higher high water line up to either the top of a coastal cliff or the landward limit of marine process (i.e., storm surge limit).
 - 5.1.2 Intertidal. The zone between the higher high water line and the lower low water line.
 - 5.1.3 Nearshore subtidal. The zone that extends from the lower low water line seaward to the 65 foot (20 m) isobath, typically within 0.6 miles (1 km) of shore.
 - 5.1.4 Shelf. The area between the 65–650 feet (20–200 m) isobath, typically within 36 miles (60 km) of shore.
 - 5.1.5 Oceanic. The zone that extends seaward from the 650 feet (200 m) isobath.
- 5.2 Substrates. The bottom materials of a body of water.
- 5.2.1 Bedrock. The solid rock underlying surface materials.
 - 5.2.2 Boulders. Large, worn, rocks >10 inches (256 mm) in diameter.
 - 5.2.3 Hardpan. Consolidated clays forming a substratum firm enough to support an epibenthos and too firm to support a normal infauna (clams, worms, etc.), but with an unstable surface that sloughs frequently.

- 5.2.4 Cobble. Rocks or pebbles, 2.5–10 inches (64–256 mm) in diameter, may be a mix of cobbles, gravel, shells, and sand, with no type exceeding 70% cover.
- 5.2.5 Mixed-coarse. Substrata consisting of cobbles, gravel, shell, and sand with no substratum type exceeding 70% cover.
- 5.2.6 Gravel. Small rocks or pebbles, 0.2–2.5 inches (4–64 mm) in diameter.
- 5.2.7 Sand. Fine substrata <0.2 inch (4 mm) in diameter, little gravel present, may be mixed with organics.
- 5.2.8 Mixed-fine. Mixture of sand and mud particles <0.2 inch (4 mm) in diameter, little gravel present.
- 5.2.9 Mud. Fine substrata <0.002 inch (0.06 mm) in diameter, little gravel present, usually mixed with organics.
- 5.2.10 Organic. Substrata composed primarily of organic matter such as wood chips, leaf litter, or other detritus.
- 5.3 Energy. Degree of exposure to oceanic swell, currents, and wind waves.
 - 5.3.1 Protected. No sea swells, little or no current, and restricted wind fetch.
 - 5.3.2 Semi-protected. Shorelines protected from sea swell, but may receive waves generated by moderate wind fetch, and/or moderate-to-weak tidal currents.
 - 5.3.3 Partially exposed. Oceanic swell attenuated by offshore reefs, islands, or headlands, but shoreline substantially exposed to wind waves, and/or strong-to-moderate tidal currents.
 - 5.3.4 Exposed. Highly exposed to oceanic swell, wind waves, and/or very strong currents.
- 5.4 Vegetation. Includes herbaceous plants and plants lacking vascular systems.
 - 5.4.1 Mixed macro algae. Includes brown, green, and red algae.
 - 5.4.2 Kelp. Subaquatic rooted vegetation found in the nearshore marine environment
 - 5.4.3 Eelgrass. Subaquatic rooted vegetation found in an estuarine environment
- 5.5 Water depth. Refers to the vertical layering of the water column.
 - 5.5.1 Surface layer. The uppermost part of the water column.
 - 5.5.1.1 Tide rip. A current of water disturbed by an opposing current, especially in tidal water or by passage over an irregular bottom.
 - 5.5.1.2 Surface microlayer (neuston). The thin uppermost layer of the water surface.
 - 5.5.2 Euphotic. Upper layer of a water body that receives sufficient sunlight for the photosynthesis of plants.
 - 5.5.3 Disphotic. Area below the euphotic zone where photosynthesis ceases.
 - 5.5.4 Demersal/benthic. Submerged lands including vegetated and unvegetated areas.

- 5.6 Water temperature. Measure of ocean water temperature.
- 5.7 Salinity. The presence and concentration of salts; salinity range that is key to the species, if it is known, will be in the comments field.
- 5.8 Forms. Morphological elements within marine areas.
- 5.8.1 Beach. An accumulation of unconsolidated material (sand, gravel, angular fragments) formed by waves and wave-induced currents in the intertidal and subtidal zones.
 - 5.8.2 A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water at higher high water for large (spring) tide. Includes off-shore marine cliffs.
 - 5.8.3 Marine cliffs (mainland). A sloping face steeper than 20½ usually formed by erosion and composed of either bedrock and/or unconsolidated materials.
 - 5.8.4 Delta. An accumulation of sand, silt, and gravel deposited at the mouth of a stream where it discharges into the sea.
 - 5.8.5 Dune. In a marine context; a mound or ridge formed by the transportation and deposition of wind-blown material (sand and occasionally silt).
 - 5.8.6 Lagoon. Shallow depression within the shore zone continuously occupied by salt or brackish water lying roughly parallel to the shoreline and separated from the open sea by a barrier.
 - 5.8.7 Salt marsh. A coastal wetland area that is periodically inundated by tidal brackish or salt water and that supports significant (15% cover) nonwoody vascular vegetation (e.g., grasses, rushes, sedges) for at least part of the year.
 - 5.8.8 Reef. A rock outcrop, detached from the shore, with maximum elevations below the high-water line.
 - 5.8.9 Tidal flat. A level or gently sloping (<5½) constructional surface exposed at low tide, usually consisting primarily of sand or mud with or without detritus, and resulting from tidal processes.
- 5.9 Water clarity. As influenced by sediment load.

6. (No Data)

Formerly contained topographic information, such as elevation, that has been moved to the life history matrix.

7. Fire as a Habitat Element

Refers to species that benefit from fire. The time frame after which the habitat is suitable for the species, if known, will be found in the comments field.

8. Anthropogenic Related Habitat Elements

This section contains selected examples of human-related habitat elements that may be a key part of the environment for many species. These habitat elements may have either a negative or positive influence on the queried species.

- 8.1 Campgrounds/picnic areas. Sites developed and maintained for camping and picnicking.
- 8.2 Roads. Either paved or unpaved.
- 8.3 Buildings. Permanent structures.
- 8.4 Bridges. Permanent structures typically over water or ravines.
- 8.5 Diseases transmitted by domestic animals. Some domestic animal diseases may be a source of mortality or reduced vigor for wild species.
- 8.6 Animal harvest or persecution. Includes illegal harvest/poaching, incidental take (resulting from fishing net by-catch, or by hay mowing, for example), and targeted removal for pest control.
- 8.7 Fences/corrals. Wood, barbed wire, or electric fences.
- 8.8 Supplemental food. Food deliberately provided for wildlife (e.g., bird feeders, ungulate feeding programs, etc.) as well as spilled or waste grain along railroads and cattle feedlots.
- 8.9 Refuse. Any source of human-derived garbage (includes landfills).
- 8.10 Supplemental boxes, structures and platforms. Includes bird houses, bat boxes, raptor and waterfowl nesting platforms.
- 8.11 Guzzlers and waterholes. Water sources typically built for domestic animal use.
- 8.12 Toxic chemical use. Proper use of regulated chemicals; documented effects only.
 - 8.12.1 Herbicides/fungicides. Chemicals used to kill vegetation and fungi.
 - 8.12.2 Insecticides. Chemicals used to kill insects.
 - 8.12.3 Pesticides. Chemicals used to kill vertebrate species.
 - 8.12.4 Fertilizers. Chemicals used to enhance vegetative growth.
- 8.13 Hedgerows/windbreaks. Woody and/or shrubby vegetation either planted or that develops naturally along fence lines and field borders.
- 8.14 Sewage treatment ponds. Settling ponds associated with sewage treatment plants.
- 8.15 Repellents. Various methods used to repel or deter wildlife species that damage crops or property (excluding pesticides and insecticides).
 - 8.15.1 Chemical (taste, smell, or tactile). Chemical substances that repel wildlife.
 - 8.15.2 Noise or visual disturbance. Nonchemical methods to deter wildlife.
- 8.16 Culverts. Drain crossings under roads or railroads.
- 8.17 Irrigation ditches/canals. Ditches built to transport water to agricultural crops or to handle runoff.

- 8.18 Powerlines/corridors. Utility lines, poles, and rights-of-way associated with transmission, telephone, and gas lines.
- 8.19 Pollution. Human-caused environmental contamination.
 - 8.19.1 Chemical. Contamination caused by chemicals.
 - 8.19.2 Sewage. Contamination caused by human waste.
 - 8.19.3 Water. Aquatic contamination from any source.
- 8.20 Piers. Structures built out over water.
- 8.21 Mooring piles, dolphins, buoys. Floating objects anchored out in the water for nautical purposes.
- 8.22 Bulkheads, seawalls, revetment. Retaining structures built to protect the shoreline from wave action.
- 8.23 Jetties, groins, breakwaters. Structures built to influence the current or protect harbors.
- 8.24 Water diversion structures. Structures built to funnel or direct water, including dams, dikes and levies.
- 8.25 Log boom. A raft of logs lashed together either to transport the logs or as barriers to boat traffic near marinas or dams.
- 8.26 Boats/ships. Watercraft, either motorized or nonmotorized.
- 8.27 Dredge spoil islands. Sediment deposited from dredging operations.
- 8.28 Hatchery facilities and fish. Fish that are hatched in captivity and later released into the wild. For simplicity this refers to freshwater areas, though marine birds and mammals likely feed on hatchery released fish too. This also includes the facilities and their operation.

B Total Functional Richness

Total functional richness is an ecological functional pattern that totals the number of KEF categories in a community. Total functional richness denotes the degree of functional complexity in a community, such that the more functionally diverse communities have a greater measure of total functional richness. The total functional richness in a community also denotes the degree to which the full “functional web” of a community would be provided or conserved (Marcot and Vander Heyden, 2001).

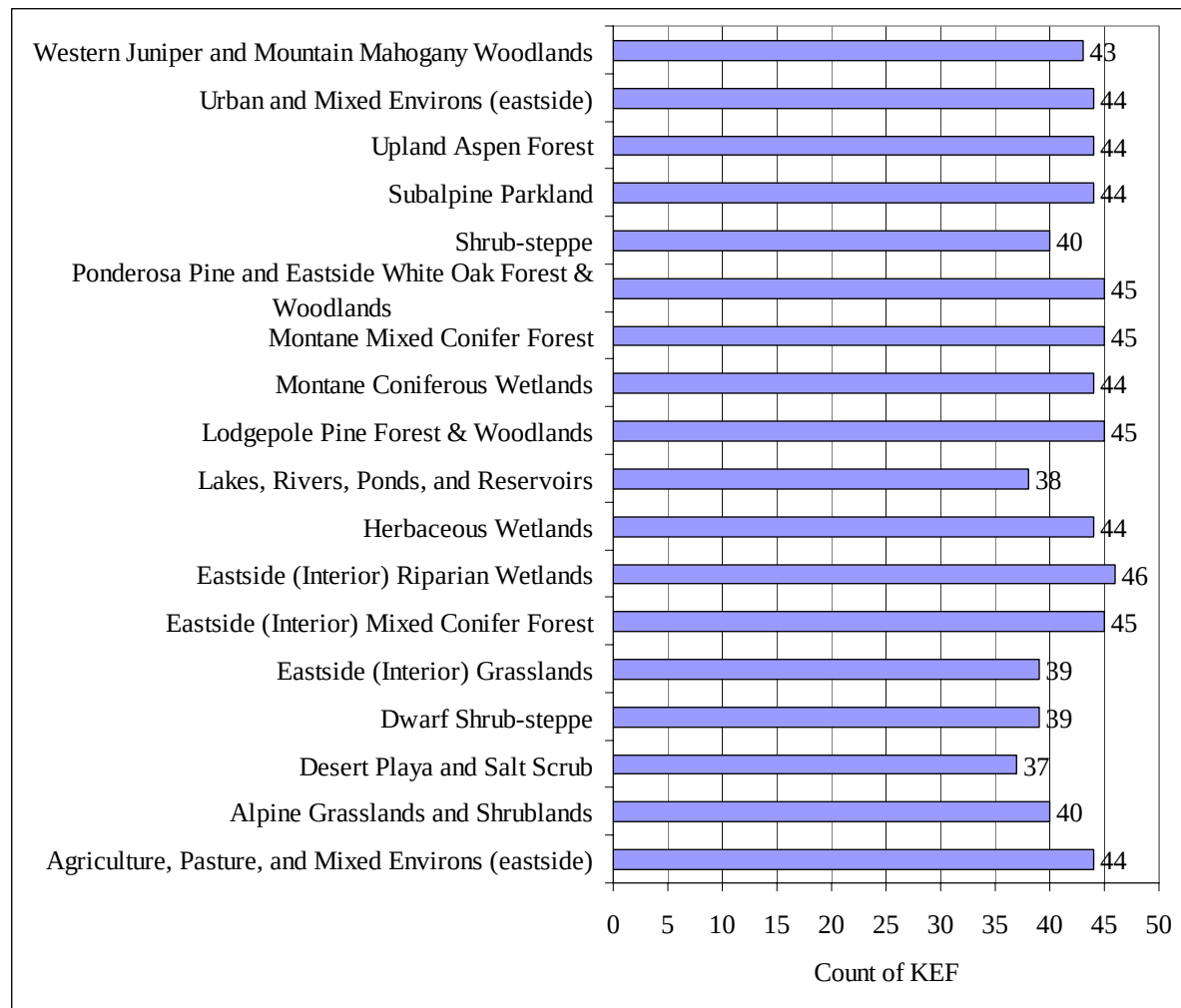


Figure 1. Total functional richness (number of KEFs) by wildlife habitat in the Upper Snake province (source: IBIS 2003).

C Wildlife Species Associated with Aquatic Environments

Table 1. Wildlife species identified as having associations with aquatic habitats in the Upper Snake province. This table was generated by searching the IBIS data set for species with category 4 KECs and then summing their respective KEFs and KECs.

Wildlife Species	KEF	KEC	Total Count
American avocet	12	4	16
American badger	1	5	6
American beaver	14	10	24
American bittern	4	2	6
American coot	8	8	16
American crow	4	7	11

Wildlife Species	KEF	KEC	Total Count
American dipper	13	2	15
American golden-plover	6	2	8
American marten	2	6	8
American tree sparrow	1	4	5
American white pelican	7	3	10
American wigeon	10	7	17
Baird's sandpiper	13	2	15
Bald eagle	12	5	17
Band-tailed pigeon	1	3	4
Bank swallow	4	4	8
Barn owl	1	4	5
Barn swallow	2	3	5
Barred owl	3	5	8
Barrow's goldeneye	7	5	12
Belted kingfisher	10	4	14
Bewick's wren	1	4	5
Big brown bat	8	4	12
Black bear	2	14	16
Black swift	1	1	2
Black tern	3	8	11
Black-bellied plover	6	2	8
Black-billed magpie	1	6	7
Black-capped chickadee	1	6	7
Black-crowned night-heron	7	5	12
Black-necked stilt	11	4	15
Blue grouse	2	4	6
Blue-winged teal	7	6	13
Bobcat	1	3	4
Bobolink	1	3	4
Bonaparte's gull	4	5	9
Bufflehead	9	5	14
Bullfrog	8	4	12
Burrowing owl	1	4	5
California gull	8	6	14
California myotis	8	3	11
California quail	1	4	5
Canada goose	8	4	12
Canvasback	15	7	22
Caspian tern	9	5	14
Cattle egret	1	5	6

Wildlife Species	KEF	KEC	Total Count
Chukar	1	4	5
Cinnamon teal	7	7	14
Clark's grebe	6	4	10
Cliff swallow	4	3	7
Common garter snake	5	4	9
Common goldeneye	9	5	14
Common loon	5	3	8
Common merganser	12	5	17
Common nighthawk	2	1	3
Common raven	2	8	10
Common tern	4	4	8
Common yellowthroat	2	3	5
Cooper's hawk	1	3	4
Coyote	1	8	9
Double-crested cormorant	8	5	13
Dunlin	14	2	16
Eared grebe	6	4	10
Eastern kingbird	1	5	6
Fisher	1	9	10
Forster's tern	10	6	16
Franklin's gull	4	7	11
Fringed myotis	6	3	9
Gadwall	8	7	15
Glaucous gull	4	6	10
Golden eagle	1	4	5
Gray partridge	1	4	5
Gray wolf	4	8	12
Great Basin spadefoot	9	7	16
Great blue heron	9	7	16
Great egret	10	6	16
Great gray owl	2	3	5
Great horned owl	1	4	5
Greater scaup	2	3	5
Greater white-fronted goose	7	7	14
Greater yellowlegs	16	2	18
Green heron	6	2	8
Green-winged teal	8	7	15
Harlequin duck	12	1	13
Herring gull	9	6	15
Hoary bat	6	3	9

Wildlife Species	KEF	KEC	Total Count
Hooded merganser	10	5	15
Horned grebe	6	4	10
Killdeer	17	5	22
Least bittern	3	5	8
Least sandpiper	15	2	17
Lesser scaup	13	7	20
Lesser yellowlegs	17	2	19
Lincoln's sparrow	1	6	7
Little brown myotis	7	3	10
Long-billed curlew	10	4	14
Long-billed dowitcher	9	2	11
Long-eared myotis	8	2	10
Long-legged myotis	8	3	11
Long-tailed vole	1	4	5
Long-toed salamander	14	6	20
Mallard	11	8	19
Marbled godwit	2	3	5
Marsh wren	4	2	6
Meadow vole	1	7	8
Merlin	2	1	3
Mink	5	7	12
Montane shrew	1	3	4
Montane vole	1	6	7
Moose	13	3	16
Mountain chickadee	1	7	8
Mountain goat	1	3	4
Mountain lion	1	4	5
Mountain quail	1	4	5
Mourning dove	4	3	7
Mule deer	2	8	10
Muskrat	9	6	15
Northern bog lemming	1	2	3
Northern goshawk	2	4	6
Northern harrier	3	2	5
Northern leopard frog	11	4	15
Northern pintail	8	7	15
Northern pocket gopher	1	4	5
Northern river otter	23	4	27
Northern rough-winged swallow	4	3	7
Northern saw-whet owl	1	2	3

Wildlife Species	KEF	KEC	Total Count
Northern shoveler	5	6	11
Northern shrike	1	2	3
Northern waterthrush	1	2	3
Osprey	7	2	9
Pacific chorus (tree) frog	9	6	15
Pacific-slope flycatcher	1	4	5
Painted turtle	8	4	12
Pallid bat	7	3	10
Pectoral sandpiper	11	2	13
Peregrine falcon	2	2	4
Pied-billed grebe	5	2	7
Pronghorn antelope	2	6	8
Purple martin	3	4	7
Raccoon	7	8	15
Red-breasted merganser	2	4	6
Red-eyed vireo	1	4	5
Redhead	13	8	21
Red-necked grebe	5	4	9
Red-necked phalarope	5	5	10
Red-tailed hawk	1	4	5
Red-winged blackbird	2	4	6
Ring-billed gull	8	7	15
Ring-necked duck	16	7	23
Ring-necked pheasant	3	4	7
Rocky Mountain bighorn sheep	1	3	4
Rocky Mountain elk	3	9	12
Ross's goose	7	2	9
Ruddy duck	11	5	16
Ruffed grouse	3	4	7
Sandhill crane	8	7	15
Semipalmated plover	10	2	12
Semipalmated sandpiper	12	2	14
Sharp-shinned hawk	1	3	4
Sharp-tailed grouse	1	5	6
Short-billed dowitcher	9	2	11
Short-eared owl	2	2	4
Silver-haired bat	3	4	7
Snow goose	7	7	14
Snowy egret	6	5	11
Snowy plover	9	2	11

Wildlife Species	KEF	KEC	Total Count
Solitary sandpiper	10	2	12
Sora	6	6	12
Spotted bat	6	2	8
Spotted sandpiper	15	5	20
Spruce grouse	2	3	5
Stilt sandpiper	10	2	12
Striped skunk	5	7	12
Swainson's hawk	1	2	3
Tailed frog	6	3	9
Thayer's gull	8	5	13
Tiger salamander	9	6	15
Townsend's big-eared bat	8	4	12
Tree swallow	1	4	5
Tricolored blackbird	1	3	4
Trumpeter swan	9	4	13
Tundra swan	8	5	13
Turkey vulture	2	1	3
Upland sandpiper	2	4	6
Violet-green swallow	2	4	6
Virginia rail	7	5	12
Water shrew	11	4	15
Water vole	5	6	11
Western grebe	6	5	11
Western harvest mouse	3	6	9
Western pipistrelle	6	2	8
Western sandpiper	14	2	16
Western screech-owl	1	2	3
Western small-footed myotis	7	3	10
Western terrestrial garter s	3	5	8
Western toad	15	5	20
White-faced ibis	5	5	10
White-tailed deer (eastside)	5	6	11
White-tailed ptarmigan	2	4	6
Whooping crane	8	7	15
Wild turkey	1	4	5
Willet	10	5	15
Wilson's phalarope	9	6	15
Wilson's snipe	10	4	14
Wolverine	2	2	4
Wood duck	10	6	16

Wildlife Species	KEF	KEC	Total Count
Yellow warbler	1	4	5
Yellow-billed cuckoo	5	4	9
Yellow-breasted chat	1	3	4
Yellow-headed blackbird	2	3	5
Yellow-pine chipmunk	1	6	7
Yuma myotis	7	3	10

D Critical Functional Link Species

Critical functional link species are those species that perform unique KEFs in a community. In other words, for a particular habitat or community, the critical functional link species are species that perform certain ecological functions that no other species perform.

Not all of the roles performed by critical functional link species are critical, however, such that communities would not collapse if some of these species were absent. For example, the brown-headed cowbird is identified as a critical functional link species for many habitats in the Upper Snake province because it is the only species that acts as a nest parasite (Table 2). Even though there would be impacts to communities if the brown-headed cowbird were to disappear from all the habitats it frequents, it is unlikely that the communities would collapse due to its absence. The disappearance of the brown-headed cowbird would most likely benefit communities because the reproductive success of other bird species would improve.

On the other hand, the rufous hummingbird and black-chinned hummingbird are vertebrate species that act as a pollination vectors for several habitats. If these hummingbirds were to disappear and there were no other pollinators for the plants in the communities they inhabited, then the effect could greatly alter the community habitat structure and function. In this scenario, the hummingbird species might be considered functional keystone species, such that their removal altered the structure and function of a community.

Table 2. List of species that perform critical functional roles in the Upper Snake province, Idaho (source: IBIS 2003).

Habitat	Critical Functional Link Species	KEF	KEF Description
Agriculture, pasture, and mixed environs (eastside)	American beaver	7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Great blue heron	3.5.2	Creates roosting, denning, or nesting opportunities
Alpine grasslands and shrublands	American pika	1.1.6	Coprophagous (feeds on fecal material)
	Black bear	6.2	Physically fragments standing wood
		8.1	Creates standing dead trees (snags)
	Deer mouse	3.7.2	Ground structures

Habitat	Critical Functional Link Species	KEF	KEF Description
	Great horned owl	3.7.1	Aerial structures
	Rocky Mountain elk	7.2	Creates ponds or wetlands through wallowing
	Rufous hummingbird	3.3	Pollination vector
Desert playa and salt scrub	Black-chinned hummingbird	3.3	Pollination vector
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Deer mouse	3.7.2	Ground structures
	Great Basin spadefoot	1.1.5	Cannibalistic
	Great horned owl	3.7.1	Aerial structures
	Mink	3.7.3	Aquatic structures
Dwarf shrub-steppe	Black bear	3.9	Primary cavity excavator in snags or live trees
		6.2	Physically fragments standing wood
		8.1	Creates standing dead trees (snags)
	Black-chinned hummingbird	3.3	Pollination vector
	Brown-headed cowbird	3.8.1	Interspecies parasite
Eastside (interior) grasslands	Black bear	3.9	Primary cavity excavator in snags or live trees
		8.1	Creates standing dead trees (snags)
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Grizzly bear	3.5.1	Creates feeding opportunities (other than direct prey relations)
	Mink	3.7.3	Aquatic structures
	Rocky Mountain elk	7.2	Creates ponds or wetlands through wallowing
Eastside (interior) mixed conifer forest	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Red squirrel	3.5.2	Creates roosting, denning, or nesting opportunities
Eastside (interior) riparian wetlands	American beaver	7.1	Impounds water by creating diversions or dams
	Bushy-tailed woodrat	3.6.2	Ground structures
	Double-crested cormorant	4.2	Diseases that affect domestic animals
	Great blue heron	3.5.2	Creates roosting, denning, or nesting opportunities
Herbaceous wetlands	American beaver	7.1	Impounds water by creating diversions or dams

Habitat	Critical Functional Link Species	KEF	KEF Description
	Black bear	3.9	Primary cavity excavator in snags or live trees
		6.2	Physically fragments standing wood
	Double-crested cormorant	4.2	Diseases that affect domestic animals
	Great blue heron	3.5.2	Creates roosting, denning, or nesting opportunities
Lakes, rivers, ponds, and reservoirs	American beaver	7.1	Impounds water by creating diversions or dams
		7.2	Creates ponds or wetlands through wallowing
	Black tern	3.7.1	Aerial structures
	Canada goose	8.3	Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)
	Double-crested cormorant	4.2	Diseases that affect domestic animals
	Great blue heron	3.5.1	Creates feeding opportunities (other than direct prey relations)
		3.5.2	Creates roosting, denning, or nesting opportunities
	Greater scaup	3.8.2	Common interspecific host
	Moose	8.2	Herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)
	Peregrine falcon	1.1.3	Tertiary consumer (secondary predator or secondary carnivore)
	Redhead	3.8.1	Interspecies parasite
Lodgepole pine forest & woodlands	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Golden-mantled ground squirrel	3.4.4	Disperses insects and other invertebrates
	Mink	3.7.3	Aquatic structures
	Red squirrel	3.5.2	Creates roosting, denning, or nesting opportunities
	Snowshoe hare	1.1.6	Coprophagous (feeds on fecal material)
Montane coniferous wetlands	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Bushy-tailed woodrat	3.6.2	Ground structures

Habitat	Critical Functional Link Species	KEF	KEF Description
	Common porcupine	4.3	Diseases that affect other wildlife species
	Deer mouse	3.7.2	Ground structures
	Snowshoe hare	1.1.6	Coprophagous (feeds on fecal material)
Montane mixed conifer forest	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Deer mouse	3.7.2	Ground structures
	Red squirrel	3.5.2	Creates roosting, denning, or nesting opportunities
Ponderosa pine and eastside white oak forest & woodlands	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Red squirrel	3.5.2	Creates roosting, denning, or nesting opportunities
	Snowshoe hare	1.1.6	Coprophagous (feeds on fecal material)
Shrub-steppe	Black-chinned hummingbird	3.3	Pollination vector
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Mink	3.7.3	Aquatic structures
	Rocky Mountain elk	7.2	Creates ponds or wetlands through wallowing
Subalpine parkland	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Deer mouse	3.7.2	Ground structures
	Fisher	3.7.3	Aquatic structures
Upland aspen forest	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Bushy-tailed woodrat	3.6.2	Ground structures
	Deer mouse	3.7.2	Ground structures
	Golden-mantled ground squirrel	3.4.4	Disperses insects and other invertebrates
		3.4.6	Disperses vascular plants
	Mink	3.7.3	Aquatic structures

Habitat	Critical Functional Link Species	KEF	KEF Description
Urban and mixed environs (eastside)	American beaver	7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Bushy-tailed woodrat	3.6.2	Ground structures
	Great blue heron	3.5.2	Creates roosting, denning, or nesting opportunities
	Great horned owl	3.7.1	Aerial structures
	Mink	3.7.3	Aquatic structures
	Nuttall's (mountain) cottontail	1.1.6	Coprophagous (feeds on fecal material)
Western juniper and mountain mahogany woodlands	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Golden-mantled ground squirrel	3.4.6	Disperses vascular plants
	Great Basin spadefoot	1.1.5	Cannibalistic
	Mink	3.7.3	Aquatic structures
	Nuttall's (mountain) cottontail	1.1.6	Coprophagous (feeds on fecal material)

E Functional Specialists

Species with the fewest KEFs are functional specialists and may be more vulnerable to extirpation from changes in environmental conditions supporting their ecological functions. There may be several species that perform the same function in a particular habitat, but the functional specialists are species that perform only one or two key ecological functions.

The functional specialist species in the Upper Snake province are listed in Table 3. There is a total of 60 species.

Table 3. Functional specialist species and their associated KEF count and KEC code in the Upper Snake province, Idaho (IBIS 2003). KEC codes are provided in section A.

Functional Specialist Common Name	Count of Key Environmental Correlates Under Each Major Category						Habitat Code ^a
	Category 1.0	Category 2.0	Category 3.0	Category 4.0	Category 7.0	Category 8.0	
American bittern				4			a, h
American dipper		1	1	13		2	g, h, i, o
American golden-plover		2	2	6			I
Baird's sandpiper		1	3	13		1	a, b, c, h, I
Black phoebe	4	1				3	I
Black swift	1		2	1			b, f, g, h, i, j, k, l, m, o
Black-bellied plover		2	3	6		4	c, I
Boreal owl	2					1	f, j, l, p
Brown creeper	2						a, f, g, j, k, l, m, p, q
Canyon wren			4				b, d, e, f, g, j, l, m, n, o, r
Common nighthawk		1	5	2	1	3	a, c, d, e, f, g, h, i, j, k, l, m, n, p, q, r
Common poorwill	1		3		1	1	a, c, d, e, f, i, j, m, n, r
Dunlin		2	3	14		8	h, I
Ferruginous hawk	3		2		1	1	a, c, d, e, n, r
Greater yellowlegs		1	2	16		2	a, c, d, e, g, h, i, n
Green heron	1	1		6		1	h, I
Harlequin duck	3			12		4	g, I
Least sandpiper		1	3	15		3	a, c, h, I
Lesser yellowlegs		1	2	17		2	a, c, d, e, g, h, i, n
Loggerhead shrike	3				1	4	a, c, d, e, h, n, r
Long-billed dowitcher		1	5	9		5	a, c, h, I
Long-eared myotis	5	2	6	8		10	a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, q, r
Lynx	3		1			2	b, f, j, k, l, o
Marsh wren		1		4		1	h
Masked shrew	3	1					f, g, j, k, l, m, o
Merlin	3	1		2		3	b, d, e, f, g, h, i, j, k, l, m, n, o, r
Northern bog lemming		1	1	1			f, h, j, k, l, o
Northern harrier	3		1	3	1	2	a, b, c, d, e, g, h, n, o, q

Functional Specialist Common Name	Count of Key Environmental Correlates Under Each Major Category						Habitat Code ^a
	Category 1.0	Category 2.0	Category 3.0	Category 4.0	Category 7.0	Category 8.0	
Northern pygmy-owl	1						a, f, g, h, j, k, l, m, o, q, r
Northern saw-whet owl	1		1	1		1	a, f, g, j, k, l, m, p, q, r
Northern shrike	3		1	1	1	3	a, c, d, e, h, n, r
Northern waterthrush	3			1			g
Olive-sided flycatcher	2				1		f, g, j, k, l, m, o
Osprey	4	2		7		4	a, b, f, g, i, j, l, m, n, o, q
Pectoral sandpiper		1	2	11		1	a, h, i
Peregrine falcon	4	1	3	2		3	c, d, e, f, g, h, i, j, k, l, m, n, p, r
Pied-billed grebe				5		1	g, h, I
Ringneck snake	2	3	4		1		a, m, n, q
Rock wren			7				b, c, d, e, f, m, n, o, r
Ross's goose				7			h, i
Rough-legged hawk	3		1			3	a, b, c, d, e, g, h, m, n, q, r
Sanderling		1					c, i
Semipalmated plover		2	3	10		1	c, i
Semipalmated sandpiper		1		12		4	i
Short-billed dowitcher		1	4	9		5	i
Short-eared owl	4	2	1	2	1	3	a, c, d, e, h, n
Snowy plover		1	4	9		2	i
Solitary sandpiper	2	2	2	10		4	a, c, d, e, g, h, i, n
Spotted bat	1		3	6		1	a, c, d, e, g, h, i, m, n
Stilt sandpiper		1		10		1	i
Swainson's hawk	5	1		1	1	4	a, b, c, d, e, g, h, n, r
Turkey vulture	3		6	2		3	a, b, c, d, e, f, g, h, j, k, l, m, n, o, p, q, r
Vaux's swift	2	1				1	a, f, g, h, i, j, k, l, m, o, p, q
Western pipistrelle	2		5	6		3	a, c, d, e, f, g, i, m, n, q, r
Western sandpiper		2	3	14		6	a, c, h, i

Functional Specialist Common Name	Count of Key Environmental Correlates Under Each Major Category						Habitat Code ^a
	Category 1.0	Category 2.0	Category 3.0	Category 4.0	Category 7.0	Category 8.0	
Western screech-owl	1			1		2	a, f, g, h, j, k, m, p, q, r
Western wood-pewee	2				1	2	a, f, g, l, m, o, p, q
White-throated swift			2			2	a, c, d, e, f, g, h, i, l, m, n, q, r
Winter wren	6						b, f, g, k, l, o
Wolverine			7	2		2	b, k, l, o

^a Habitat Codes: a = agriculture, pasture, and mixed environments (eastside); b = alpine grasslands and shrublands; c = desert playa and salt scrub; d = dwarf shrub-steppe; e = eastside (interior) grasslands; f = eastside (interior) mixed conifer forest; g = eastside (interior) riparian wetlands; h = herbaceous wetlands; i = lakes, rivers, ponds, and reservoirs; j = lodgepole pine forest and woodlands; k = montane coniferous wetlands; l = montane mixed conifer forest; m = ponderosa pine and eastside white oak forest and woodlands; n = shrub-steppe; o = subalpine parkland; p = upland aspen forest; q = urban and mixed environments (eastside); r = western juniper and mountain mahogany woodlands

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APPENDIX 2-3—FOCAL HABITAT DESCRIPTIONS

1 Riparian/Herbaceous Wetlands

Geographic Distribution—Riparian and wetland habitats dominated by woody plants are found throughout the Columbia River basin. Lowland willow and other riparian shrublands are the major riparian types throughout the Upper Snake province at lower elevations. Common shrub associates include sandbar willow (*Salix exigua*), water birch (*Betula occidentalis*), yellow willow (*Salix lutea*), and Woods' rose (*Rosa woodsii*) (Tuhy and Jensen 1982, Hall and Hansen 1997, Jankovsky-Jones *et al.* 1999). Black cottonwood riparian habitats occur at low to middle elevations and develop best along large rivers, but these habitats are also present in narrow bands along small streams in the subalpine zone (Hall and Hansen 1997). Subdominant members of the overstory include narrowleaf cottonwood (*Populus angustifolia*), lanceleaf cottonwood (*P. acuminata*), and peachleaf willow (*Salix amygdaloides* var. *wrightii*).

White alder riparian habitats are restricted to perennial streams at low elevations, in drier climatic zones in Hells Canyon at the border of Oregon, Washington, and Idaho, in the Malheur River drainage, and in western Klickitat and south-central Yakima counties, Washington. Quaking aspen wetlands and riparian habitats are widespread but rarely a major component throughout the basin. Ponderosa pine–Douglas-fir riparian habitat occurs only around the periphery of the Columbia River basin in Washington and up into lower montane forests.

Physical Setting—Riparian habitats appear along perennial and intermittent rivers and streams. This habitat also appears in impounded wetlands and along lakes and

ponds. Their associated streams flow along low to high gradients. The riparian and wetland forests are usually in fairly narrow bands along the moving water that follows a corridor along montane or valley streams. The most typical stand is limited to 100 to 200 ft (31–61 m) from streams. Riparian forests also appear on sites subject to temporary flooding during spring runoff. Irrigation of streamsides and toeslopes provides more water than precipitation and is important in the development of this habitat, particularly in drier climatic regions. Hydrogeomorphic surfaces along streams supporting this habitat have seasonally to temporarily flooded hydrologic regimes. Riparian and wetland habitats are found at elevations from 100 to 9,500 ft (31–2,896 m).

Landscape Setting—Riparian habitats occur along streams, seeps, and lakes within the mixed conifer forest, ponderosa pine forest and woodland, western juniper and mountain mahogany woodlands, and (part of the) shrub-steppe habitats. The riparian/herbaceous wetland habitat may be described as occupying warm montane and adjacent valley and plain riparian environments.

Structure—This habitat contains shrubland, woodland, and forest communities. Stands are closed to open canopies and often multilayered. A typical riparian habitat would be a mosaic of forest, woodland, and shrubland patches along a stream course. The tree layer can be dominated by broadleaf, conifer, or mixed canopies. Tall shrub layers, with and without trees, are deciduous and often nearly completely closed thickets. These woody riparian habitats have undergrowth of low shrubs or dense patches of grasses, sedges, or forbs. Tall shrub communities (20–98 ft [6–30 m], occasionally tall enough to be considered woodlands or forests) can be interspersed with sedge meadows or moist,

forb-rich grasslands. Intermittently flooded riparian habitat has groundcover composed of steppe grasses and forbs. Rocks and boulders may be a prominent feature in this habitat.

Composition—Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), quaking aspen (*P. tremuloides*), white alder (*Alnus rhombifolia*), peachleaf willow, and in northeast Washington, paper birch (*Betula papyrifera*) are dominant and characteristic tall deciduous trees. Water birch (*B. occidentalis*), shining willow (*Salix lucida* ssp. *caudata*), and, rarely, mountain alder (*Alnus incana*) are codominant to dominant mid-size deciduous trees. Each can be the sole dominant in stands. Conifers can occur in this habitat, though rarely in abundance and more often as individual trees. The exception is ponderosa pine (*Pinus ponderosa*) or Douglas-fir (*Pseudotsuga menziesii*) that characterizes a conifer-riparian habitat in portions of the shrub-steppe zones.

A wide variety of shrubs are found in association with forest/woodland versions of this habitat. Redosier dogwood (*Cornus sericea*), mountain alder, gooseberry (*Ribes* spp.), rose (*Rosa* spp.), common snowberry (*Symphoricarpos albus*), and Drummond's willow (*Salix drummondii*) are important shrubs in this habitat. Bog birch (*B. nana*) and Douglas spiraea (*Spiraea douglasii*) can occur in wetter stands. Redosier dogwood and common snowberry are shade tolerant and dominate stand interiors, while these shrubs and others occur along forest or woodland edges and openings. Mountain alder is frequently a prominent shrub, especially at middle elevations. Tall shrubs (or small trees) often growing under or with white alder include chokecherry (*Prunus virginiana*), water birch, shining willow, and netleaf hackberry (*Celtis reticulata*).

Shrub-dominated communities contain most of the species associated with tree

communities. Willow species (*Salix bebbiana*, *S. boothii*, *S. exigua*, *S. geyeriana*, or *S. emmonii*) dominate many sites. Mountain alder can be dominant and is at least codominant at many sites. Chokecherry, water birch, Saskatoon serviceberry (*Amelanchier alnifolia*), black hawthorn (*Crataegus douglasii*), and redosier dogwood can also be codominant to dominant. Shorter shrubs, such as Woods' rose, spiraea, snowberry, and gooseberry, are usually present in the undergrowth.

The herb layer is highly variable and composed of an assortment of graminoids and broadleaf herbs. Native grasses (*Calamagrostis canadensis*, *Elymus glaucus*, *Glyceria* spp., and *Agrostis* spp.) and sedges (*Carex aquatilis*, *C. angustata*, *C. lanuginosa*, *C. lasiocarpa*, *C. nebrascensis*, *C. microptera*, and *C. utriculata*) are significant in many habitats. Kentucky bluegrass (*Poa pratensis*) can be abundant in areas that were heavily grazed in the past. Other weedy grasses, such as orchard grass (*Dactylis glomerata*), reed canarygrass (*Phalaris arundinacea*), timothy (*Phleum pratense*), bluegrass (*Poa bulbosa* and *P. compressa*), and tall fescue (*Festuca arundinacea*), often dominate disturbed areas. A short list of the great variety of forbs that grow in this habitat includes Columbian monkshood (*Aconitum columbianum*), alpine leafybract aster (*Aster foliaceus*), ladyfern (*Athyrium filix-femina*), field horsetail (*Equisetum arvense*), cow parsnip (*Heracleum maximum*), skunkcabbage (*Lysichiton americanus*), arrowleaf groundsel (*Senecio triangularis*), stinging nettle (*Urtica dioica*), California false hellebore (*Veratrum californicum*), American speedwell (*Veronica americana*), and pioneer violet (*Viola glabella*).

Other Classifications and Key

References—Cowardin *et al.* (1979) called this habitat palustrine scrub-shrub and forest.

Other references that describe this habitat are Daubenmire 1970, Miller 1976, Manning and Padgett 1992, Kovalchik 1993, Christy and Titus 1996, and Crowe and Clausnitzer 1997. This habitat occurs in both lotic and lentic systems and is represented as riparian and wetland areas in the Idaho gap analysis (Scott *et al.* 2002) and as palustrine forest, palustrine shrubland, and palustrine emergent in the National Wetland Inventory (NWI).

Natural Disturbance Regime—This habitat is tightly associated with stream dynamics and hydrology. Flood cycles occur within 20 to 30 years in most riparian shrublands, although flood regimes vary among stream types. Fires recur typically every 25 to 50 years, but fire can be nearly absent in colder regions or on topographically protected streams. Rafted ice and logs in freshets may cause considerable damage to tree boles in mountain habitats. Beavers crop younger cottonwood and willows and frequently dam side channels in these stands. These forests and woodlands require various flooding regimes and specific substrate conditions for reestablishment. Grazing and trampling is a major influence in altering structure, composition, and function of this habitat; some portions are very sensitive to heavy grazing.

Succession and Stand Dynamics—Riparian vegetation undergoes “typical” stand development that is strongly controlled by a site’s conditions immediately following flooding and shifts in hydrology, or its “initial condition.” The initial condition of any hydrogeomorphic surface is made up of the plants that survived the disturbance, the plants that can get to the site, and the amount of unoccupied habitat that is available for plant invasions. These factors select the species that can survive or grow at the site. Subsequent or repeated floods, or other influences on the initial condition, also affect that selection of species. A typical woody riparian habitat

dynamic is the invasion of woody and herbaceous plants onto a new alluvial bar away from the main channel. If the bar is not scoured in 20 years, a tall shrub and small deciduous tree stand develops. Approximately 30 years without disturbance or change in hydrology allows trees to overtop shrubs and form woodland. Another 50 years without disturbance allows conifers to invade, and in another 50 years, a mixed hardwood–conifer stand develops. Many deciduous tall shrubs and trees cannot be invaded by conifers. Each stage can be reinitiated, held in place, or shunted into different vegetation by changes in stream or wetland hydrology, fire, grazing, or an interaction of those factors.

Effects of Management and Anthropogenic Impacts—Management effects on woody riparian vegetation can be obvious (e.g., removal of vegetation by dam construction, roads, or logging), or they can be subtle (e.g., removing beavers from a watershed, removing large woody debris, or constructing a weir dam for fish habitat). In general, excessive livestock or native ungulate use leads to less woody cover and an increase in sod-forming grasses, particularly on fine-textured soils. Undesirable forb species, such as stinging nettle and horsetail, increase with livestock use.

Status and Trends—Quigley and Arbelbide (1997) concluded that the cottonwood–willow cover type covers significantly less area now than it did before 1900 in the Inland Pacific Northwest. The authors also concluded that, although riparian shrubland had been a minor part of the landscape, occupying 2%, it had since declined to 0.5% of the landscape. Before 1900, approximately 40% of riparian shrublands occurred above 3,280 ft (1,000 m); now, nearly 80% is found above that elevation. This change reflects losses to agricultural development, roads, and dams and other flood-control activities. The current riparian shrublands contain many exotic plant

species and generally are less productive than they were historically. Quigley and Arbelbide (1997) found that riparian woodland was always rare and that the change in extent from the past is substantial.

2 Open Water

Geographic Distribution—Lakes in Idaho occur statewide and are found from 234 m to about 3,302 m above sea level. There are over 5,000 lakes and reservoirs in Idaho, of which 1,228 have been named. They total 265,822 hectares (ha). The largest and deepest lake in Idaho is Lake Pend Oreille at 38,331 ha and 347 m deep.

Streams and rivers are distributed statewide in Idaho, forming a continuous network connecting high mountain areas to lowlands. There are thousands of named rivers and streams in Idaho, totaling 133,055 km. Idaho has areas of both substantial and negligible topographic relief due to geographic and geologic features creating rivers, creeks, and lakes. Several major river systems cross Idaho and two large rivers are contained completely within the state. The single most unifying geographical feature is the Snake River, which has its source in the mountains of Yellowstone National Park and meanders west to the Oregon border and then north to Hells Canyon, where it joins the Salmon River, continues north to Lewiston where the Clearwater enters, and heads west to join the Columbia River. The river is more than 1,609 km long and drains more than 258,998 km² of country. The Snake River carries 40 million acre-feet of water and drops more than 2,133 m in elevation by the time it empties into the Columbia River (Digital Atlas of Idaho 2003).

The Snake River system contains many canyons along its expanses across Idaho. The Snake runs through a canyon fifty miles long as it enters Idaho from Wyoming. Several

rivers and tributaries flow into the Snake and enter through their own canyons. Blue Lakes Canyon is on the Snake River five miles below Shoshone Falls near the city of Twin Falls. Blue Lakes Canyon contains farmland and a country club along the Snake River almost 152 m straight down from the desert floor. The Hagerman Valley is another interesting segment of the winding Snake River containing a grand canyon. This valley is a wide canyon having a high, steep north wall that issues beautiful flowing springs called Thousand Springs. Here, millions of gallons of water gush from the rocky canyon wall and cascade into the Snake River. Hydrologists infer that the water source is the Big Lost Sinks where the Big and Little Lost river's disappear into the lava beds near Arco about 240 km northeast of Hagerman Valley (Digital Atlas of Idaho 2003).

The most well-known part of the Snake River Canyon, however, is between Idaho and Oregon. It is Hells Canyon, the Grand Canyon of the Snake, or Seven Devils Canyon. It is 2,407 m from the bottom of the canyon to the top of Devil Peak. This makes it the deepest gorge in North America. It is about 685 m deeper than the Grand Canyon of the Colorado River in Arizona (Digital Atlas of Idaho 2003).

In addition to deep canyon gorges, the Snake River also has several important waterfalls as a result of sudden regional changes in elevation. These include the spectacular Shoshone Falls, which boasts 64 m of relief, 16 m more than Niagara. Other waterfalls in the state include Big Fiddler Creek, which has one of the highest falls in Idaho at 186 m high. It is on the South Fork Boise River above Arrowrock Dam. Moyie Falls on the Moyie River near Bonners Ferry, Idaho, is noted for its stone formations, which make the water seem to be full of colored glass crystals. Several towns in Idaho are named after waterfalls: American Falls, Idaho Falls,

Post Falls, and Twin Falls (Digital Atlas of Idaho 2003).

The untamed and imposing Salmon River—"River of No Return"—winds 684 km through the mountains of central Idaho, its canyon gorge deeper than the Grand Canyon of the Colorado. It flows through the Sawtooth Wilderness Area and finally joins the Snake River about 50 miles south of Lewiston. A spawning stream for Pacific salmon, it is one of the longest and most rugged rivers lying wholly within one state (Digital Atlas of Idaho 2003).

The Boise, Payette, and Weiser rivers flow into the Snake River in southwestern Idaho as it forms the Oregon–Idaho border. In addition, there are many shorter tributaries of the Snake River in southern Idaho (Digital Atlas of Idaho 2003).

Rivers and streams in Idaho are fed by rain and located in areas with terrain of varying stability. Rivers and streams composed of sheared bedrock have high suspended-sediment loads. Beds composed of gravel and sand are easily transported during floods. Rivers and streams composed of volcanically derived bedrock are more stable. They have low sediment-transport rates and stable beds composed largely of cobbles and boulders, which move only during extreme events (Everest *et al.* 1987).

Physical Setting—Continental glaciers melted and left depressions where water accumulated and formed many lakes in the region. Many of Idaho's lakes are actually reservoirs formed behind the numerous dams on the state's waterways. Dams are constructed to store water for irrigation, generate hydroelectric power, and keep floodwater from destroying farms and cities.

All areas of Idaho undergo the transition through the four seasons, but the seasons

manifest differently according to geographic location. Idaho has three main geographic provinces: mountains, valleys, and plains. There is little difference in climate between the mountains and the valleys, except that the mountains shelter valleys, resulting in a moderated climate compared with that in the mountains.

The plains are semiarid flatlands that have nearly equal amounts of precipitation and evaporation. Annual highs and lows, or seasonal extremes, also vary greatly, resulting in bone-chilling winters and blistering summers.

January is the coldest month of the year in Idaho, usually having average temperatures below freezing. Some areas have temperatures well below zero through much of the winter. The record low in Idaho is -51°C , recorded at the Island Park Dam in 1943. Temperatures routinely drop to -28°C in mountainous northern and eastern Idaho. Snowfall is often heavy in these areas, and the annual precipitation from snow and rain is between 50 and 89 cm, respectively. However, the average annual precipitation for Idaho is 31.6 cm, a result of the very dry conditions existing on the plains.

Landscape Setting—This habitat occurs throughout Idaho. Ponds, lakes, and reservoirs are typically adjacent to herbaceous wetlands, while rivers and streams typically adjoin the riparian wetlands or herbaceous wetlands.

Structure—There are four distinct zones within this aquatic system: 1) the littoral zone at the edge of lakes is the most productive with diverse aquatic beds and emergent wetlands (part of herbaceous wetland's habitat); 2) the limnetic zone is deep open water, dominated by phytoplankton and freshwater fish, and extends down to the limits of light penetration; 3) the profundal zone below the limnetic zone is devoid of

plant life and dominated with detritivores; and 4) the benthic zone reflecting bottom soil and sediments. Nutrients from the profundal zone are recycled back to upper layers by the spring and fall turnover of the water. Water in temperate climates stratifies because of the changes in water density. The uppermost layer, the epilimnion, is where water is warmer (less dense). Next, the metalimnion or thermocline is a narrow layer that prevents the mixing of the upper- and lowermost layers. The lowest layer is the hypolimnion, with colder and denser waters. During the fall turnover, the cooled upper layers are mixed with other layers through wind action.

Other Classifications and Key

References—This habitat is called riverine and lacustrine in Anderson *et al.* (1998), Cowardin *et al.* (1979), Mayer and Laudenslayer (1988), and Wetzel (1983). However, it is referred to as open water in the Idaho gap analysis (Scott *et al.* 2002).

Natural Disturbance Regime—There are seasonal and decadal variations in the patterns of precipitation. The majority of the precipitation occurs in the form of snow at the higher elevations. The snowmelt-driven flow regimes result in low water levels in fall and winter and high water levels during spring and early summer. High-elevation lands with deeper snowpacks generate peak runoff beginning in late April and lasting until late May. Floods occur in Idaho every year. Flooding season generally occurs during late winter and early spring and is typically caused by melting snow. The amount of flooding depends on how fast the snow melts. Significant flooding may result from cloudbursts caused by thunderstorms, primarily during the summer months, but cloudbursts may occur throughout the year.

Effects of Management and Anthropogenic

Impacts—Sewage effluents and agricultural runoff can cause significant eutrophication to

water bodies such as occurred at Cascade Reservoir (Zimmer 1983). The situation has improved with public education, cleanup efforts, and planning (USBOR 2002).

Removal of gravel results in reduction of spawning areas for anadromous fish. Overgrazing and loss of vegetation caused by logging produce increased water temperatures and excessive siltation, harming the invertebrate communities (Mac *et al.* 1998). Incorrectly installed culverts may act as barriers to migrating fish and contribute to erosion and siltation downstream (Phinney and Bucknell 1975). Construction of dams is associated with changes in water quality, loss of fish passage, competition between species, loss of spawning areas because of flooding, and declines in native fish populations (Mac *et al.* 1998). Historically, the region's rivers contained more braided multi-channels. Flood-control measures—such as channel straightening, diking, or removal of streambed material, along with urban and agriculture development—have all contributed to a loss of oxbows, river meanders, and floodplains. Unauthorized or overappropriated withdrawals of water from the natural drainages have also caused a loss of open water habitat that has been detrimental to fish and wildlife production, particularly in the summer (Phinney and Bucknell 1975).

Agricultural, industrial, and sewage runoff such as salts, sediments, fertilizers, pesticides, and bacteria harm aquatic species (Mac *et al.* 1998). Sludge and heavy waste buildup in estuaries is harmful to fish and shellfish. Unregulated aerial spraying of pesticides over agricultural areas also poses a threat to aquatic and terrestrial life (IDEQ and ODEQ 2001). Clearcut logging can alter snow accumulation and increase the size of peak flows during times of snowmelt (Sullivan *et al.* 1987). Clearcutting and vegetation removal affects the temperatures of streams, increasing them in the summer and decreasing

them in winter. Building of roads, especially those of poor quality can be a major contributor to sedimentation in the streams (Everest *et al.* 1987).

Status and Trends—The principal trend has been in relationship to dam building or channelization for hydroelectric power, flood control, or irrigation purposes.

3 Shrub-Steppe

Geographic Distribution—Shrub-steppe habitats are common across the Columbia Plateau of Washington, Oregon, Idaho, as well as in adjacent Wyoming, Utah, and Nevada. This habitat type extends up into the cold, dry environments of surrounding mountains.

Basin big sagebrush shrub-steppe occurs along stream channels and in valley bottoms and flats throughout Idaho. Wyoming sagebrush shrub-steppe is the most widespread habitat, occurring throughout the Columbia Plateau and the northern Great Basin. Mountain big sagebrush shrub-steppe habitat occurs throughout the mountains of Idaho. Bitterbrush shrub-steppe habitat appears primarily in the southern portion of Idaho. Interior shrub dunes and sandy steppe and shrub-steppe habitat is concentrated at low elevations in isolated pockets in the Owyhee Uplands.

Physical Setting—Generally, this habitat is associated with dry, hot environments in the Pacific Northwest, although variants appear in cool, moist areas with some snow accumulation in climatically dry mountains. Elevation range is wide (300–9,000 ft [91–2,743 m]), with most habitats occurring between 2,000 and 6,000 ft (610–1,830 m). Habitat occurs on deep alluvial, loess, silty, or sandy-silty soils on stony flats, ridges, mountain slopes, or slopes of lakebeds with ash or pumice soils.

Landscape Setting—Shrub-steppe habitat defines a biogeographic region and is the major vegetation on average sites in the Columbia Plateau, usually below ponderosa pine forest and woodland and below western juniper and mountain mahogany woodland habitats. It forms mosaic landscapes with these woodland habitats and grasslands, dwarf shrub-steppe, and desert playa and salt scrub habitats. Mountain big sagebrush shrub-steppe occurs at high elevations, occasionally within the dry mixed conifer forest and montane mixed conifer forest habitats. Shrub-steppe habitat can appear in large landscape patches. Livestock grazing is the primary land use in the shrub-steppe, although much has been converted to irrigation or dryland agriculture. Large areas occur in military training areas and wildlife refuges.

Structure—This habitat is a shrub savanna or shrubland with shrub coverage of 10 to 60%. In an undisturbed condition, shrub cover varies between 10 and 30%. Shrubs are generally evergreen, although deciduous shrubs are prominent in many habitats. Shrub height is typically medium tall (1.6–3.3 ft [0.5–1.0 m]), although some sites support shrubs approaching 9 ft (2.7 m). Vegetation structure in this habitat is characteristically an open shrub layer over a moderately open to closed bunchgrass layer. The more northern or productive sites generally have a denser grass layer and sparser shrub layer than southern or more xeric sites do. In fact, the rare site in good condition is better characterized as grassland with shrubs than as shrubland. The bunchgrass layer may contain a variety of forbs. Good-condition habitat has very little exposed bare ground: mosses and lichens carpet the area between taller plants. However, heavily grazed sites have dense shrubs making up greater than 40% cover, with introduced annual grasses and little or no moss or lichen cover. Moist sites may support tall bunchgrasses (> 3.3 ft [1 m]) or rhizomatous grasses. More southern shrub-

steppe may have native low shrubs dominating with bunchgrasses.

Composition—Characteristic and dominant mid-tall shrubs in the shrub-steppe habitat include all three subspecies of big sagebrush (basin [*Artemisia tridentata* ssp. *tridentata*], Wyoming [*A. t.* ssp. *wyomingensis*] or mountain [*A. t.* ssp. *vaseyana*]), antelope bitterbrush (*Purshia tridentata*), and two shorter sagebrushes (silver [*A. cana*] and three-tip [*A. tripartite*]). Each of these species can be the only shrub or they can appear in complex seral conditions with other shrubs. Common shrub complexes are bitterbrush and Wyoming big sagebrush, bitterbrush and three-tip sagebrush, Wyoming big sagebrush and three-tip sagebrush, and mountain big sagebrush and silver sagebrush. Wyoming and mountain big sagebrush can codominate areas with tobacco brush (*Ceanothus velutinus*). Rabbitbrush (*Chrysothamnus viscidiflorus*) and short-spine horsebrush (*Tetradymia spinosa*) are common associates and often dominate sites after disturbance. Big sagebrush occurs with the shorter stiff sagebrush (*A. rigida*) or low sagebrush (*A. arbuscula*) on shallow soils or high-elevation sites. Many sandy areas are shrub-free or open to patchy shrublands of bitterbrush and/or rabbitbrush. Silver sagebrush is the dominant and characteristic shrub along the edges of stream courses, moist meadows, and ponds. Silver sagebrush and rabbitbrush are associates in disturbed areas.

When this habitat is in good or better ecological condition, a bunchgrass-steppe layer is characteristic. Diagnostic native bunchgrasses that often dominate different shrub-steppe habitats are 1) mid-grasses: bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), bottlebrush squirreltail (*Elymus elymoides*), and Thurber needlegrass (*Stipa thurberiana*); 2) short grasses: threadleaf sedge (*Carex*

filifolia) and Sandberg bluegrass (*Poa sandbergii*); and 3) the tall grass: basin wildrye (*Leymus cinereus*). Idaho fescue is characteristic of the most productive shrub-steppe vegetation. Bluebunch wheatgrass is codominant at xeric locations, whereas western needlegrass (*Stipa occidentalis*), long-stolon sedge (*Carex inops*), or Geyer's sedge (*C. geyeri*) increase in abundance in higher-elevation shrub-steppe habitats. Needle and thread (*Hesperostipa comata*) is the characteristic native bunchgrass on stabilized, sandy soils. Indian ricegrass (*Achnatherum hymenoides*) characterizes dunes. Grass layers on montane sites contain slender wheatgrass (*Elymus trachycaulus*), mountain fescue (*F. brachyphylla*), green fescue (*F. viridula*), Geyer's sedge, or tall bluegrasses (*Poa* spp.). Bottlebrush squirreltail can be locally important in the Columbia River basin, sand dropseed (*Sporobolus cryptandrus*) is important in the Basin and Range Province, and basin wildrye is common in the more alkaline areas. Nevada bluegrass (*Poa secunda*), Richardson muhly (*Muhlenbergia richardsonis*), or alkali grass (*Puccinella* spp.) can dominate silver sagebrush flats. Many sites support nonnative plants, primarily cheatgrass (*Bromus tectorum*) or crested wheatgrass (*Agropyron cristatum*) with or without native grasses. Shrub-steppe habitat, depending on site potential and disturbance history, can be rich in forbs or have little forb cover. Trees may be present in some shrub-steppe habitats, usually as isolated individuals from adjacent forest or woodland habitats.

Other Classifications and Key

References—Kuchler (1964) called this habitat sagebrush steppe and Great Basin sagebrush. This habitat has also been called xeric shrublands (Scott *et al.* 2002). Other references describing this habitat include Daubenmire 1970, Winward 1970, Winward 1980, Hironaka *et al.* 1983, Volland 1985,

Johnson and Clausnitzer 1992, and Johnson and Simon 1987.

Natural Disturbance Regime—Barrett *et al.* (1997) concluded that the fire-return interval for this habitat is 25 years. The native shrub-steppe habitat apparently lacked extensive herds of large grazing and browsing animals until the late 1800s. Burrowing animals and their predators likely played important roles in creating small-scale patch patterns.

Succession and Stand Dynamics—With disturbance, mature stands of big sagebrush are reinvaded through soil-stored or windborne seeds. Invasion can be slow because sagebrush is not disseminated over long distances. Site dominance by big sagebrush usually takes a decade or more, depending on fire severity and season, seed, rain, post-fire moisture, and plant competition. Three-tip sagebrush is a climax species that reestablishes (from seeds or commonly from sprouts) within 5 to 10 years following a disturbance. Certain disturbance regimes promote three-tip sagebrush, which can outcompete herbaceous species. Bitterbrush is a climax species that plays a seral role, colonizing by seed onto rocky and/or pumice soils. Bitterbrush may be declining, replaced by woodlands in the absence of fire. Silver sagebrush is a climax species that establishes during early seral stages and coexists with later-arriving species. Big sagebrush, rabbitbrush, and short-spine horsebrush invade and can form dense stands after fire or livestock grazing. Frequent or high-intensity fire can create a patchy shrub cover or eliminate shrub cover and create grassland habitat.

Effects of Management and Anthropogenic Impacts—Shrub density and annual cover increase with livestock use, whereas bunchgrass density decreases. Repeated or intense disturbance, particularly on drier sites, leads to cheatgrass dominance and

replacement of native bunchgrasses. Dry and sandy soils are sensitive to grazing, with needle and thread replaced by cheatgrass at most sites. These disturbed sites can be converted to modified grasslands in the agriculture habitats.

Status and Trends—Shrub-steppe habitat still dominates most of southeastern Oregon, although half of its original distribution in the Columbia River basin has been converted to agriculture. Alteration of fire regimes, fragmentation, livestock grazing, and the addition of over 800 exotic plant species have changed the character of shrub-steppe habitat. Quigley and Arbelbide (1997) concluded that big sagebrush and mountain sagebrush cover types are significantly smaller in area than they were before 1900 and that the bitterbrush/bluebunch wheatgrass cover type is similar to the pre-1900 extent. They also concluded that successional pathways for basin big sagebrush and big sagebrush-warm potential vegetation types are altered, that some pathways of antelope bitterbrush are altered, and that most pathways for big sagebrush-cool are unaltered. Overall, this habitat has seen an increase in exotic plant importance and a decrease in native bunchgrasses. More than half of the Pacific Northwest shrub-steppe habitat community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al.* 1998).

4 Pine/Fir Forest

Geographic Distribution—Ponderosa pine is the most widely distributed pine species in North America, ranging north to south from southern British Columbia to central Mexico and east to west from central Nebraska to the west coast (Little 1979). Ponderosa pine ecosystems occupy about 15.4 million ha across 14 states (Garrison *et al.* 1977). Pacific ponderosa pine ranges from latitude 52 degrees N in the Fraser River drainage of

southern British Columbia south through the mountains of Washington, Oregon, and California to latitude 33 degrees N near San Diego. In the northeastern part of its range, it extends east of the Continental Divide to longitude 110 degrees W in Montana and south to the Snake River Plain in Idaho (Oliver and Ryker 1990).

Physical Setting—This habitat generally occurs on the driest sites supporting conifers in the Pacific Northwest. Tree species that thrive on sites that are relatively warm and dry tend to dominate. These species include ponderosa pine, Douglas-fir, and western larch (*Larix occidentalis*). This habitat is widespread and variable, appearing on moderate to steep slopes in canyons and foothills and on plateaus or plains near mountains. In Idaho, this habitat can be maintained by the dry pumice soils. Average annual precipitation ranges from about 36 to 76 cm on ponderosa pine sites, often as snow.

Both the mildest and coldest of these dry montane forests can support pure stands of Douglas-fir. On the warmest and driest sites, ponderosa pine tends to grow in pure stands. These stands become increasingly open with decreasing elevation or increasingly dry soils until they are so sparse that they are no longer considered forests. Ponderosa pine “woodlands,” in which trees are so few and widely spaced that none of their crowns touch, are common at lower timberline and typically mark the transition from forest to grassland or shrubland. This transition generally occurs within 300 m of the valley base elevation (Arno 1979).

Landscape Setting—This woodland habitat typifies the lower tree line zone, forming transitions with mixed conifer forest and western juniper and mountain mahogany woodlands, shrub-steppe, grassland, or agriculture habitats. Douglas-fir–ponderosa pine woodlands are found near or within the

mixed conifer forest habitat. Ponderosa pine woodland is the vegetation type that Americans most commonly associate with western mountains (Peet 1988). However, the warm, dry conditions that naturally favor development and persistence of these open, parklike stands are characteristic of only a small fraction of the forested area within the northern Rocky Mountains. Douglas-fir often predominates at lower elevations, where valley base elevations are high and winter temperatures are too low for ponderosa pine. Western larch, the only deciduous conifer in the region, is an often conspicuous component of low-elevation forests.

Structure—This habitat is typically a woodland or savanna with tree canopy coverage of 10 to 60%, although closed-canopy stands are possible. The tree layer is usually composed of widely spaced, large conifer trees. Many stands tend toward a multilayered condition, with encroaching conifer regeneration. Isolated, taller conifers above broadleaf deciduous trees characterize part of this habitat. Deciduous woodlands or forests are an important part of the structural variety of this habitat. Clonal deciduous trees can create dense patches across a grassy landscape rather than scattered individual trees. The undergrowth may include dense stands of shrubs or, more often, be dominated by grasses, sedges, or forbs. Shrub-steppe shrubs may be prominent in some stands and create a distinct grassland habitat that is sparse in trees and shrubs.

Composition—Ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) are the most common evergreen trees in this habitat. The deciduous conifer western larch (*Larix occidentalis*) can be a codominant with the evergreen conifers, but it is seldom a canopy dominant. Grand fir (*Abies grandis*) may be frequent in the undergrowth on more productive sites, giving stands a multilayered structure. In rare

instances, grand fir can be codominant in the upper canopy.

The understories of xeric, old forests are usually sparse due to the lack of moisture. Common native grasses and grasslike plants include Idaho fescue, rough fescue, bluebunch wheatgrass, pinegrass (*Calamagrostis rubescens*), and elk sedge (*Carex garberi*). Forbs include arrowleaf balsamroot (*Balsamorhiza sagittata*), lupines (*Lupinus* spp.), heartleaf arnica (*Arnica cordifolia*), and western meadow-rue (*Thalictrum occidentale*). Common snowberry, mountain snowberry (*Symphoricarpos oreophilus*), antelope bitterbrush, white spirea (*Spiraea betulifolia*), Oregon grape (*Mahonia aquifolium*, formerly *Berberis aquifolium*), Saskatoon serviceberry (*Amelanchier alnifolia*), ninebark (*Physocarpus* spp.), russet buffaloberry (*Shepherdia canadensis*), common juniper (*Juniperus communis*), and chokecherry are important woody species (Pfister *et al.* 1977, Cooper *et al.* 1991).

Other Classifications and Key

References—The Society of American Foresters refers to this habitat as Pacific ponderosa pine–Douglas-fir. Scott *et al.* (2002) called this habitat needleleaf forest–ponderosa pine. Other references describing elements of this habitat include Volland 1985, Johnson and Clausnitzer 1992, and Lillybridge *et al.* 1995.

Natural Disturbance Regime—Fire plays an important role in creating vegetation structure and composition in this habitat. Most of the habitat has experienced frequent low-severity fires that maintained woodland or savanna conditions. A mean fire interval of 20 years for ponderosa pine is the shortest interval for the vegetation types listed by Barrett *et al.* (1997). Soil drought plays a role in maintaining an open tree canopy in part of this dry woodland habitat.

Succession and Stand Dynamics—This habitat is climax on sites near the dry limits of each of the dominant conifer species and more seral as the environment becomes more favorable for tree growth. Open seral stands are gradually replaced by more closed, shade-tolerant climax stands.

Effects of Management and Anthropogenic Impacts

—Before 1900, this habitat was mostly open and park-like with relatively few undergrowth trees. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy. For example, this habitat includes previously natural fire-maintained stands in which grand fir can eventually become the canopy dominant. Fire suppression has led to a buildup of fuels that increase the likelihood of stand-replacing fires. Heavy grazing, in contrast to fire, removes the grass cover and tends to favor shrub and conifer species. Fire suppression, combined with grazing, creates conditions that support invasion by conifers. Large, late seral ponderosa pine and Douglas-fir are harvested in much of this habitat. Under most management regimes, typical tree size decreases and tree density increases in this habitat. In some areas, patchy tree establishment at the forest-steppe boundary has created new woodlands.

Status and Trends—Quigley and Arbelbide (1987) concluded that the interior ponderosa pine cover type is significantly less in extent than it was before 1900. They included much of this habitat in their dry forest potential vegetation group 181, which they concluded has departed from natural succession and disturbance conditions. The greatest structural change in this habitat is the reduced extent of the late seral, single-layer condition. This habitat is generally degraded because of increased exotic plants and decreased native bunchgrasses. One-third of ponderosa pine and dry Douglas-fir or grand fir community

types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al.* 1998).

5 Juniper/Mountain Mahogany

Geographic Distribution—Western juniper occurs from southeastern Washington and Oregon southward to the upper slopes of the Sierra Nevada and San Bernardino mountains of southern California (Sowder *et al.* 1965). The species occurs along the western edge of the Great Basin in southwestern Idaho and northwestern Nevada (Meeuwig and Murray 1978). Western juniper woodlands with shrub-steppe species appear throughout the range of the juniper/mountain mahogany habitat. Many isolated mahogany communities occur throughout canyons and mountains across the range of this habitat.

During the past 150 years, western juniper has extended its range and now occupies approximately 42 million acres (17 million ha) in the Intermountain West (Bunting 1990, Ferry *et al.* 1995). It grows over approximately 4 million acres (1.6 million ha) in the Pacific Northwest (Eddleman *et al.* 1994).

Physical Setting—This habitat is widespread and variable, occurring in basins and canyons and on slopes and valley margins in the southern Columbia Plateau, as well as on fire-protected sites in the northern Basin and Range Province. It may be found on benches and foothills. Western juniper and/or mountain mahogany woodlands are often found on shallow soils on flats at middle to high elevations, usually on basalts. Other sites range from deep, loess soils and sandy slopes to very stony canyon slopes. At lower elevations or in areas outside shrub-steppe, this habitat occurs on slopes and in areas with shallow soils. Mountain mahogany can occur

on steep rimrock slopes, usually in areas of shallow soils or protected slopes. This habitat can be found at elevations of 1,500 to 8,000 ft (457–2,438 m) but mostly from 4,000 to 6,000 ft (1,220–1,830 m). Average annual precipitation ranges from approximately 10 to 13 inches (25–33 cm), with most occurring as winter snow.

Landscape Setting—This habitat reflects a transition between ponderosa pine forest and woodland and shrub-steppe, grasslands, and rarely desert playa and salt desert scrub habitats. Western juniper generally occurs on higher topography, whereas the shrub communities are more common in depressions or steep slopes with bunchgrass undergrowth. In the Great Basin, mountain mahogany may form a distinct belt on mountain slopes and ridgetops above pinyon–juniper woodland. Mountain mahogany can occur in isolated, pure patches that are often very dense. The primary land use is livestock grazing.

Structure—This habitat is made up of savannas, woodlands, or open forests with 10 to 60% canopy cover. The tallest layer is composed of short (6.6–40 ft [2–12 m] tall) evergreen trees. Dominant plants may assume a tall-shrub growth form on some sites. The short trees appear in a mosaic pattern, with areas of low or medium-tall (usually evergreen) shrubs alternating with areas of tree layers and widely spaced low or medium-tall shrubs. The herbaceous layer is usually composed of short or medium-tall bunchgrass or, rarely, rhizomatous grass–forb undergrowth. These vegetated areas can be interspersed with rimrock or scree. A well-developed cryptogam layer often covers the ground, although bare rock can make up much of the groundcover.

Composition—Western juniper and/or mountain mahogany dominate these woodlands with either bunchgrass or shrub-

steppe undergrowth. Western juniper (*Juniperus occidentalis*) is the most common dominant tree in these woodlands. Part of this habitat has curl-leaf mountain mahogany (*Cercocarpus ledifolius*) as the only dominant tall shrub or small tree. Mahogany may be codominant with western juniper. Ponderosa pine (*Pinus ponderosa*) can grow in this habitat and, in some rare instances, may be an important part of the canopy.

The most common shrubs in this habitat are basin, Wyoming, or mountain big sagebrush (*Artemisia tridentata* ssp. *tridentata*, *A. t.* ssp. *wyomingensis*, and *A. t.* ssp. *vaseyana*) and/or bitterbrush (*Purshia tridentata*). These shrubs usually provide significant cover in juniper stands. Low or stiff sagebrush (*Artemisia arbuscula* or *A. rigida*) is a dominant dwarf shrub in some juniper stands. Mountain big sagebrush appears most commonly with mountain mahogany and mountain mahogany mixed with juniper. Snowbank shrubland patches in mountain mahogany woodlands are composed of mountain big sagebrush with bitter cherry (*Prunus emarginata*), quaking aspen (*Populus tremuloides*), and Saskatoon serviceberry (*Amelanchier alnifolia*). Shorter shrubs such as mountain snowberry or creeping Oregon grape (*Mahonia repens*) can be dominant in the undergrowth. Rabbitbrush (*Chrysothamnus nauseosus* and *C. viscidiflorus*) increase with grazing.

Part of this woodland habitat lacks a shrub layer. Various native bunchgrasses dominate different aspects of this habitat. Sandberg bluegrass (*Poa sandbergii*), a short bunchgrass, is the dominant and most common grass throughout many juniper sites. Medium-tall bunchgrasses such as Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), needlegrasses (*Stipa occidentalis*, *S. thurberiana*, *S. lemmonii*), and bottlebrush squirreltail (*Elymus elymoides*) can dominate undergrowth. Threadleaf sedge (*Carex*

filifolia) and basin wildrye (*Leymus cinereus*) are found in lowlands, and Geyer's and Ross' sedges (*Carex geyeri*, *C. rossii*), pinegrass (*Calamagrostis rubescens*), and blue wildrye (*E. glaucus*) appear on mountain foothills. Sandy sites typically have needle and thread (*Hesperostipa comata*) and Indian ricegrass (*Oryzopsis hymenoides*). Cheatgrass (*Bromus tectorum*) or bulbous bluegrass (*Poa bulbosa*) often dominates overgrazed or disturbed sites. In good condition, this habitat may have mosses growing under the trees.

Other Classifications and Key

References—This habitat is also called juniper steppe woodland (Kuchler 1964) and western juniper, Utah juniper, and pinyon pine/juniper (Scott *et al.* 2002). Other references describing this habitat include Dealy 1971, Downing 1983, Johnson and Clausnitzer 1992, and Tisdale 1986.

Natural Disturbance Regime—Both mountain mahogany and western juniper are fire intolerant. Under natural high-frequency fire regimes, both species formed savannas or occurred as isolated patches on fire-resistant sites in shrub-steppe or steppe habitat. Western juniper is considered a topoedaphic climax tree in a number of sagebrush–grassland, shrub-steppe, and drier conifer sites. The species is an increaser in many earlier seral communities in these zones and invades without fires. Most trees taller than 13 ft (4 m) can survive low-intensity fires. The historical fire regime of mountain mahogany communities varies with community type and structure. The fire-return interval for mountain mahogany (along the Salmon River in Idaho) was 13 to 22 years until the early 1900s but has increased ever since. Mountain mahogany can live to 1,350 years in western and central Nevada. Some old growth mountain mahogany stands avoid fire by growing on extremely rocky sites.

Succession and Stand Dynamics—Juniper invades shrub-steppe and steppe habitats and reduces undergrowth productivity. Although slow seed dispersal delays recovery time, western juniper can regain dominance in 30 to 50 years following fire. A fire-return interval of 30 to 50 years typically arrests juniper invasion. The successional role of curl-leaf mountain mahogany varies with community type. Mountain brush communities where curl-leaf mountain mahogany is either dominant or codominant are generally stable and successional rates are slow.

Effects of Management and Anthropogenic Impacts—Over the past 150 years, with fire suppression, overgrazing, and changing climatic factors, western juniper has increased its range into adjacent shrub-steppe, grassland, and savanna habitats. Increased density of juniper and reduced fine fuels from an interaction of grazing and shading result in high-severity fires that eliminate woody plants and promote herbaceous cover, primarily annual grasses. Diverse mosses and lichens occur on the ground in this type if it has not been too disturbed by grazing. Excessive grazing decreases bunchgrasses and increases exotic annual grasses, as well as various native and exotic forbs. Animals seeking shade under trees decrease or eliminate bunchgrasses and contribute to increasing cheatgrass cover.

Status and Trends—This habitat is dominated by fire-sensitive species; therefore, the range of western juniper and mountain mahogany has expanded because of an interaction of livestock grazing and fire suppression. Quigley and Arbelbide (1997) concluded that, in the Inland Pacific Northwest, juniper/sagebrush, juniper woodland, and mountain mahogany cover types are now significantly greater in extent than they were before 1900. Although this habitat type covers more area, its condition is generally degraded because of increased

exotic plants and decreased native bunchgrasses. One-third of Pacific Northwest juniper and mountain mahogany community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al.* 1998).

6 Whitebark Pine

Geographic Distribution—Whitebark pine is a picturesque tree of the subalpine forest and tree line. Its distribution is split into two broad sections. Western populations of whitebark pine extend from about latitude 55 degrees N in western British Columbia, along the lower part of the Fraser River, south into Washington and along the Cascade Range, southward through the high mountains of Washington and Oregon into California. In northern California, whitebark pine is scattered in isolated populations, but farther south in the Sierra Nevada Range of central California, it is more continuous to its southern limit near Mount Whitney at about latitude 37 degrees N (Hitchcock *et al.* 1969, Cronquist *et al.* 1972, Bailey 1975). Eastern populations occur from about latitude 55 degrees N in central Alberta, Canada, and follow the northern Rocky Mountains southward into western Montana and central Idaho. Stands are extensive in northwestern Wyoming. Except for disjunct populations in northeastern Nevada (about latitude 41 degrees N), the southern and eastern limits of whitebark pine are the Wind River Mountains of Wyoming (Hitchcock *et al.* 1969, Cronquist *et al.* 1972, Bailey 1975). Whitebark pine does not occur south of the Wyoming basin. The distribution of whitebark pine is strongly influenced by the Clark's nutcracker (*Nucifraga columbiana*), a bird that is important for seed dispersal and seedling establishment (Lanner 1980, Steele *et al.* 1983).

Physical Setting—Slow-growing and long-lived, the whitebark pine is typically more

than 100 years old before it produces cones. Whitebark pine's growth form ranges from a krummholz mat to a moderately tall, upright tree, but the tree is often short and heavily branched, with multiple stems. Whitebark pine typically grows with other high-mountain conifers but can form nearly pure stands in relatively dry mountain ranges (Arno and Hoff 1989). Where associated trees are capable of forming closed stands, whitebark pine can be a long-lived, dominant seral species if periodic disturbance, such as fire, removes its shade-tolerant competitors. On a broad range of dry, windy sites, however, whitebark pine is a climax tree because it is hardier and more durable than subalpine fir and other tree species (Arno and Hoff 1989). The sites where whitebark pine is seral tend to be moister and more productive than sites where the tree is climax (Arno 1986).

Landscape Setting—Whitebark pine grows on dry, rocky subalpine slopes and exposed ridges on high mountains between 5,900 and 9,950 ft (1,800 and 3,030 m). It is characteristic of tree line where it forms dense krummholz thickets. In Banff and Jasper National Parks at tree line (about 6,560 to 7,550 ft [2,000–2,300 m]), whitebark pines are dwarfed and isolated on dry, exposed sites. At the northern end of its range, the tree is a minor component of tree line. Whitebark pine is an important component of high-elevation forests in Idaho, Montana, and Wyoming between 5,900 and 10,500 ft (1,800 and 3,200 m). In high-elevation forests in the Cascade Range of southern Oregon and northern California between 8,000 and 9,500 ft (2,440 and 2,900 m), whitebark pine is a major component of tree line (Arno 1986, Arno and Hoff 1990). Whitebark pine occurs at elevations as low as 4,820 ft (1,470 m) in British Columbia and the Cascades of Washington. The lowest reported natural occurrence of whitebark pine is 3,600 ft (1,100 m) on Mt. Hood in Oregon. In the

southern Sierra Nevada, it commonly occurs at elevations up to 11,500 ft (3,500m) (Arno 1986).

As mentioned earlier, sites where whitebark pine occurs as a climax are drier than those where it is seral. Whitebark pine is important in areas where the mean annual precipitation is 24 to 70 inches (600–1,800 mm) (Arno and Hoff 1990). The climate is characterized by cool summers and cold winters with deep snowpack. Trees have high frost resistance and low shade tolerance. They occur predominately on acidic substrates, although they have also been reported on calcareous ones. Most soils under whitebark pine stands are Inceptisols. The growth of whitebark pine in Montana and Wyoming is reported as good on sandy-loam and loam, fair on gravels and clay loams, and poor on clay (Forcella and Weaver 1977, Steele *et al.* 1983, Eggers 1986, Arno and Hoff 1990).

The whitebark pine habitat lies above the mixed montane conifer forest or lodgepole pine forest habitats and below the alpine grassland and shrubland habitats. Associated wetlands in subalpine parklands extend upward a short distance into the alpine zone. Primary land use is recreation, watershed protection, and grazing.

Structure—Whitebark pine habitat has a tree layer with typically between 10 and 30% canopy cover. Openings among trees are highly variable. The habitat appears either as parkland, that is, a mosaic of treeless openings and small patches of trees, often with closed canopies, or as woodlands or savanna-like stands of scattered trees. The ground layer can be composed of 1) low to matted dwarf shrubs 1 ft (0.3 m) tall that are evergreen or deciduous and often small-leaved; 2) sod grasses, bunchgrasses, or sedges; 3) forbs; or 4) moss- or lichen-covered soils. Herb- or shrub-dominated wetlands appear within the parkland areas and

are considered part of this habitat. Wetlands can occur as deciduous shrub thickets up to 6.5 ft (2 m) tall, scattered tall shrubs, dwarf shrub thickets, or herbaceous plants shorter than 1.6 ft (0.5 m). In general, eastern Cascade Range and Rocky Mountain areas are parklands and woodlands typically dominated by grasses or sedges, with fewer heathers.

Composition—In western North America, whitebark pine is a dominant or codominant species in many high-elevation forests. In the Rocky Mountains, eastern Cascade Range, and Blue Mountains, it is a minor component in mixed stands of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). It is found with mountain hemlock (*Tsuga mertensiana*) in the Cascade and British Columbia Coast ranges. In the upper subalpine forests of California, it is associated with subalpine fir, lodgepole pine (*Pinus contorta*), western white pine (*P. monticola*), foxtail pine (*P. balfouriana*), and limber pine (*P. flexilis*) (Arno 1980, Arno and Hoff 1990).

Drier areas are more woodland or savanna-like, often with low shrubs such as common juniper (*Juniperus communis*), kinnikinnick (*Arctostaphylos uva-ursi*), low whortleberries or grouseberries (*Vaccinium myrtillus* or *V. scoparium*), or common beargrass dominating the undergrowth. Wetland shrubs in the subalpine parkland habitat include bog-laurel (*Kalmia microphylla*), Booth's willow (*Salix boothii*), undergreen willow (*S. commutata*), Sierran willow (*S. eastwoodiae*), and blueberries (*Vaccinium uliginosum* or *V. deliciosum*).

Undergrowth in drier areas may be dominated by pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*C. rossii*), smooth woodrush (*Luzula glabrata* var. *hitchcockii*), Drummond's rush (*Juncus drummondii*), or short fescues

(*Festuca viridula*, *F. brachyphylla*, *F. saximontana*).

The remaining flora of this habitat is diverse and complex. The following herbaceous broadleaf plants are important indicators of differences in the habitat: American bistort (*Polygonum bistortoides*), American false hellebore (*Veratrum viride*), fringe leaf cinquefoil (*Potentilla flabellifolia*), marsh marigolds (*Caltha leptosepala*), avalanche lily (*Erythronium montanum*), partridgefoot (*Luetkea pectinata*), Sitka valerian (*Valeriana sitchensis*), subalpine lupine (*Lupinus arcticus* ssp. *subalpinus*), and alpine aster (*Aster alpigenus*). Showy sedge (*Carex spectabilis*) is also locally abundant (Cronquist *et al.* 1972, Dittberner and Olson 1983, Arno 1986).

Other Classifications and Key

References—Quigley and Arbelbide (1997) called this habitat whitebark pine and whitebark pine–subalpine larch cover types. Kuchler (1964) included this habitat within the subalpine fir–mountain hemlock forest. Scott *et al.* (2002) classified the habitat as subalpine pine, subalpine fir/whitebark pine, and mixed whitebark pine forests (Kuramoto and Bliss 1970, Douglas and Bliss 1977, Arno 1979, Lillybridge *et al.* 1995).

Natural Disturbance Regime—Although fire is rare to infrequent in this habitat, it plays an important role, particularly in drier environments. Before 1900, whitebark pine woodland fire intervals varied from 50 to 300 years. Wind blasting by ice and snow crystals is a critical factor in these woodlands and establishes the higher limits of the habitat. Periodic shifts in climatic factors, such as drought, snowpack depth, or snow duration, either allow tree invasions into meadows and shrublands or eliminate or retard tree growth.

Succession and Stand Dynamics—In upper-elevation subalpine forests, whitebark pine is

generally seral and competes with and is replaced by more shade-tolerant trees. Subalpine fir, a very shade-tolerant species, is the most abundant associate and most serious competitor of whitebark pine. Although whitebark pine is more shade tolerant than lodgepole pine and subalpine larch (*Larix lyallii*), it is less shade tolerant than Engelmann spruce and mountain hemlock (*Tsuga mertensiana*). Whitebark pine is the potential climax species on high, exposed tree line sites and exceptionally dry sites (Arno 1986, Eggers 1986, Tomback 1986, Arno and Hoff 1990). It sometimes acts as a pioneer species in the invasion of meadows and burned areas (Forcella and Weaver 1977, Fischer and Bruce 1983). On dry, wind-exposed sites, the regeneration of whitebark pine may require several decades, even though it is often the first tree to become established (Weaver and Dale 1974, Fischer and Clayton 1983, Arno and Hoff 1990). The fact that the Clark's nutcracker disperses seed allows whitebark pine to be more widespread as a seral species. The bird's dispersal of seeds throughout subalpine habitats is partly responsible for the status of whitebark pine as a pioneer and post-fire invader (Steele *et al.* 1983).

Effects of Management and Anthropogenic Impacts—Fire suppression has contributed to change in habitat structure and functions. For example, the current “average” whitebark pine stand will burn every 3,000 years or longer because of fire suppression. Blister rust, an introduced pathogen, is increasing whitebark pine mortality in these woodlands (Ahrensleger 1987). Even limited logging can have prolonged effects because of slow invasion rates of trees. This is particularly important on drier sites and in subalpine larch stands. During wet cycles, fire suppression can lead to tree islands coalescing and parklands converting to a more closed forest habitat. Parkland conditions can displace alpine conditions through tree invasions.

Livestock use and heavy horse or foot traffic can trample and compact soil. Slow growth in this habitat prevents rapid recovery.

Status and Trends—Whitebark pine might be declining because of the effects of blister rust or fire suppression leading to conversion of parklands to more closed forest. Global climate warming will likely have an amplified effect throughout this habitat. Less than 10% of Pacific Northwest subalpine parkland community types listed in the National Vegetation Classification are considered imperiled (Anderson *et al.* 1998).

7 Aspen

Geographic Distribution—Quaking aspen (*Populus tremuloides*) is the most widely distributed tree in North America, but the habitat type is a minor one throughout eastern Washington, Oregon, and Idaho. It occurs from Newfoundland west to Alaska and south to Virginia, Missouri, Nebraska, and northern Mexico. A few scattered populations occur farther south in Mexico to Guanajuato (Little 1979). Distribution is patchy in the West, with trees confined to suitable sites. Aspen stands are much more common in the Rocky Mountain states. Density is greatest in Minnesota, Wisconsin, Michigan, Colorado, and Alaska; each of these states contains at least two million acres of commercial quaking aspen forest. Maine, Utah, and central Canada also have large acreages of quaking aspen (Jones and Schier 1985, Perala and Carpenter 1985).

Physical Setting—This habitat generally occurs on well-drained mountain slopes or canyon walls that have some moisture. Rockfalls, talus, or stony north slopes are often typical sites. This habitat may occur in steppes on moist microsites. It is not associated with streams, ponds, or wetlands. This habitat is found at elevations from 2,000 to 9,500 ft (610–2,896 m).

Landscape Setting—Aspen forms a “subalpine belt” above the western juniper and mountain mahogany woodland habitats and below montane shrub-steppe habitat. It can occur in seral stands in the lower mixed conifer forest and the ponderosa pine forest and woodland habitats. Primary land use is livestock grazing.

Structure—Deciduous trees, usually less than 48 ft (15 m) tall, dominate this woodland or forest habitat. The tree layer grows over a forb-, grass-, or low shrub-dominated undergrowth. Relatively simple two-tiered stands characterize the typical vertical structure of woody plants in this habitat. This habitat is composed of one to many clones of trees, with larger trees toward the center of each clone. Conifers invade and create mixed evergreen-deciduous woodland or forest habitats.

Composition—Quaking aspen is the characteristic and dominant tree in this habitat. It is the sole dominant in many stands, although scattered ponderosa pine (*Pinus ponderosa*) or Douglas-fir (*Pseudotsuga menziesii*) may be present. Snowberry (*Symphoricarpos oreophilus* and, less frequently, *S. albus*) is the most common dominant shrub. Tall shrubs such as Scouler’s willow (*Salix scouleriana*) and Saskatoon serviceberry (*Amelanchier alnifolia*) may be abundant. On mountain or canyon slopes, antelope bitterbrush (*Purshia tridentata*), mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), low sagebrush (*A. arbuscula*), and curl-leaf mountain mahogany (*Cercocarpus ledifolius*) often occur in and adjacent to this woodland habitat.

In some stands, pinegrass (*Calamagrostis rubescens*) may dominate the groundcover without shrubs. Other common grasses are Idaho fescue (*Festuca idahoensis*), California brome (*Bromus carinatus*), or blue wildrye (*Elymus glaucus*). Characteristic tall forbs

include horsemint (*Agastache* spp.), aster (*Aster* spp.), senecio (*Senecio* spp.), and coneflower (*Rudbeckia* spp.). Low forbs include meadow-rue (*Thalictrum* spp.), bedstraw (*Galium* spp.), sweetcicely (*Osmorhiza* spp.), and valerian (*Valeriana* spp.).

Other Classifications and Key

References—This habitat is called aspen by the Society of American Foresters and aspen woodland by the Society of Range Management. The Oregon Gap II Project (Kiilsgaard 1999) cover type that would represent this type is aspen groves. Other references describing this habitat include Franklin and Dyrness 1973, Williams and Lillybridge 1983, Agee 1994, Howard 1996, Mueggler 1988, and Ritter 2000.

Natural Disturbance Regime—Fire plays an important role in maintenance of this habitat. Quaking aspen will colonize sites after fire or other stand disturbances through root sprouting. Research on fire scars in aspen stands in central Utah (Howard 1996) indicated that most fires occurred before 1885 and concluded that the natural fire-return interval was 7 to 10 years. Ungulate browsing plays a variable role in aspen habitat: ungulates may slow tree regeneration by consuming aspen sprouts on some sites and may have little influence in other stands.

Succession and Stand Dynamics—There is no generalized successional pattern across the range of this habitat. Aspen sprouts after fire and spreads vegetatively into large clonal or multiclinal stands. Because aspen is shade intolerant and cannot reproduce under its own canopy, conifers can invade most aspen habitat. In central Utah, quaking aspen was invaded by conifers in 75 to 140 years. Apparently, some aspen habitat is not invaded by conifers, but eventually clones deteriorate and shrubs, grasses, and/or forbs grow in.

This transition to grasses and forbs is more likely on dry sites.

Effects of Management and Anthropogenic Impacts—Domestic sheep reportedly consume four times more aspen sprouts than cattle do. Heavy livestock browsing can adversely impact aspen growth and regeneration. With fire suppression and alteration of fine fuels, fire rejuvenation of aspen habitat has been greatly reduced since about 1900. Conifers now dominate many seral aspen stands, and extensive stands of young aspen are uncommon.

Status and Trends—With fire suppression and change in fire regimes, the aspen forest habitat is less common than it was before 1900. None of the five Pacific Northwest upland quaking aspen community types in the National Vegetation Classification is considered imperiled (Anderson *et al.* 1998).

8 Mountain Brush

Geographic Distribution—This habitat occurs as a patchily distributed resource primarily on steep canyon slopes in the margins of the Columbia River basin in Idaho.

Physical Setting—This habitat develops in hot dry climates in the Pacific Northwest. Annual precipitation totals 12 to 20 inches (31–51 cm); only 10% falls in the hottest months (July through September). Mountain shrub habitat occurs as a transition community between sagebrush steppe and conifer communities. Mountain shrub is found at moderately high elevations, often associated with Douglas-fir and aspen communities, on sites that are more mesic than sagebrush steppe but drier than aspen. Mountain shrub is usually found on north and east slopes that tend to be cooler and moister than south and west aspects.

Landscape Setting—This habitat is generally found in steeper aspects within a mosaic of shrub-steppe, aspen, and pine/fir forest habitats. This habitat can develop near talus slopes, at the heads of dry drainages, and on toeslopes in moist shrub-steppe and steppe zones. At lower-elevation sites, these are more often in a mix with perennial grasses, dry rocky grasslands, and low-elevation riparian habitats. The primary surrounding land use is livestock grazing. Mountain brush is widely regarded as important to wildlife for its food and cover values, as well as providing integral components of watershed stability and species diversity (Lanner 1983, Stauffer and Peterson 1985, Steele and Geier-Hayes 1995).

Structure—The mountain brush habitat is generally a mix of tall (5 ft [1.5 m]) to medium (1.6 ft [0.5 m]) deciduous shrublands in a mosaic with bunchgrass or annual grasslands. Shrub canopies are almost always closed (>60% cover), forming a thicket of interwoven stems and branches. Shrub layers can be one or two tiered, but they are often so dense that they restrict the herbaceous layer to shade-tolerant rhizomatous species.

Composition—Mountain brush is a highly diverse community with chokecherry (*Prunus virginiana*), serviceberry (*Amelanchier alnifolia*), currant (*Ribes* sp.), mountain snowberry (*Symphoricarpos oreophilus*), buckbrush (*Ceanothus cuneatus*), mountain mahogany, big tooth maple (*Acer grandidentatum*), antelope bitterbrush (*Purshia tridentata*), and elderberry (*Sambucus racemosa*), often intermingled with mountain big sagebrush. The herbaceous understory is typically composed of perennial grasses such as Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and Sandberg bluegrass (*Poa secunda*). Perennial forbs are also important understory components and may include nodding microseris (*Microseris*

nutans), arrowleaf balsamroot (*Balsamorhiza sagittata*), narrow-leaf collomia, (*Collomia linearis*), blue-eyed Mary (*Collinsia verna*), pink microsteris (*Microsteris gracilis*), Indian paintbrush, (*Castilleja* sp.), owl-clover (*Orthocarpus tenuifolius*), buckwheat (*Fagopyrum esculentum*), and tapertip hawksbeard (*Crepis acuminata*).

Other Classifications and Key

References—This habitat is called mountain brush (Shiflet 1994). The Oregon Gap II Project (Kiilsgaard, C. 1999) represents this type as eastside big sagebrush shrubland. Scott *et al.* (2002) classified this habitat as non-forested lands—grasslands. Other references describing this habitat are Daubenmire (1970), Tisdale (1986), and Johnson and Simon (1987).

Natural Disturbance Regime—Stand-replacing fires occur from 25 to 100 years (63-year midrange) in mountain shrub (Loop and Gruell 1973), though fire-return intervals may vary widely with changes in elevation, aspect, site moisture, and associated forest or woodland communities. Fuel loadings vary among communities. All species of mountain shrubs resprout after fire, except for mountain big sagebrush. Mountain shrub communities generally recover rapidly following wildland fire and are considered to be fire tolerant. Mountain shrub is classified as Fire Regime—V (Hardy *et al.* 2001).

Succession and Stand Dynamics—Many of the major shrubs sprout following fire and are maintained with moderate fire frequency. Most thickets will increase in size without fire. This habitat has increased primarily in moist steppe and shrub-steppe habitat with fire suppression and restricted grazing. Prolonged fire suppression may lead to invasions by tree species. Apparently some representatives of this habitat potentially support pine/fir forests after a long, fire-free period.

Effects of Management and Anthropogenic Impacts—Livestock grazing in shrub-steppe habitat changes the surrounding fine-fuel matrix for fire. That, combined with fire suppression, leads to a change in habitat patch size, structure, and composition. In response to fire suppression, shrub thickets on northerly aspects near lower tree line tend to increase in patch size and height and be invaded by tree species. With heavy livestock grazing, shrubs are browsed, broken, and trampled, which eventually creates a more open shrubland with a more abundant herbaceous layer.

Status and Trends—The mountain brush habitat is restricted in range and probably has decreased locally in the Upper Snake province.

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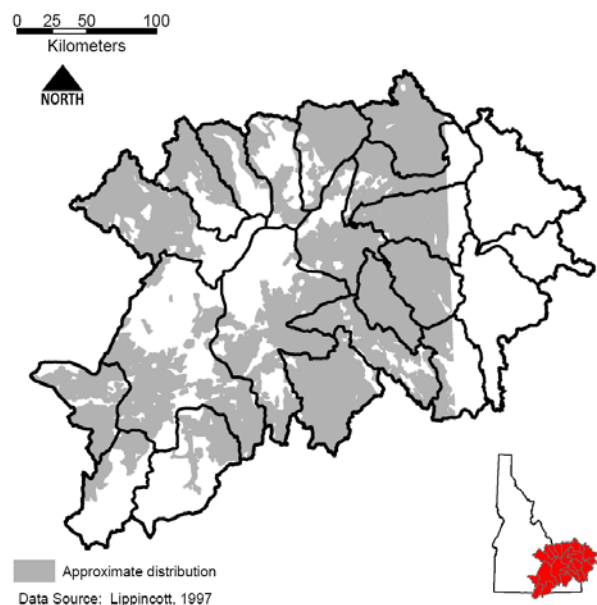
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APPENDIX 2-4—TERRESTRIAL FOCAL SPECIES DESCRIPTIONS

1 Riparian/Herbaceous Wetlands

1.1 Western Toad (*Bufo boreas*)



A currently accepted subspecies of the western toad that occurs in Idaho is the western toad (*Bufo boreas* ssp. *boreas*). This toad also occurs in western British Columbia and southern Alaska and southward to Washington, Oregon, western Montana, western Wyoming, northern California, Nevada, western Utah, and western Colorado (Stebbins 1951, Schmidt 1953). Amphibians generally seem to be more sensitive to environmental changes than other taxonomic groups are. Western toads repeatedly use individual stumps or logs, a habit that may be important for conservation and recovery programs to consider.

The western toad is found in the Rocky Mountains in aspen (*Populus* spp.) groves and riparian forests (Kricher 1993). In Colorado, the largest populations are typically found in areas characterized by willows (*Salix* spp.), bog birch (*Betula glandulosa*), and shrubby

cinquefoil (*Potentilla fruticosa*) (USFWS 1994). In the Pacific Northwest, the western toad occurs in mountain meadows and less commonly in Douglas-fir forests (*Pseudotsuga menziesii*) (Kricher 1993). Western toads have been collected from sedge meadows near a pond occurring in a creosotebush (*Larrea tridentata*) community and from aspen (*Populus* spp.)-willow groves within big sagebrush (*Artemisia tridentata*)-grassland (Stebbins 1951).

Western toads are widespread throughout the mountainous areas of northwestern North America, ranging from sea level to elevations near or above regional tree line, or 10,000 feet (305–3,050 m) in elevation (Stebbins 1951, Verner and Boss 1980). The toad is uncommon at the higher elevations (Verner and Boss 1980). Western toads occupy desert streams and springs, grasslands, and mountain meadows; they are less common in heavily wooded regions. They are usually found in or near ponds, lakes (including saline lakes), reservoirs, rivers, and streams (Stebbins 1951, Stebbins 1985).

Western toads are active from January to October, depending on latitude and elevation (Stebbins 1985). At low elevations, western toads are active at night; at high elevations and in the northern parts of their range, they are diurnal (Stebbins 1985). Diurnal and nocturnal activities are often related to seasonal changes in temperature; most western toads are diurnal during spring and fall but nocturnal during the warmer summer months (USFWS 1994).

Body temperature of western toads is closely correlated with the substrate temperature. Basking behavior and conduction from a substrate are primary means of increasing body temperature, while evaporation and conduction of heat to a cooler medium lead to

cooling. To avoid evaporative conditions, the frogs usually spend the daylight hours on the forest floor in the soil under rocks, logs, stumps, or other surface objects or in rodent burrows (Stebbins 1951, Kahn 1960, Porter 1972, Stebbins 1985, Kricher 1993). Individuals have been observed to use the same retreat repeatedly. In locations where there is little or no hiding cover, western toads may spend most of the day in water (Stebbins 1951). Under more humid conditions, western toads may become active during the day (Porter 1972).

In central Oregon, the minimum breeding age for male western toads is 3 years, and probably 4 or 5 years for females (Olson 1992). Male western toads breed every year, while females breed at less regular intervals, depending on individual condition and previous years' breeding effort (Olson 1992). Sex ratios differ according to habitat type: males are more numerous in wet areas; females, more numerous in dry habitats (USFWS 1994).

Western toads require open water for breeding (Verner and Boss 1980). All breeding members of a local population tend to lay their eggs in the same location, which is used repeatedly from year to year. For example, at one site on a permanent lake in the Cascade Range in Oregon, western toads returned each year to the same submerged willow clumps (Olson 1992).

Eggs are laid in open water from February to July, with peak activity occurring in April. Timing of egg-laying activity varies with elevation and weather conditions (Verner and Boss 1980). Eggs are usually laid in late May or early June (USFWS 1994). They are laid in gelatinous strings of 13 to 52 eggs per inch, in masses of up to 16,500 per clutch (Stebbins 1951, Kahn 1960). Egg development rate is partially dependent on temperature; hatching times vary (Porter 1972). Eggs are usually

laid in shallow water (not deeper than 12 inches [30 cm] but usually at least 6 inches [5 cm] deep (Kahn 1960, Olson 1992). The warmth of shallow water increases the rate at which development occurs; shallow water and vegetative matter may contribute to protecting eggs from predation by fish (Olson 1992). Woody debris or submerged vegetation is also used to protect egg masses (Kahn 1960, Olson 1992).

Metamorphosis is usually completed within 3 months of egg laying. The time required for metamorphosis is given as 30 to 45 days for the western toad (Stebbins 1951). Female western toads at least 10 to 11 years of age have been reported (Olson 1992). In Colorado, western toads probably attain a maximum age of at least 9 years (USFWS 1994).

Western toads wait for their prey on the surface of the ground or in shallow burrows dug by other animals. Their diet consists largely of bees, beetles, ants, and arachnids. Other foods include crayfish, sowbugs, grasshoppers, trichopterans, lepidopterans, and dipterans (Stebbins 1951, Verner and Boss 1980).

Tadpoles are preyed upon by fish, herptiles, birds, and mammals (Porter 1972). Toads in general tend to walk or hop rather than jump (like frogs). Their slow movement makes them vulnerable to predators; however, the western toad (like other toads) produces skin toxins that are avoided by many predator species. The nocturnal habit may also help reduce predation (Kricher 1993). Adult western toads are preyed upon by common ravens (*Corvus corvax*) and probably also by other birds, herptiles, and mammals (Olson 1992, Porter 1972). A badger (*Taxidea taxus*) was recorded as having consumed five adult *Bufo* (probably western toad, which was the only *Bufo* species in the area) in Wyoming (Martin 1973).

Mortality of western toads is greatest during the larval and juvenile stages but is slight thereafter. Most mortality can be attributed to unseasonable weather and predation on juvenile toads. There is very little predation on adult toads, and mortality of adults is low (USFWS 1994). Western toads are also taken by people for the pet trade (Martin 1992).

1.2 Yellow-billed Cuckoo (*Coccyzus americanus*)



The yellow-billed cuckoo is distributed throughout much of the mideastern United States, southeastern Canada, the Greater Antilles, and Mexico. The species winters primarily in South America east of the Andes Mountains. There are also reports of the species west of the Andes in northern Colombia (Hilty and Brown 1986).

The species' range boundaries are confused by recurrent observations of nonbreeding individuals away from breeding sites. For instance, there are several reports of vagrants in Canadian prairie provinces in July (Koes and Taylor 1996) and in Alaska (Tobish and Isleib 1992). The species may also wander north or east in the fall before migrating

south. Some individuals have also been observed in Britain, Ireland, and Western Europe, and the birds were found either dead or near death (Cramp 1985). These birds became disoriented in frontal zones north of Bermuda, and then were carried east (Cramp 1985).

The yellow-billed cuckoo prefers open woodlands with clearings and low, dense, scrubby vegetation; it is often associated with waterways. Generally, the species is absent from heavily forested areas and large urban areas (Eaton 1988). In the central United States and Canada, the bird occupies woodlands, abandoned farmland, overgrown fruit orchards, successional shrubland, and dense thickets along streams and marshes (Johnsgard 1979, Peck and James 1983, Eaton 1988, Jauvin 1996). It is also found in willow (*Salix* spp.)-dogwood (*Cornus* spp.) shrub wetlands. The yellow-billed cuckoo is primarily solitary during the breeding season, observed either alone or in breeding pairs (Oberholser 1974). The bird gathers in large flocks during migration (Hilty and Brown 1986).

There are reports of the bird breeding in southeastern Idaho (Dobkin 1994). Age at first breeding is believed to be at about one year of age. Females lay between 1 and 5 eggs, with 2 to 3 being the usual. Sets of 6 or more eggs may be attributed to more than one female laying eggs in a single nest (Nolan and Thompson 1975). The number of broods per season is not confirmed, though the species is believed to have a single brood, with nesting timed to coincide with temporary local abundance of food (Nolan and Thompson 1975).

The yellow-billed cuckoo is known to parasitize at least 11 other bird species: it lays its eggs in the nests of other species such as the American robin. The yellow-billed cuckoo does not randomly lay eggs in nests of other

birds but selects hosts with similarly colored eggs (Hughes 1997).

There is little information on the life span and survivorship of the yellow-billed cuckoo because so very few banded birds have been recovered. Three banded birds were captured at 4 years of age (Canadian Wildlife Service, cited in.

The yellow-billed cuckoo eats primarily large insects like caterpillars, katydids, cicadas, grasshoppers, and crickets (Nolan and Thompson 1975, Laymon 1980).

Occasionally, the bird eats small frogs, and arboreal lizards (Voous 1955, Hamilton and Hamilton 1965). In winter, the cuckoo more frequently eats fruit and seeds than it does in summer (Rappole *et al.* 1983). The bird forages in open areas, woodlands, orchards, and adjacent streams. The majority of food items are collected from riparian habitats (Laymon 1980).

Eggs and nestlings may be taken by avian predators, mammals, or snakes (Nolan 1963, Potter 1980). Raptors may be an important cause of adult mortality both along the migration route and upon arrival in wintering grounds following migration.

1.3 American Beaver (*Castor canadensis*)



The American beaver inhabits riparian areas of mixed coniferous-deciduous forests and deciduous forests containing abundant beaver foods and lodge-building material such as quaking aspen (*Populus tremuloides*), willows (*Salix* spp.), alders (*Alnus* spp.), redosier dogwood (*Cornus sericea*), and cottonwoods (*Populus* spp.) (Patric and Webb 1953, Allen 1983). Suitable habitat for beavers must contain all of the following: stable aquatic habitat providing adequate water; a channel gradient of less than 15%; and quality food species in sufficient quantity (Allen 1983). Through tree-harvesting activity, beavers can usually control water depth and stability on small streams, ponds, and lakes and can also have an effect on natural succession.

Large lakes or reservoirs (8 ha in surface area) with irregular shorelines provide optimum habitat for beavers. Lakes and reservoirs that have extreme annual or seasonal fluctuations in the water level are generally unsuitable habitat for beavers (Allen 1983, Smith and Peterson 1991). Intermittent streams or streams that have

major fluctuations in discharge have little year-round value as beaver habitat (Allen 1983). Food availability is another factor determining suitable habitat for beavers (Harris 1991). Beavers often occupy marshes, ponds, and lakes when an adequate supply of food is available. They generally forage no more than about 90 m from water, though foraging distances of up to 200 m have been reported (Allen 1983).

In Idaho, beavers breed between mid-January and early June (Lippincott 1997). Beavers are generally monogamous, although males will mate with other females (Van Gelden 1982, Merritt 1987). Only the dominant female of a beaver colony breeds, producing one litter a year (Van Deelen 1991). The gestation period is four months, with the average litter size varying between two and three kits (Rue 1967, Van Gelden 1982, Zeveloff 1988, Van Deelen 1991). Kits are weaned at two to three months and can swim by one week of age (Van Gelden 1982, Zeveloff 1988). Beavers become sexually mature between ages two and three (Lawrence 1954, Wilkinson 1962). They live up to 11 years in the wild and between 15 and 21 years in captivity (Rue 1967, Merritt 1987).

Beavers are active throughout the year and usually nocturnal. They live in colonies (average five beavers per colony) that consist of three age classes: adults, kits, and yearlings that were born the previous spring (Lawrence 1954). After young beavers reach their second or third year, they are forced to leave the family group (Lawrence 1954, Merritt 1987, Zeveloff 1988). Dispersal may be delayed in areas with high beaver densities. Subadults generally leave the natal colony in late winter or early spring (Van Deelen 1991). Subadult beavers have been reported to migrate as far as 236 km, although average migration distances range from 8 to 16 km (Allen 1983). Adult beavers are nonmigratory (Allen 1983).

Beavers are herbivores. During late spring and summer, their diet consists mainly of fresh herbaceous matter (Allen 1983, Lawrence 1954). Beavers appear to prefer herbaceous vegetation to woody vegetation during all seasons if it is available. Woody vegetation may be consumed during any season, although its highest utilization occurs from late fall through early spring when herbaceous vegetation is not available. The majority of the branches and stems of woody vegetation are cached for later use during winter (Allen 1983). Trees and shrubs closest to the water's edge are generally used first (Allen 1983).

Winter is a critical period, especially for colonies on streams because they must subsist solely on their winter food caches. In contrast with stream colonies, those on lakes are not solely dependent on their stores of woody vegetation; they can augment their winter diet of bark with aquatic plants (Lawrence 1954).

Aquatic vegetation such as duckweed (*Lemna* spp.), pondweed (*Potamogeton* spp.), and waterweed (*Elodea* spp.) are preferred foods when available (Allen 1983). The thick, fleshy rhizomes of water lilies (*Nymphaea* spp. and *Nuphar* spp.) may be used as a food source throughout the year. If present in sufficient amounts, water lily rhizomes may provide an adequate winter food source, resulting in little or no tree cutting or food caching of woody materials (Allen 1983, Lawrence 1954). Other important winter foods of beavers living on lakes include the rhizomes of sedges and the rootstocks of mat-forming shrubs (Lawrence 1954).

Aspen and willows are considered preferred beaver foods; however, these species are generally riparian species and so may be more available for beaver foraging but not necessarily preferred over all other deciduous tree species. Beavers have been reported to subsist in some areas by feeding on conifer

trees, but these trees are a poor-quality food source (Allen 1983).

The lodge is the major source of escape, resting, thermal, and reproductive cover for beavers. Beavers usually construct lodges so that the structure is surrounded by water or located against a bank. Water protects the lodge from predators and provides concealment for beavers when traveling to and from food-gathering areas and caches (Allen 1983). On lakes and ponds, lodges are frequently situated in areas that provide shelter from wind, waves, and ice (Allen 1983). Damming large streams that have swift, turbulent waters creates calm pools for feeding and resting (Harris 1991).

Beavers have few natural predators; however, in certain areas, they may face predation pressure from wolves (*Canis lupus*), coyotes (*Canis latrans*), lynx (*Lynx canadensis*), fishers (*Martes pennanti*), wolverines (*Gulo gulo*), and occasionally bears (*Ursus* spp.). Minks (*Mustela vison*), otters (*Lutra canadensis*), hawks, and owls periodically prey on kits (Rue 1967, Merritt 1987). Humans kill beavers for their fur (Lawrence 1954, Merritt 1987).

However, beavers will live near people if all habitat requirements are met (Rue 1967). Railways, roads, and land clearing adjacent to waterways may affect beaver habitat suitability. Transplants of beaver may be successful on strip-mined land or in new impoundments where water conditions are relatively stable. Highly acidic waters, which often occur in strip-mined areas, are acceptable for beaver if suitable foods are present (Allen 1983).

Beaver activity can have a significant influence on stream and riparian habitats (Munther 1981, Barnes and Dibble 1988, Johnston and Naiman 1990, Van Deelen 1991). Through tree-harvesting

activity, beavers can affect natural succession. Other than humans, beavers are the only mammals in North America that can fell mature trees; therefore, their ability to decrease forest biomass is much greater than that of other herbivores (Allen 1983). In addition, beaver ponds conserve spring runoff, thus ensuring more constant stream flow, diminishing floods, conserving soil, and helping maintain the water table (Hazard 1982).

Beaver activity can be beneficial to some wildlife species (Johnson 1989, Van Deelen 1991). Waterfowl often benefit from the increased edge, diversity, and invertebrate communities created by beaver activity (Van Deelen 1991). Occupied beaver-influenced sites produce more waterfowl because of improved water stability and increased brood-rearing cover; waterfowl production declines when beavers leave an area. Great blue herons (*Ardea herodias*), ospreys (*Pandion halietus*), bald eagles (*Haliaeetus leucocephalus*), kingfishers (*Ceryle alcyon*), and many species of songbirds also benefit from beaver activity. Otters, raccoons (*Procyon lotor*), mink, and muskrat (*Ondatra zibethica*) thrive on the increased foraging areas produced by beaver activity. Berry-producing shrubs and brush in areas cut by beavers attract white-tailed deer (*Odocoileus virginianus*) and black bear (*Ursus americanus*) (Van Deelen 1991).

Beaver activity can also improve fish habitat. Production of three trout species (*Salmo* spp. and *Salvelinus fontinalis*) in a stream in the Sierra Nevada increased due to a higher standing crop of invertebrates in beaver ponds (Gard 1961). Smallmouth bass (*Micropterus dolomieu*) and northern pike (*Esox lucius*) also benefit from beaver impoundments (Van Deelen 1991). In some instances, beaver ponds have provided up to six times more salmonids (by total weight) per acre than adjacent stream habitat without beaver ponds

has provided (Munther 1981). In areas of marginal trout habitat, however, beaver activity can reduce trout production. Beaver-caused loss of streamside shade and diminished water velocity can result in lethal water temperatures (Van Deelen 1991).

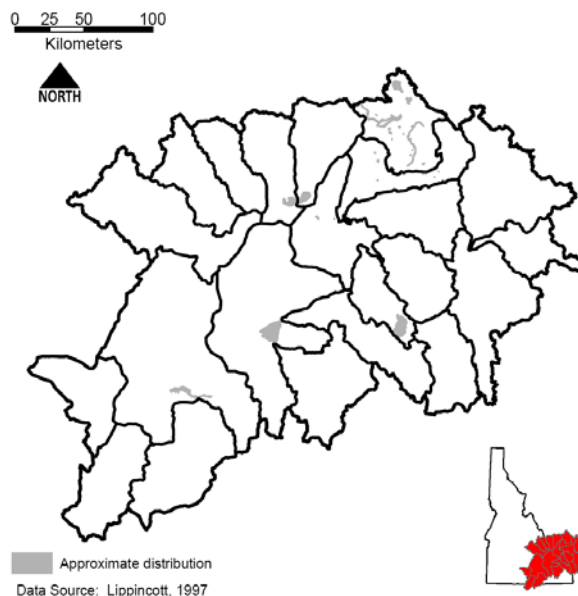
The amount of influence that cattle have on riparian environment can be reduced by beaver activity in many valley bottoms. If beavers are thoroughly established in willow habitats of wide valleys prior to cattle being introduced, the immediate effect of cattle on the stream is often minor (Munther 1981).

Beaver activity can also have detrimental effects. Beaver-caused flooding often kills valuable lowland timber (Van Deelen 1991). Human–beaver conflicts occur when beavers flood roadways and agricultural lands or dam culverts and irrigation systems. Also, beavers have potential to increase waterborne pathogens (including *Giardia lamblia*) downstream of their activity (Van Deelen 1991).

Information on the direct effects that fire has on beavers was not found in the literature; however, beavers can probably easily escape fire (Tesky 1993). Since lodges are typically built over water, they are probably at little risk of being destroyed by fire. Fire occurring in riparian areas often benefits beaver populations (Kelleyhouse 1979). Beavers are adapted to the early stages of forest succession. Quaking aspen, willows, alders, and redosier dogwood—prime beaver food trees—all sprout vigorously after fire. As succession progresses, these trees become too large for beavers to use or are replaced by climax trees (Wright and Bailey 1982). Recurring fires within parts of boreal forests have allowed aspen and willow to replace coniferous forests. This change favors beaver populations since willow and aspen are important food sources.

2 Open Water

2.1 Trumpeter Swan (*Cygnus buccinator*)



The trumpeter swan is listed as a species of special concern in Idaho (Category A, Draft List) and Montana and as a Priority 1 species in Wyoming. Region 1 of the U.S. Forest Service lists the trumpeter swan as a sensitive species on the Beaverhead, Gallatin, and Custer National Forests in Montana. Region 4 (Draft List) also lists the swan as a sensitive species (Clark *et al.* 1989, Reel *et al.* 1989, Finch 1992). The swan is listed as vulnerable in Alberta, British Columbia, Saskatchewan, and Yukon Territory in Canada (CSEWC 1992).

Trumpeter swans were once abundant and widespread in North America. By 1920, the commercial swanskin trade, coupled with sport hunting and habitat destruction, reduced the species to near extinction. The trumpeter swan breeding range extended from Alaska eastward to Ontario and south to Oregon, the Rocky Mountains, Nebraska, and northern Missouri (Shea 1979). Now, only two major populations remain (Palmer 1976, Shea 1979,

Bellrose 1980). The Pacific population of trumpeter swans breeds in Alaska and British Columbia and winters along the Pacific Coast from Alaska to northern Oregon (Clark *et al.* 1989 (Shea 1979). The mid-continental population nests in Alberta, British Columbia, the Yukon Territory, Northwest Territories, Saskatchewan, and the Greater Yellowstone region (Shea 1979, Clark *et al.* 1989). Over-hunting of trumpeter swans destroyed most of the species' traditional migration patterns to southerly winter habitats. As a result, virtually all mid-continental trumpeter swans, regardless of their summer range, now winter in the Greater Yellowstone Ecosystem (Clark *et al.* 1989).

Trumpeter swans are generally found in wetland areas among aquatic and tall emergent vegetation as the vegetation provides shelter and cover (Hansen 1971). Plants found in most trumpeter swan habitats include willows (*Salix* spp.), alders (*Alnus* spp.), cottonwoods (*Populus* spp.), water milfoil (*Myriophyllum exalbescens*), arrowhead (*Sagittaria latifolia*), and pondweeds (*Potamogeton* spp.) (Banko 1960, Hansen *et al.* 1971). Adults may remove vegetation around the nest until the nest is surrounded by open water. This strategy provides good visibility and protection from land predators (Anon. 1992). Nests are built in water 1 to 3 feet deep (Bellrose 1980), often on a muskrat house, beaver lodge, or small island (Reel *et al.* 1989). Occasionally, a nest is located on or near the shoreline of a small inlet in a large lake (Hansen *et al.* 1971). During winter, trumpeter swans prefer open sites with few trees or shrubs to obscure their vision while feeding (Clark *et al.* 1989). Winter habitat must provide extensive beds of aquatic plants and water that remains ice-free.

Trumpeter swans most often form pair bonds when they are 2 or 3 years old and first nest when they are 4 or 5 years old. Most pairs remain together year-round and bond for life

(Clark *et al.* 1989, Reel *et al.* 1989, Anon. 1992). Egg laying normally begins in late April or early May and is completed about mid-May (Palmer 1976, Bellrose 1980). In Alberta, eggs are laid in mid-May (Anon. 1992). Each breeding pair uses only one nest, and the female lays 5 to 6 eggs (Palmer 1976, Madge and Burn 1988, Anon. 1992). If the eggs are destroyed, the pair probably will not re-nest (Anon. 1992). The incubation period is 33 to 37 days (Banko 1960, Bellrose 1980, Reel *et al.* 1989).

Trumpeter swan cygnets grow rapidly (Bellrose 1980). They are fully feathered in 9 to 10 weeks but are unable to fly until 13 to 15 weeks in Alaska and 14 to 17 weeks in Montana (Bellrose 1980, Palmer 1976, respectively). Cygnets remain with their parents throughout their first winter. They separate from the parents the following spring, but siblings may remain together into their third year. Family bonds are strong; subadult siblings may rejoin parents after nesting ends or in subsequent winters (Clark *et al.* 1989). Trumpeter swans may live up to 35 years in captivity but usually do not live more than 12 years in the wild (Anon. 1992).

Nonbreeding subadults molt first, and it is rare for both members of a breeding pair to be flightless at the same time. The male of the pair usually molts first. Some paired birds begin to molt as early as nonbreeders do. Many, however, delay a month or longer. Some trumpeter swans are flightless until early September in Alaska and until October in Montana. Trumpeter swans are normally flightless for about 30 days (Bellrose 1980).

Trumpeter swans eat the roots, stems, leaves, and/or seeds of a variety of aquatic vegetation, and they occasionally eat insects (Anon. 1992). Initially, young cygnets eat large aquatic insects and snails. Cygnets feed on the water's surface and often depend on the adults to stir up the water around them.

Within 2 to 3 weeks, cygnets start to eat aquatic plants (Anon. 1992).

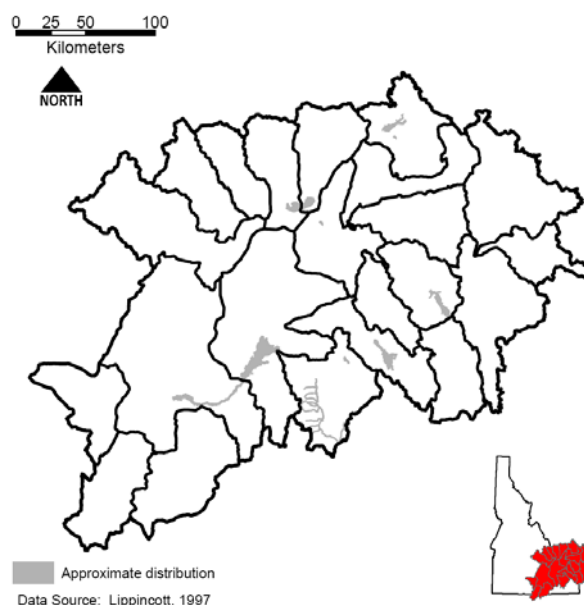
Trumpeter swans feed on the following: the tubers of duck-potato (*Sagittaria* spp.) and sago pondweed (*Stuckenia pectinatus*); the stems and leaves of sago and other pondweeds (*Potamogeton* spp.), water milfoil (*Myriophyllum verticillatum*), muskgrass (*Chara* spp.), waterweed (*Elodea canadensis*), and duckweed (*Lemna triscula*); the seeds of yellow pond lily (*Nuphar polysepala*), water shield (*Bransenia schreber*), smartweed (*Polygonum* spp.), sedges (*Carex* spp.), and spikerush (*Eleocharis* spp.); and the stems and roots of grasses and sedges (Banko 1960, Palmer 1976, Bellrose 1980, Anon. 1992).

After they reach flying age, trumpeter swans have few natural enemies, except for humans. Coyotes (*Canis lutrans*), river otters (*Lutra canadensis*), minks (*Mustela vison*), and golden eagles (*Aquila chrysaetos*) have been blamed for cygnet deaths in Yellowstone National Park and Red Rock Lakes National Wildlife Refuge (Shea 1979). The following species also occur in trumpeter swan habitat and could potentially prey on trumpeter swans: the black bear (*Ursus americanus*), lynx (*Lynx canadensis*), bald eagle (*Haliaeetus leucocephalus*), great horned owl (*Bubo virginianus*), mountain lion (*Felis concolor*), bobcat (*Lynx rufus*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), and raccoon (*Procyon lotor*), as well as gulls (*Larus* spp.) (Shea 1979).

Trumpeter swans are sensitive to human activities on their breeding grounds. Intrusions by people at nesting wetlands have caused temporary and permanent nest abandonment, as well as movements from breeding and staging areas (Anon. 1992). Trumpeter swans will not nest on lakes that have been intensively developed for recreation. The swans are most sensitive to

disturbance from mid-April to mid-June (Anon. 1992). Cygnet survival is associated with spring weather and favorable water levels. It is extremely important to properly manage water levels so that nest flooding is avoided and growth of aquatic vegetation is encouraged through nutrient cycling (Reel *et al.* 1989).

2.2 Western Grebe (*Aechmophorus occidentalis*)



The western grebe breeds in Idaho and overwinters primarily on the Pacific Coast, from southern British Columbia to southern Baja California and Sinaloa, Mexico. The species breeds on freshwater lakes and marshes that have extensive areas of open water bordered by emergent vegetation. Breeding areas contain open water of at least several square kilometers (Storer and Nuechterlein 1992).

The species migrates at night, probably in flocks (Nuechterlein and Storer 1982). Many birds from the northern populations move west to the Pacific Coast from early September to early November, with peaks migrations recorded in October. Over the

winter, western grebes prefer to hunt on salt or brackish bays, estuaries, or sheltered seacoasts and are infrequently seen on freshwater lakes or rivers. The birds fly east from the Pacific Coast to the interior breeding areas from late April to early May.

Western grebes are monogamous, and the pair bond is maintained at least until the chicks are several weeks old, but it is unknown whether pairs reunite in subsequent years (Storer and Nuechterlein 1992). Unpaired males outnumber females in late-courting groups, suggesting a male-biased sex ratio. Western grebes display two courtship ceremonies that are a series of different behaviors such as rushing, weed dancing, preening, and elaborate neck stretching (Nuechterlein and Storer 1982).

The western grebe is highly social during the breeding period, with nesting occurring in colonies of up to several hundred or thousand individuals on one lake. The colonies are often in areas flooded with emergent vegetation. Beds of extremely thick submergent vegetation such as water milfoil (*Myriophyllum exalbescens*) and pondweed (*Potamogeton* spp.) are also used. Nests are rarely less than 6 feet (2 m) apart (Nuechterlein 1975).

Birds probably can breed in their first year, although small groups of nonbreeding birds are often observed (Storer and Nuechterlein 1992). Normally, one brood is raised per year. The mean clutch size is between 2 and 3 chicks, but clutch size tends to decrease the later in the season the eggs are laid. The number of clutches per season is normally one, but replacement clutches are common. The first chicks hatch in 22 to 24 days (Lindvall and Low 1982). Both members of the pair are usually at the nest and defend it vigorously against other members of the nesting colony. Parental care tends to cease after 8 weeks. Western grebes are known to

live up to 14 years, but most banded birds have been recovered at minimum ages of between 6 and 7 years (Eichhorst 1992).

The main food items taken by western grebes are fish, which are reported to compose 81 to 100% of the diet (Wetmore 1924, Lawrence 1950).

The western grebe consumes a wide variety of fishes (Palmer 1962). Other animals eaten by the western grebe are salamanders (*Ambystoma*), crustaceans, polychaete worms, and insects (grasshoppers and a variety of aquatic forms).

Predators of the western grebe include the bald eagle (*Haliaeetus leucocephalus*) and mink (*Mustela vison*). Raccoons will take nesting adults and eggs. Large gulls (*Larus* spp.) prey on eggs and chicks if humans disturb a nesting colony. Eggs are consumed by common ravens (*Corvus corax*) or pecked and eaten by coots and Forster's terns, usually after human interference. Chicks are also vulnerable to predation by bass (*Micropterus* spp.) and pike (*Esox* spp.).

The major cause of nest and egg losses for this species is wave action during windstorms. Large numbers of migrant birds have been frozen into a lake during a quick freeze-up (Nero 1960). Also, adults are awkward on land and around nests, and newly hatched chicks are frequently found dead from being trampled in the nest.

2.3 American White Pelican (*Pelecanus erythrorhynchos*)



The American white pelican occurs mainly in western and southern portions of North America. A huge white bird with black-tipped wings, it has an enormous flattened bill with a bright yellow-orange pouch for feeding. The white pelican can reach a height of 55 to 70 inches (14–18 cm), weigh between 13 and 21 pounds (5–8 kg), and have a wingspan of up to 10 feet (3 m). During the breeding season, a short, yellowish crest appears on the back of the head, and a horny plate appears on the upper mandible of the male. This pelican is gregarious, usually traveling in flocks and nesting in colonies.

In Idaho, the white pelican breeds at Minidoka National Wildlife Refuge, at Blackfoot Reservoir, and on the Snake River near Glenns Ferry. The species annually migrates south to where the minimum temperature stays above 39 °F (4 °C). The winter range of the white pelican includes the Pacific Coast from central California and southern Arizona south to Baja California, western Mexico, and Nicaragua. Some birds

remain year-round in central Durango, Mexico (Knoder *et al.* 1980).

White pelicans first breed at 3 years, and they probably breed annually thereafter (Evans and Knopf 1993). Females lay only one clutch per season of between 1 and 3 eggs. Reduced clutches are common in this species due to egg loss (Evans and Knopf 1993, Knopf 1979). Upon hatching, the young are totally dependent on their parents for food, warmth, and protection. By about 3 weeks of age, they become more mobile. Generally, if there are two hatchlings, only one of the two young survives, the other being harassed or expelled from the nest by its older nest mate (Evans and Knopf 1993). After fledging, 41% mortality occurs in the first year, 16% in the second year (Strait and Sloan 1974). The maximum reported life span for a white pelican, based on 4,344 bird-band returns, is 26.4 years (Clapp *et al.* 1982).

Throughout their range, white pelicans eat small, schooling fish. The pelicans do not dive for food but cooperate to surround fish in shallow water, where the birds then scoop the fish into their pouches. Pelicans also take larger sluggish bottom feeders, salamanders, and crayfish (Evans and Knopf 1993).

Mammalian predators include the red fox (*Vulpes vulpes*) and coyote (*Canis latrans*). (Thompson *et al.* 1979). Avian predators include large white-headed gulls (*Larus spp.*), ravens (*Corvus corax*), great horned owls (*Bubo virginianus*), and bald eagles (*Haliaeetus leucocephalus*). Gulls and ravens tend to take eggs (Thompson *et al.* 1979), while great horned owls and eagles take young.

In recent decades, the number of pelicans has declined because of the pesticides, human disturbance, and draining of wetlands.

2.4 American Avocet (*Recurvirostra americana*)



The American avocet is a large shorebird with long bluish legs, a long, thin bill that curves upward, and a black-and-white chevron pattern on its back. The bird is between 17 and 18.5 inches (43–47 cm) long, including a 3.25- to 3.75-inch (8.2–9.5 cm) bill; the bird weighs between 9.7 and 12.4 ounces (275–350 g). The plumage on the avocet's head and neck becomes a cinnamon color in early spring when the birds begin to form mating pairs and migrate to breeding areas.

The American avocet migrates north to the wetlands of the arid western United States from March to May and returns to the southern winter ranges from July to October. Large numbers of the species breed at the marshes of the Great Salt Lake, Utah, and the Tulare Basin, California. The avocet also breeds in the Upper Snake province, arriving between April and May. After the breeding season is over, the birds migrate to parts of California and southern Texas, southward through Mexico to Central America.

Upon arriving at the breeding grounds, the mated pair copulates several times. Most avocets breed at 2 years, but some breed in their first year. Females lay between 3 and 4 eggs, with 4 being the usual (Robinson *et al.* 1997). Both parents incubate the eggs for about 23 to 25 days (Gibson 1971, Hamilton 1975). Chicks stay in the nest no more than 24 hours after the last chick hatches (Robinson *et al.* 1997). In dense nesting areas, chicks sometimes move from nest to nest and are brooded by different adults. Broods are led to nursery areas of shallow water that have vegetation that can be used for cover. The young become independent in about 6 weeks. American avocets are known to live for at least 9 years (Robinson *et al.* 1997).

The avocet feeds by thrusting its bill underwater and swinging it from side to side along the bottom to stir up aquatic insects (Hamilton 1975). It also eats crustaceans and other aquatic animals, as well as plants, that it happens to stir up or that it finds at the surface of the pond or marsh.

The avocet eats primarily aquatic invertebrates and also takes terrestrial invertebrates, small fish, and seeds. In freshwater wetlands, the avocet will eat water boatmen (Hemiptera, Corixidae), adult and larval beetles (Coleoptera), fly larvae (Diptera), midges (Chironomidae), and, in more saline wetlands, brine flies (Wetmore 1925). The avocet will also eat seeds of marsh or aquatic plants, specially sago pondweed (*Stuckenia pectinatus*), salt grass (*Distichlis spicata*), and bulrushes (Robinson *et al.* 1997). In permanent shallow lakes and inland sloughs, the avocet will eat amphipods (*Gammarus lacustris* and *Hyalella azteca*) (Edwards and Bush 1989). Other foods identified from avocet stomachs include terrestrial insects such as grasshoppers (Orthoptera), caterpillars (Lepidoptera), beetles (Coleoptera), true bugs (Hemiptera), flies (Diptera) and ants, bees and wasps

(Hymenoptera), and spiders (Araneae); small minnows (Cyprinidae); and a small salamander (Salamandridae) (Wetmore 1925).

Predators of adult avocets include the peregrine falcon (*Falco peregrinus*), prairie falcon (*F. mexicanus*), great horned owl (*Bubo virginianus*), and northern harrier (*Circus cyaneus*) (Porter and White 1973, Evans 1988). Falcons and harriers, as well as mink (*Mustela vison*), are known to prey on the young. Predators of avocet eggs include gulls, ravens (*Corvus corax*), badgers (*Taxidea taxus*), striped skunks (*Mephitis mephitis*), long-tailed weasels (*M. frenata*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), red fox, and gopher snakes (*Pituophis melanoleucus*) (Gibson 1971, Grover and Knopf 1982, Sidle and Arnold 1982, Alberico 1993).

2.5 Common Loon (*Gavia immer*)



The common loon breeds on freshwater lakes, predominately in the broadband of boreal and mixed forest across North America (Barr 1973, 1996). The common loon is very striking, with a black-and-white checkered back, glossy black head, and white “necklace”

around the throat. Males and females look the same, though males are generally larger.

Adults are large-bodied, weighing from 2.5 to over 6.1 kg and measuring between 66 and 91 cm long (McIntyre and Barr 1997).

Although they are thought of as solitary birds, loons sometime gather into small groups in the summer. In September, group feeding is quite common as loons gather on larger lakes during migration. Loons are usually found in groups on their ocean wintering grounds.

In spring, loons arrive on northern lakes as soon as the ice thaws. After a loon starts to breed, it attempts to breed every year thereafter. Loons are solitary nesters. Small lakes, generally covering between 5 and 50 hectares, can accommodate one pair of nesting loons (Kerekes *et al.* 1994). Larger lakes may have more than one pair of breeding loons, with each pair occupying a bay or section of the lake (Yonge 1981). Some loons may nest on lakes that cover less than 7 hectares and use other nonterritorial lakes for foraging (McIntyre 1975).

There is no data on age at first breeding, but it is thought that the common loon first breeds at 4 years, or as late as 7 years (McIntyre and Barr 1997). The oldest banded bird recovered was almost 8 years old (Clapp *et al.* 1982). One loon was recorded to return to breeding grounds for 9 years. There is no data on survivorship, but it is assumed that the life span of the common loon is similar to that of the Arctic loon (*Gavia arctica*), 25 to 30 years (Nilsson 1977).

Banding studies have shown that loons sometimes switch mates after a failed nesting attempt and even between nesting attempts in the same season (Evers 1993). Loons build their nests close to the water, with the best sites being completely surrounded by water, such as on an island, muskrat house, half-submerged log, or sedge mat (Olson and

Marshall 1952, Palmer 1962, Vermeer 1973, Alvo 1981, McIntyre 1988). The same sites are often used from year to year (McIntyre 1974). Usually one or two eggs are laid in late June.

Both the male and female help with nest building and incubation, which usually lasts 27 to 31 days (Yonge 1981). If the eggs are lost, the pair may reneest, often in the same general location (McIntyre 1975). Chicks are fed exclusively by their parents for the first few weeks of life, and up until the chicks are 8 weeks old, the adults are with them most of the time (McIntyre and Barr 1997). After this time, the chicks begin to dive for some of their own food, and by 11 or 12 weeks of age, the chicks are providing almost all of their own food and may be able to fly (McIntyre and Barr 1997).

Early in their life, chicks are fed small food items including snails, small fish, crayfish, minnows, and some aquatic vegetation. As they grow, they are fed more fish. Adult common loons eat primarily live fish, other aquatic vertebrates, and some invertebrates and occasionally eat vegetation (Barr 1996).

The loon's skeleton and muscular systems are designed for swimming and diving. The legs are placed far back on the body, allowing for excellent movement in water but making the birds ungainly on land. The loon's head can be held directly in line with the neck during diving to reduce drag, and the legs have powerful muscles for swimming (Wilcox 1952). Many bones of the loon's body are solid, rather than hollow like those of other birds. These heavy bones make loons less buoyant and help them dive (McIntyre and Barr 1997). The loon's large webbed feet, not their wings, provide propulsion underwater.

Adult common loons have few known predators on breeding grounds, primarily due to careful nest site selection. Placing nests on

islands and floating artificial structures, rather than on natural shoreline, results in increased nest success (McIntyre and Mathisen 1977). Still, some predators manage to raid nest sites; such predators include American crows (*Corvus brachyrhynchos*), ravens (*Corvus corax*), gulls (*Larus* spp.), striped skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), mink (*Mustela vison*), and weasels (*Mustela* spp.). Young chicks are taken by northern pike (*Esox lucius*), muskellunge (*E. masquinongy*), snapping turtles, bald eagles, and gulls (Yonge 1981).

3 Shrub-steppe

3.1 Sagebrush (*Artemisia* spp.)

3.1.1 Wyoming Big Sagebrush (*Artemisia tridentata* ssp. *wyomingensis*)

Wyoming big sagebrush-steppe communities are prevalent in the West (Howard 1999). There are two other widely distributed subspecies of big sagebrush: basin big sagebrush (*A. tridentata* ssp. *tridentata*) and mountain big sagebrush (*A. tridentata* ssp. *vaseyana*) (Beetle and Young 1970, Hickman 1993, Kartesz 1994). It is impossible to distinguish Wyoming big sagebrush from basin or mountain big sagebrush without molecular analysis (Beetle and Alvin 1965, Weber 1987).

Wyoming big sagebrush is a native shrub (Balliet *et al.* 1986, Dorn 1988, Hickman 1993, Cronquist *et al.* 1994). It is the most drought tolerant of the three major big sagebrush subspecies (Meyer and Monsen 1993). Plants are generally 46 to 76 cm tall, with rounded, uneven crowns. The main stem is usually branched at or near ground level into two or more sub-stems (Schlatterer 1973, Beetle and Johnson 1982). Wyoming big sagebrush is technically an evergreen but semi deciduous in habit. It develops two types

of leaves: large ephemeral leaves and smaller, perennial leaves produced from ephemeral leaf axes (Miller and Shultz 1987). The inflorescence is an open, many-flowered spike (Beetle and Johnson 1982). The fruit is a small, easily shattered achene (Shaw and Monsen 1990).

The root system is deep and well developed, with many laterals and one or more taproots. The majority of roots (about 35% of the total root system) are in the upper first foot (30.5 cm) of soil. Some roots may penetrate as far as 6 feet (1.8 m) (Fernandez and Caldwell 1975, Leaf 1975, Sturges 1977). Roots are infected with the vesicular-arbuscular mycorrhizae (VAM) (*Glomus microcarpus* and *Gigaspora* spp.) (Doerr *et al.* 1971, Bethlenfalvai and Dakessian 1984, Hurley and Wicklow-Howard 1986).

Wyoming big sagebrush reproduces from seed; it does not sprout or layer (Beetle and Young 1965, Schlatterer 1973, McArthur *et al.* 1977). Pollination is mostly by outcrossing, but plants can also self-pollinate (Freeman *et al.* 1991). Wyoming big sagebrush is also a long-lived species. Maximum life span may exceed 150 years (Ferguson 1964).

Wyoming big sagebrush is most common on foothills, undulating terraces, slopes, and plateaus but also occurs in basins and valley bottoms (Francis 1983, Tiedeman *et al.* 1987, Dorn 1988, Hodgkinson 1989, Cronquist *et al.* 1994). Aspect varies, but shrubs are most common on south- to west-facing slopes (Tweit and Houston 1980, Tiedeman *et al.* 1987, Burke *et al.* 1989). The plant occurs on frigid, mesic, and xeric soils of silty, clayey, skeletal, and mixed textures (Passey *et al.* 1982, Francis 1983, Winward 1983, Holland 1986, Hodgkinson 1989). In the Snake River Plain of southern Idaho, Wyoming big sagebrush communities occur on sites that receive more than 8 inches (20 cm) of annual

precipitation. Where the ranges of Wyoming and mountain big sagebrush overlap, Wyoming big sagebrush generally occurs where precipitation is less than 12 inches (30 cm), whereas mountain big sagebrush occurs on wetter sites (Hironaka *et al.* 1983, Hironaka 1986, Bunting *et al.* 1993). In the southern Rocky Mountains, Wyoming big sagebrush occurs on low- to mid-elevation sites that receive precipitation mainly as rain, whereas mountain big sagebrush occurs above 6,900 feet (2,100 m), where most precipitation is snow (Leaf 1975).

Wyoming big sagebrush communities are common in southern Idaho (Kaltenecker and Wicklow-Howard 1994). The sagebrush occurs in pinyon-juniper (*Pinus-Juniperus* spp.) woodlands and ponderosa pine (*P. ponderosa*) forests, often as a dominant shrub (Tausch and Tueller 1990, Eddleman *et al.* 1994, Rose and Eddleman 1994, West *et al.* 1998). On the Snake River Plain, community associates include budsage (*Artemisia spinescens*), shadscale (*Atriplex confertifolia*), littleleaf horsebrush (*Tetradymia glabrata*), green rabbitbrush (*Chrysothamnus viscidiflorus*), winterfat (*Krascheninnikovia lanata*), Indian ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), Sandberg bluegrass (*Poa secunda*), and cheatgrass (*Bromus tectorum*) (Bunting *et al.* 1993). Soil crusts of cyanobacteria, lichens, and mosses including twisted moss (*Tortula ruralis*), fire moss (*Ceratodon purpureus*), silvergreen bryum moss (*Bryum argenteum*), and funaria moss (*Funaria hygrometrica*) may be well represented.

Wyoming big sagebrush is preferred browse for wild ungulates (Peek *et al.* 1979, Welch and McArthur 1986, Shaw and Monsen 1990, Bray *et al.* 1991), and Wyoming big sagebrush communities are important winter ranges for big game (McArthur *et al.* 1977, Twit and Houston 1980, Mueggler and

Stewart 1981, Hironaka *et al.* 1983). Pronghorn usually browse Wyoming big sagebrush heavily (Allen *et al.* 1984). On the Idaho National Engineering and Environmental Laboratory, for example, the shrub comprised 90% of the diet of pronghorn from fall through spring. Lagomorphs may browse Wyoming big sagebrush heavily in winter (Gates and Eng 1984). Wyoming big sagebrush is a crucial food item for the sage-grouse and part of the bird's critical habitat (Tweit and Houston 1980, Clifton 1981, Autenrieth *et al.* 1982, Welch *et al.* 1991, Fischer *et al.* 1993, Fischer *et al.* 1996).

Wyoming big sagebrush is a mid to late seral species (Eddleman and Doescher 1978, Francis 1983). It may take a decade or longer for Wyoming big sagebrush reestablishment after a stand-replacing event such as fire (Sturges 1994). Prior to reestablishment of Wyoming big sagebrush, disturbed Wyoming big sagebrush communities are mostly populated with associated grasses. For instance, cheatgrass dominates many Wyoming big sagebrush stands in southern Idaho, northern Nevada, and eastern Oregon.

Fire is the principal means of renewal for decadent stands of Wyoming big sagebrush (Blank *et al.* 1994). After fire, Wyoming big sagebrush establishes from the seedbank (Beetle and Young 1965, Schlatterer 1973, McArthur *et al.* 1977), from seed produced by remnant plants that escaped fire (Bushey 1987), and from plants adjacent to the burn that seed in (Clifton 1981, Bushey 1987). Fires in Wyoming big sagebrush are usually not continuous, and remnant plants are the principal means of post-fire reproduction (Bushey 1987). Fire does not stimulate germination of soil-stored Wyoming big sagebrush seed, but neither does fire inhibit its germination (Chaplin and Winward 1982).

Interestingly, Native Americans made tea from big sagebrush leaves. They used the tea

as a tonic and an antiseptic for treating colds, diarrhea, and sore eyes and as a rinse to ward off ticks. Big sagebrush seeds were eaten raw or made into meal (Mozingo 1987). The wood is extremely aromatic when burned, and the wood smoke was used to mask the effects of an encounter with a skunk (Elmore 1976).

3.1.2 Mountain Big Sagebrush (*Artemisia tridentata* var. *vaseyana*)

Mountain big sagebrush is a long-lived (50+ years), woody, aromatic, native, evergreen shrub (Beetle and Johnson 1982, Blank *et al.* 1994). Shrubs often appear flat topped from a distance because of the nearly equal height of flowering stalks (Lackschewitz 1991). The fruit is a small, easily shattered achene that falls or is blown near the parent plant (Young and Evans 1989, Shaw and Monsen 1990). Root length of mature plants is about 2 m (6.5 feet) (Richards and Caldwell 1987). Mountain big sagebrush roots are colonized by fungi that form symbiotic vesicular-arbuscular mycorrhizae (Caldwell *et al.* 1985, Trent *et al.* 1994). Aboveground, the plant is host to an unidentified, pathogenic snow-mold fungus that decreases shrub cover and productivity (Hess *et al.* 1985, Nelson and Sturges 1986).

Mountain big sagebrush usually flowers in late summer and fall, but some strains may flower as early as July (Johnson 2000). Seed matures from September through October (McArthur *et al.* 1979). Mature seeds fall or are blown from inflorescences during autumn and winter, and emergence occurs in winter or spring (McDonough and Harniss 1974, Young and Evans 1989, Meyer and Monsen 1991). Seeds are short-lived (less than 5 years in warehouse) and probably do not form a persistent seed bank (Young and Evans 1989, Meyer *et al.* 1990). Mountain big sagebrush can reproduce vegetatively by layering

(Beetle and Young 1965, McArthur *et al.* 1979, Harvey 1981, Beetle and Johnson 1982). It does not resprout when aboveground tissues are killed by fire or other means (Blaisdell 1953, Blaisdell *et al.* 1982).

In the Intermountain West, mountain big sagebrush usually occurs in the upper elevational range of the big sagebrush zone in montane valleys and on foothills, slopes, and high ridges (Beetle 1960, Beetle 1961, McArthur *et al.* 1979, Winward 1980, Blaisdell *et al.* 1982). In northerly parts of its range, this species occurs in mountain valleys and on mountain slopes and ridges as high as 9,850 feet (3,000 m) (McArthur *et al.* 1979). In Idaho, it has been reported as low as 2,500 feet (780 m). Soils are moderately deep, well drained, slightly acidic to slightly alkaline and characterized by late-melting winter snow cover and summer moisture (Beetle 1961, West *et al.* 1978, McArthur *et al.* 1979, Blaisdell *et al.* 1982, Tueller and Eckert 1987, Burke 1989, Burke *et al.* 1989). This shrub grows in full sun but tolerates shade, often occurring in association with mature conifers (West *et al.* 1978, Noste and Bushey 1987).

Mountain big sagebrush occurs over a range of habitats from montane parklands to warm desert fringes in western North America, often as a dominant in shrublands or codominant in savannah (Johnson 2000). This species is a common component of shrub patches in arid grasslands (Mueggler and Campbell 1982, Marlow *et al.* 1987, Vaitkus and Eddleman 1991, Johnson *et al.* 1994, Rose and Eddleman 1994). It occurs widely throughout Great Basin pinyon-juniper woodlands dominated by true pinyon (*Pinus edulis*), singleleaf pinyon (*P. monophylla*), and Utah juniper (*Juniperus osteosperma*) (Tueller *et al.* 1979). Mountain big sagebrush has been reported in association with numerous other tree species, including quaking aspen (*Populus tremuloides*)

(Mueggler and Campbell 1982, Mueggler 1985, Burke *et al.* 1989, Chambers 1989), ponderosa pine (*P. ponderosa*) (Peek *et al.* 1979, Harvey 1981, Johnson *et al.* 1994, Rose and Eddleman 1994), lodgepole pine (*P. contorta*) (Beetle 1961, Chambers 1989), Douglas-fir (*Pseudotsuga menziesii*) (Pfister *et al.* 1977, Harvey 1981), limber pine (*P. flexilis*) (Beetle 1961, Plummer 1976, Pfister *et al.* 1977, Harvey 1981), subalpine fir (*Abies lasiocarpa*) (McLean 1970), and whitebark pine (*P. albicaulis*) (Beetle 1961, Mumma 1990). Mountain big sagebrush may also occur in association with white fir (*A. concolor*) and Engelmann spruce (*Picea engelmannii*).

Common plant associates in Idaho and Montana include Woods' rose (*Rosa woodsii*), mountain snowberry (*Symphoricarpos oreophilus*), green rabbitbrush (*Chrysothamnus viscidiflorus*), antelope bitterbrush (*Purshia tridentata*), and Rocky Mountain juniper. Associated grasses and forbs include Kentucky bluegrass (*Poa pratensis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), cheatgrass (*Bromus tectorum*), prairie Junegrass (*Koeleria macrantha*), green needlegrass (*Nassella viridula*), needle and thread (*Hesperostipa comata*), Sandberg bluegrass (*Poa secunda*), and bottlebrush squirreltail (*Elymus elymoides*) (Winward 1970, Marlow *et al.* 1987, Kaltenecker and Wicklow-Howard 1994, Monsen and Anderson 1995).

Publications listing mountain big sagebrush as a dominant, codominant, or indicator species include the following: *Sagebrush-Grass Habitat Types of Southern Idaho* (Hironaka *et al.* 1983), *Aspen Community Types on the Caribou and Targhee National Forests in Southeastern Idaho* (Mueggler and Campbell 1982), *Grassland and Shrubland Habitat Types of the Shoshone National Forest* (Tweit and Houston 1980), *Taxonomic and*

Ecological Relationships of the Big Sagebrush Complex in Idaho (Winward 1970), and *Sagebrush Steppe* (Young *et al.* 1977).

The ecology of mountain big sagebrush in the West has been altered by postsettlement increases or decreases in historical fire intervals, livestock grazing, widespread invasion by exotic annuals, and perhaps climate change (Burkhardt and Tisdale 1976, Blaisdell *et al.* 1982, West 1988, Miller and Rose 1998). Historical abundance of big sagebrush has been disputed. According to reviews (Beetle and Johnson 1982, West 1988) and a comparative examination of 20 historical photos from three states (Kuchler 1964), big sagebrush was abundant and codominant with perennial bunchgrasses in presettlement times. Sagebrush species do not appear to have increased their range on a large scale, but reviewers agree that big sagebrush has increased in density in many places in response to excessive grazing and altered fire regimes. Mountain big sagebrush is readily killed by fire and requires at least 15 years to recover after fire (Bunting *et al.* 1987).

In the juniper woodlands of southern Idaho, western juniper has invaded large areas of mountain big sagebrush shrubland. Burkhardt and Tisdale (1969, 1976) reviewed possible causes, including destruction of grassland via livestock grazing, increased seed dispersal by sheep, climate change, and a reduction of the historic fire-return interval. In field sites, they examined seed dispersal mechanisms, fire history, and juniper seedling establishment and concluded that succession of sagebrush-grass shrublands to juniper woodlands is directly related to cessation of periodic fires. In the same region, Hironaka *et al.* (1983) identified 10 climax habitat types dominated by mountain big sagebrush.

There has been extensive documentation that many wild animals rely on the big sagebrush ecosystem for both food and cover (McGee 1979, Nagy 1979, Peek *et al.* 1979, Blaisdell *et al.* 1982, Hironaka *et al.* 1983, Noste and Bushey 1987, Wambolt *et al.* 1994, Welch *et al.* 1996). Wildlife researchers have argued that neither the importance of sagebrush as forage nor the effects of foraging on sagebrush are fully appreciated (Wambolt 1995, 1996; Welch and Wagstaff 1992).

Historically, Native Americans used big sagebrush leaves and branches for medicinal teas and used the leaves as a fumigant. Bark was woven into mats, bags, and clothing (Parish *et al.* 1996).

3.1.3 Black Sagebrush (*Artemisia nova*)



A native evergreen shrub, black sagebrush is small, spreading, and aromatic. Heights usually range from 6 to 18 inches (15–45 cm) but occasionally reach up to 30 inches (76 cm) on productive sites (McArthur and Stevens 1986). Although plants may have an upright habit, the branches are typically decumbent and arise from a spreading base. Black sagebrush has a shallower, more

fibrous root system than big sagebrush does (Kleinman 1976). As a result, annual growth depends largely on soil moisture content near the ground surface.

Growth is initiated in April, with new leaves being produced from May throughout most of the summer (Beetle 1960). Flower heads first appear in July, but blooming does not occur until September; flowers may be numerous one year and particularly sparse in another (McMurray 1986). Seed dispersal takes place in October (McMurray 1986). Late spring leaves and summer leaves persist through the winter (McMurray 1986).

Black sagebrush is a significant browse species within the Intermountain region (McMurray 1986). It is especially important on low-elevation winter ranges in the southern Great Basin where extended snow-free periods allow animals to access plants throughout most of the winter (Johnson 1978). In these areas, black sagebrush is heavily utilized by pronghorn and mule deer (Beale and Smith 1970, McAdoo and Klebenow 1979, Clary and Beale 1983) and highly preferred by domestic sheep (Clary 1986). Stands are often contiguous with salt desert communities in the southern Great Basin. Relative to the surrounding vegetation, good-condition winter ranges are productive and also offer a good selection of associated species. Many of these ranges have been seriously depleted by past overgrazing (McMurray 1986).

Black sagebrush is highly nutritious winter forage. Although not as productive as many other forage species, black sagebrush has winter nutritive quality that is second only to that of big sagebrush (Cook and Stoddart 1953, Behan and Welch 1986). However, black sagebrush may be lethal to domestic sheep if it comprises the bulk of their diet for even a short time (McMurray 1986). This situation is most likely to occur when animals

are concentrated on winter ranges (Johnson 1978). On spring and transitional ranges, black sagebrush is thought to cause abortion in sheep. Recent studies have shown that it is a preconditioning plant responsible for horsebrush-related photosensitization in sheep (Johnson 1978).

Black sagebrush regenerates almost exclusively from seed (Beetle 1960), spreading aggressively on favorable sites, and is a good conservation plant for dry, shallow, stony soils and mine spoils. Mature, self-perpetuating stands of black sagebrush are considered to be indicators of climax conditions. Seedlings are present during early seral stages, and plants coexist with later-arriving species (McMurray 1986). Long-established black sagebrush stands in Nevada have recently undergone invasion by both Utah juniper (*Juniperus osteosperma*) and singleleaf pinyon (*Pinus monophylla*). This invasion, which accelerated around 1921, has been attributed to the combined effects of overgrazing, fire suppression, and climatic change (Blackburn and Tueller 1970).

Black sagebrush is considered a climax species and has been used as an indicator in a number of habitat-typing systems within the sagebrush-grass region (McMurray 1986). It also occurs as an understory dominant within forested communities. Forested habitat types using black sagebrush as an indicator have been identified within ponderosa pine and juniper series and pinyon-juniper (*Pinus-Juniperus* spp.) series (Alexander 1985).

Historically, fire has had little or no influence in communities dominated by black sagebrush (Winward 1985). When exposed to fire, plants are easily killed and do not sprout (Wright *et al.* 1979, Volland and Dell 1981). Use of prescribed burning is not usually feasible where black sagebrush forms dense stands. Since plants are nonsprouters, fire is not recommended on winter ranges where this

species constitutes an important forage plant (McMurray 1986).

3.2 Northern Sagebrush Lizard (*Sceloporus graciosus graciosus*)

A member of the spiny lizard family, the northern sagebrush lizard is about 5 to 6 inches (12–15 cm) long. It is grayish-green to brown, with some darker spots and crossbars and faint, light-colored dorsolateral stripes. Sides are reddish-orange behind the forelegs. Males have light blue mottling (not patches) on their throat and darker blue belly patches. Females have pinkish-orange on their sides and neck (Behler and King 1979).

The northern sagebrush lizard ranges from Montana southward to northwestern New Mexico and west to Washington, Oregon, California, and Baja California (Nussbaum *et al.* 1983). The species is also present in North Dakota. The northern sagebrush lizard is often found in pinyon-juniper woodlands and sagebrush flats.

The lizard is a ground-dweller, appearing to prefer sagebrush and gravelly soils or fine-sand dunes. Home range size averaged about 4,300 to 6,450 square feet (400–600 m²) in Utah. M'Closkey *et al.* (1997) found that areas experimentally depopulated of this species were quickly recolonized from surrounding areas. The sagebrush lizard is never far from shelter such as stony piles, crevices, or animal burrows. The species is found in elevations from sea level to about 10,500 ft (3,200 m) (Stebbins 1985).

The species produces a single clutch of 1 to 8 eggs, which are laid between June and July (Tinkle *et al.* 1993). Eggs hatch in 45 to 75 days (Tinkle *et al.* 1993). In Colorado and Utah, most adult females produce 2 clutches annually. Sagebrush lizards are sexually mature in their first (southern portion of

range) or second (northern) year. In southern Utah, most females produce their first clutch at an age of about 22 to 24 months (some matured in about one year under uncommon optimal conditions). In southern Utah and west-central California, annual survival rate averaged roughly 50 to 60% in adults and less than 30% in juveniles and eggs (Tinkle *et al.* 1993). The southern Utah population appeared to be substantially resource limited.

The northern sagebrush lizard eats insects such as beetles, flies, ants, caterpillars, spiders, ticks, mites, and aphids. The species is diurnal and becomes inactive in cold winter weather; duration of the inactive period varies with local climate. In southern Utah, the lizard is active mainly from early April to mid-September (Tinkle *et al.* 1993).

Predators of sagebrush lizards include striped whipsnakes (*Masticophis taeniatus*), night snakes (*Hypsiglena* spp.), and a variety of predatory birds.

3.3 Greater Sage-Grouse (*Centrocercus urophasianus*)



The greater sage grouse historically inhabited much of the sagebrush-dominated regions of North America. The species is renowned for its spectacular breeding displays, during which large numbers of males congregate to perform a strutting display (Johnsgard 1973). Today, sage-grouse populations are declining throughout most of their range, mostly due to habitat loss and degradation (Hays *et al.* 1998).

Sage-grouse are relatively large, with the males being larger than the females. Males weigh 3.75 to 6.4 pounds (1.7–2.9 kg) and are 26 to 30 inches (65–75 cm) long; females weigh 2.2 to 4 pounds (1.0–1.8 kg) and are 19.7 to 23.6 inches (50–60 cm) long (Schroeder *et al.* 1999). Both sexes have narrow, pointed tails; feathering to the base of the toes; a variegated pattern of grayish brown, buffy, and black on the upper parts of the body; and a black belly (Johnsgard 1973). Males are more colorful than females and have a black throat and bib; scaly, white foreneck plumage; and a large, white ruff on the breast (Dunn *et al.* 1987). Males also exhibit two large, frontally directed air sacs of olive-green skin and yellow superciliary combs that enlarge during breeding display (Johnsgard 1973, Udvardy 1977). Sage-grouse are thought to live up to 10 years in the wild, but in one study, the average life span of sage-grouse in both hunted and protected populations was 1 to 1.5 years (Elman 1974); in another study, sage-grouse 3 to 4 years of age were considered old (Wallestad 1975).

Female sage grouse are sexually mature their first fall and nest the following spring (Patterson 1952). Males are sexually mature the spring following their first winter. Yearling males engage in display and breeding but devote less time and energy to courtship activities than adults do (Wiley 1974).

In early April, male and female sage-grouse gather for displaying and mating at specific locations, called leks. At the beginning of the breeding season, male sage-grouse establish small territories on the lek. The males occupying territories near the center of the lek may be more successful at mating (Davis 1978). After mating, sage-grouse hens leave the lek to nest. Most hens build nests under shrubs (Jarvis 1974, Wallestad and Pyrah 1974, Roberson 1984), specifically in areas with medium-high shrub cover and residual grass (i.e., dry grass from the previous growing season) (Schoenberg 1982, Gregg 1991, Sime 1991). Hens incubate 7 to 15 eggs for about 25 to 27 days (Connelly *et al.* 1991). After hatching, chicks wait until they are dry before they leave the nest. Sage-grouse hens attempt to raise one brood in a season (Girard 1937). The chicks feed themselves, but hens spend considerable time keeping chicks warm and guarding them for the first four to five weeks (Patterson 1952).

Sage-grouse usually roost on the ground from evening until early morning, feed and rest during the afternoon, and return to their roosting site at night (Johnsgard 1973). Sage-grouse use shrub stands with medium to very high shrub cover primarily for foraging and loafing (Autenrieth 1981, Emmons and Braun 1984, Roberson 1984).

Sagebrush, grasses, forbs, and insects comprise the annual diet of sage-grouse. Sagebrush comprises 60 to 80% of the yearly diet of adult sage-grouse (Patterson 1952, Wallestad *et al.* 1975, Remington and Braun 1985) and as much as 95 to 100% of the winter diet (Roberson 1984). Forbs may constitute 50% of the diet of juveniles up to 11 weeks of age (Klebenow and Gray 1968, Peterson 1970). Forbs also appear to be important to nesting hens in the pre-laying period (Barnett and Crawford 1993). Insects make up 50% of the diet during the first and second week of life (Patterson 1952,

Klebenow and Gray 1968, Peterson 1970). Chicks younger than 3 weeks old require insects for survival and chicks older than 3 weeks have reduced growth rates when insects were removed from the diet.

Some researchers consider water a key component of sage-grouse habitat (Carr 1967, Savage 1969, Call and Maser 1985). Others have found no evidence that sage-grouse prefer sites close to water (Wallestad 1975, Autenrieth 1981, Cadwell *et al.* 1994). Sage-grouse need to consume water, but they typically obtain enough water by consuming vegetation that stores water, such as succulent forbs. Sage-grouse may concentrate in late summer and fall where water or succulent forbs are available. Water sources include streams, springs, water holes, and cattle troughs. Where water is available, sage-grouse normally visit water sites in the morning and evening. Sage-grouse that occupy areas with little precipitation may migrate to areas containing water during summer and fall. Chicks require water soon after hatching (Girard 1937), so hens with broods often migrate to areas containing water. Petersen (1980) found that hens with broods remained in upland habitat until succulent forbs disappeared; then they moved to wet meadows in late summer.

Sources of mortality of sage-grouse include predation, weather, accidents, disease and parasitism, and environmental hazards such as pesticides. These natural and human-influenced factors become more important management issues with small populations. Blus *et al.* (1989), for instance, found organophosphorus insecticides (dimethoate or methamidophos) directly responsible for the death of sage-grouse that occupied or were near sprayed alfalfa or potato fields in southeastern Idaho. Predation is a limiting factor throughout the annual sage-grouse cycle, but its severity depends on habitat quality. Raptors and crows are the primary

predators of sage-grouse (Patterson 1952, Lumsden 1968, Wiley 1973), while coyotes (*Canis latrans*), bobcats (*Lynx rufus*), minks (*Mustela vison*), badgers (*Taxidea taxus*), and ground squirrels (*Spermophilus* spp.) are the most important ground predators. Weather can influence nesting success and survival of young chicks (Dalke *et al.* 1963, Autenrieth 1981). Diseases and parasites do not appear to be a significant source of mortality (Girard 1937, Batterson and Morse 1948).

3.4 Sage Sparrow (*Amphispiza belli*)



The sage sparrow breeds from the northern edges of the Great Basin sagebrush expanses in shrub-steppe habitats west of the Rocky Mountains southward to Baja California in the chaparral and sagebrush scrub. There are five subspecies of sage sparrow; *A. belli nevadensis* breeds in Idaho and migrates to the southwestern United States and south to portions of northwestern Mexico for the winter.

The sage sparrow nests in saltbush and rabbitbrush. Most nests are found within or under shrubs (Green 1981, Petersen and Best

1985). The sparrow tends to choose shrubs that are clumped with others and about 26 inches (66 cm) high (Reynolds 1981). Most nests are placed in the densest portion of nest-site vegetation (Petersen and Best 1985). Sage sparrows also show strong breeding site fidelity (Petersen and Best 1987).

Females lay between 1 and 4 eggs, with 3 being the usual (Reynolds 1981). Successful nests averaged 1.3 fledglings/nest (Reynolds 1981). Most *A. belli nevadensis* raise 2 or 3 clutches per season (Martin and Carlson 1998). Both parents feed the young. The sage sparrow male is expected to live for at least 3 years; the female, 2 years. One *A. belli nevadensis* individual was recovered at 6 years old (Wiens 1985).

The sage sparrow's diet varies depending on the season. The species heavily consumes seeds, including grasses, in April and again in July and August (Rotenberry 1980). During May and June, breeding adults take a wide variety of arthropods, primarily beetles (Coleoptera), grasshoppers and crickets (Orthoptera), and butterfly and moth larvae (Lepidoptera) (Wiens and Rotenberry 1979, Rotenberry 1980). Larger prey items are consumed early in the breeding season (April), and prey gradually decline in size to August (Rotenberry 1980). The sage sparrow consumes 44% animal and 56% seed and plant materials in fall, switching to 13% animal and 87% seed and plant material in winter.

Predators of the sage sparrow eggs and young include the Townsend's ground squirrel (*Spermophilus townsendii*), loggerhead strike, and common raven (*Corvus corax*) (Reynolds 1981, Rotenberry and Wiens 1989). Sage sparrow bones are found in great horned owl (*Bubo virginianus*) pellets (Bond 1940).

4 Pine/Fir Forest (Dry, Mature)

4.1 Great Gray Owl (*Strix nebulosa*)



The great gray owl is a large gray owl with a distinctively large facial disk of light gray with darker gray or brown concentric rings. The owl has a black chin with white along the sides that runs into the bottom white border of the facial disk. The iris of the eye is lemon yellow, and the bill is bright yellow to pale olive green. The ears lack tufts. The bottom portion of the wings (primaries and secondaries) and the tail are barred with dark and light gray. The under parts are a grayish-white with dark grayish-brown streaks. Males and females are identical in plumage except that the females may appear slightly darker and larger.

The great gray owl inhabits many types of forests in North America, favoring dense coniferous forests that are near muskegs, meadows, or open fields. This combination allows conifers for nesting and roosting, along with abundant small rodents that occur in the forest openings. In the southern parts of its

range, the owl seeks deciduous or coniferous forests at elevations up to 9,200 feet (2,800 m) (Bull and Duncan 1993). In Idaho and Wyoming, over 90% of sightings of great gray owls are in the lodgepole pine (*Pinus contorta*)-Douglas-fir (*Pseudotsuga menziesii*)-aspen (*Populus tremuloides*) zone (Franklin 1987). The owl may migrate to lower elevations during winter months (Bull and Henjum 1990).

The great gray owl does not build its own nest or modify a nest in any way other than to potentially deepen the cup (Voous 1988). Most nesting is done in abandoned raptor or crow nests or broken-off treetops. Nest sites are often reused for several years (Bull *et al.* 1989, Franklin 1988). The age at first breeding is commonly 3 years, although some birds occasionally breed at 2 years, and rarely in their first year (Bull and Duncan 1993). A mated pair will produce one brood per year.

Typically, clutch size is between 3 and 5 eggs (Franklin 1988). If eggs are lost, renesting may occur two additional times, but only one clutch is raised yearly (Voous 1988). The female usually lays one egg per day, and the incubation period is generally 30 days (Franklin 1988). The male does all the hunting during this period (Bull and Duncan 1993). Although the owlets leave the nest at 20 to 29 days old, they are incapable of flight (but can climb trees well) for another 7 to 14 days (Franklin 1988). Fledging occurs before the owlets are 55 days old, but they are cared for by the female until 4 to 5 months of age when they begin to disperse (Bull and Henjum 1990). Great gray owls can live for at least 13 years (Bull and Duncan 1993).

The great gray owl's diet consists almost entirely of small rodents. About 90% of the diet is pocket gophers (*Thomomys* spp.) and voles (*Microtus* spp.) (Franklin 1988). Other small mammals taken by the owl include

shrews (*Sorex* spp.), deer mice (*Peromyscus maniculatus*), squirrels, young rabbits, hares (*Lepus* spp.), rats, moles (*Scapanus* spp.), and weasels (*Mustela* spp.). Also taken are birds, usually small, though there are records of sharp-shinned hawks (*Accipiter striatus*), ducks, and grouse being taken (Collins 1980, Nero 1980, Bull *et al.* 1989). Small mammals are usually swallowed whole, while larger prey is torn into pieces.

The great gray owl can detect prey under snow by sound alone and will dive into the snow for hidden prey (Law 1960, Godfrey 1967, Nero 1969). Generally, the owl hunts from a perch by listening and watching. Although primarily nocturnal and crepuscular, the owl may occasionally hunt by day both during winter when days are dark and overcast and while feeding young (Brunton and Pittaway 1971, Bull and Duncan 1993).

The great gray owl is generally tolerant of other owls and diurnal birds of prey. However, there is frequent predation on juvenile great gray owls by northern goshawks and great horned owls, particularly when grouse and hares are scarce (Nero 1980). Red-tailed hawks are also known to attack juvenile great gray owls (Bull and Henjum 1990). Lynx (*Lynx canadensis*) and great horned owls may occasionally kill an adult great gray owl (Duncan 1987). Other potential predators are black bears (*Ursus americanus*) and fishers (*Martes pennanti*) (Duncan 1987).

Colliding with automobiles is a major cause of mortality in some years (Nero and Copland 1981). Timber harvest has the greatest potential impact on populations (Bull and Duncan 1993). Perches need to be left in clear-cut areas so that the owls can readily hunt. Strychnine poisoning of pocket gophers may also have a potential harmful effect (Bull and Duncan 1993).

4.2 Black-backed Woodpecker (*Picoides arcticus*)

The black-backed woodpecker is dependent on fire landscapes and other large-scale forest disturbances (Hutto 1995, Caton 1996, Murphy and Lehnhausen 1998, Hoyt 2000). Fire suppression and post-fire salvage logging are detrimental to this species and have reduced its habitat. This woodpecker is listed as a species of special concern in Idaho.

Compared with other woodpeckers, the black-backed woodpecker is missing a hind toe and thus has only two toes in front and one behind. The male has a yellow cap, which the female does not have; a solid black back and white throat, breast; and belly; and heavily barred sides. The solid black color is glossy, reflecting green on the back and blue on the head. The face pattern consists of a fine white line behind the eye. The bird is approximately 9 to 10 inches (23–25 cm) long and has a wingspread of about 14 to 15.75 inches (36–40 cm) (Robbins *et al.* 1966). The female resembles the male except for lacking the yellow cap and having a more conspicuous line of white behind the eye.

The black-backed woodpecker is an active bird, climbing along branches looking for insects. It hops down blackened/burnt trees, on which it blends in quite well, and strips away bark to expose grubs. The black-backed woodpecker's diet includes approximately 75% insects such as wood-boring beetles, grubs, weevils, ants, other beetles, and spiders (Beal 1911, Goggans *et al.* 1988, Murphy and Lehnhausen 1998). Besides insects, it also feeds on berries and other small fruits, acorns, and nuts (Beal 1911; Lippincott 1997).

The nest of this species is generally excavated by both sexes, but mostly by the male, in the body of dead trees such as spruces, ponderosa pine, and birches. The entrance hole is about 1.6 to 2 inches (4–5 cm) in diameter and from

10 to 15 inches (25–38 cm) deep (Dixon and Saab 2000). The nest cavity is smooth and broad at the bottom and can be anywhere from 5 to 69 feet (1.5–21 m) above the ground. From mid-May to mid-June, approximately 3 to 6 eggs (usually 4) are laid; they are rounded and pure white. Only one brood is raised in a season (Bent 1939). Incubation is carried out by both sexes and lasts approximately 14 days (Lippincott 1997). The young follow their parents until autumn. There is no data on survivorship or longevity, but it is believed that the black-backed woodpecker can live as long as 8 years (Dixon and Saab 2000).

Little information is available on the causes of mortality, but it is presumed that predation by raptors is a factor. Another limiting factor for the black-backed woodpecker is its dependence upon dramatic changes in forest structure and composition, like fire and insect outbreaks. Fire-management policies and prescribed-burning programs (USDI and USDA 1998) that diminish the chances of large, severe wildfires may have negative consequences for the black-backed woodpecker.

4.3 Boreal Owl (*Aegolius funereus*)



The boreal owl occupies boreal and subalpine forests across Canada and southward to northeastern Washington, Idaho, Montana, and northeastern Minnesota and farther south in mountains to Colorado and New Mexico. In Montana and Idaho, the boreal owl is found to favor spruce-fir or subalpine-fir above 5,180 feet (1,580 m) (Palmer 1986).

The boreal owl is a small owl that lacks ear tufts. The male and female are alike in plumage. The general color of the upper parts is dark brown. The backside has dispersed, large, white spots. The owl's crown is thickly spotted with smaller white spots. The facial disk is white with a dark brown border at the sides. A slim black border surrounds the eyes. Cinnamon-brown occurs below and at the sides of the bill. The chest, flanks, and belly are white and heavily streaked with brown. The feet are feathered; the claws are black. The irises are lemon yellow, and the bill is dark grayish-horn with a yellowish tip.

Except in years of reduced food availability, both sexes can breed the year after hatching

(Korpimaki 1988). The boreal owl nests in woodpecker holes (pileated and northern flicker) or nest boxes (Hayward and Hayward 1993). Clutch size ranges from 2 to 4 eggs, with 3 being the most common. The incubation period is from 26 to 32 days (Hayward and Hayward 1993). The young owls fledge at 28 to 36 days but remain close (< 100 yards) from the nest for the first week while being fed by the adults. They slowly move farther away but do not become independent until 3 to 6 weeks after leaving the nest cavity. Banded boreal owls have been known to live for almost 16 years. In Idaho, annual survival for adults was 46% (Hayward 1989).

The primary foods of the boreal owl are small mammals, birds, and insects. The owl's preferred food is the vole, which may make up as much as 75% of the diet (Palmer 1986, Hayward *et al.* 1993). The boreal owl is primarily a nocturnal forager, except in the far north where there is continuous light during summer, though the owl will also forage intermittently during daylight hours in the southern latitudes (Norberg 1970, Mikkola 1983). It is a "sit and wait" predator (Hayward *et al.* 1993). It can locate prey by sound alone and capture prey beneath the snow or vegetation (Norberg 1970).

Martens (*Martes* spp.) are important predators of owlets and adult females at nest sites. Another nest predator is the pine squirrel (*Tamiasciurus hudsonicus*). Important predators of young and adults include the Cooper's hawk (*Accipiter cooperi*), northern goshawk (*A. gentiles*), and great horned owl (*Bubo virginianus*) (Herrera and Hiraldo 1976, Mikkola 1983, Reynolds *et al.* 1990).

The correlation of prey availability and both the owl's nomadic movement patterns and yearly variation in nesting success and productivity suggests that food supply may regulate owl abundance in some portions of

its range (Hayward and Hayward 1993). Pileated woodpecker and common flicker distributions may also limit nest cavity availability and, therefore, owl abundance.

4.4 Northern Goshawk (*Accipiter gentilis*)



The range of the northern goshawk (*Accipiter gentilis atricapillus*) is circumpolar (Knopf 1977). Its year-round range¹ in North America extends from northern Alaska and Canada south to northern Mexico, Colorado, Minnesota, and western Maryland (AOU 1957, Scott 1987). Winter sightings of the northern goshawk have been recorded in Missouri, Tennessee, West Virginia, Virginia, and Florida (AOU 1957). Winter migration begins in late August to early September. Spring migration begins in early February and is usually complete by mid-March. Many

¹ *A. gentilis* ssp. *atricapillus* occupies most of the mentioned range; *A. gentilis* ssp. *lainyi* occupies a limited range on Masset, Queen Charlotte, and Vancouver islands, British Columbia (AOU 1957).

birds, however, remain in their territories year-round, moving only when prey is limited (Palmer 1988).

The northern goshawk is a forest dweller, using a wide variety of forest ages, structural conditions, and successional stages (Reynolds *et al.* 1992a,b). For hunting habitat, the northern goshawk prefers the transitional zones from bog to forest and forest to shrubland. Riparian zones and mosaics of forested and open areas are also important hunting habitats (DuBois *et al.* 1987, Palmer 1988). The northern goshawk uses stands of old growth forest as nesting sites (DuBois *et al.* 1987). The northern goshawk often dwells in ponderosa pine (*Pinus ponderosa*), mixed-species, and spruce-fir forests. Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and grand fir (*A. grandis*) frequently dominate the mixed-species forests. Dominants in spruce-fir forests include Engelmann spruce (*Picea engelmannii*) and subalpine fir (*A. lasiocarpa*) (Reynolds *et al.* 1992b).

The home range size for a pair of northern goshawks is about 6,000 acres (2,400 ha). Within the home range, there are three areas of use: the nest area, the post-fledging family area, and the foraging area. More than 20% of the home range is old growth forest (Reynolds *et al.* 1992a,b; St. Clair 1992]. Within a home range, there are usually two to four alternative nest areas (Reynolds *et al.* 1992a,b). The tree selected for nesting has a crotch, fork, or several limbs on one side to support the platform nest (Palmer 1988). The post-fledging family area is about 420 acres (168 ha) made up of a mosaic of forest types that provide hiding cover for the fledglings and habitat for abundant prey (Reynolds *et al.* 1992a,b). The foraging area is about 5,400 acres (2,160 ha) and consists of a mosaic of shrublands, forests, and openings with perching trees from which the owls can

observe prey (Palmer 1988, Reynolds *et al.* 1992a,b).

Northern goshawks are monogamous. If a mate is lost, the northern goshawk will form another pair bond (Palmer 1988). The goshawk selects a preexisting nest or builds a platform nest (Knopf 1977). Nesting occurs from early April to mid-June, depending on latitude (Palmer 1988). Some yearling females breed with older males; yearling males are typically incapable of breeding (Palmer 1988). Generally, 25% of northern goshawks breed as yearlings; another 25%, in their second year; and the remainder, in their third year (Ehrlich *et al.* 1988).

The clutch size of the northern goshawk varies from 1 to 5 eggs, with a mean of 3 eggs per clutch. One egg is laid every 2 days. If a nest is destroyed early in the breeding season, the northern goshawk will nest again. The incubation period is 32 to 34 days. The young fledge in 37 to 41 days, with the smaller, faster-developing males fledging a few days before the females (Palmer 1988).

The female northern goshawk begins molting at the start of incubation and pauses when the young are about ready to fledge. The male molts during this pause. The female resumes molting when the young are flying and hunting on their own (Palmer 1988).

The diet of the northern goshawk changes with the season. In spring and summer, the diet is mainly birds, with a few small mammals. In winter, it consists of prey species that do not migrate or hibernate. In northern portions of the goshawk's range, the bird preys upon ptarmigans (*Lagopus* spp.) in the winter. In southern portions of the range, the goshawk consumes ruffed grouse (*Bonasa umbellus*), blue grouse (*Dendragapus obscurus*), hares (*Lepus* spp.), and red squirrels (*Tamiasciurus hudsonicus*) (Palmer 1988).

The wide distribution of the northern goshawk results in a varied prey base. Stomach and pellet contents show the following prey animals: robins (*Turdus migratorius*), Steller's jays (*Cyanocitta stelleri*), mallards (*Anas platyrhynchos*), black ducks (*Anas rubripes*), sparrows (Ploceidae), warblers (Parulidae), kestrels (*Falco tinnunculus*), crows (*Corvus* spp.), hares, cottontails (*Sylvilagus* spp.), chipmunks (*Eutamias* spp.), ground squirrels (*Spermophilus* spp.), woodchucks (*Marmota monax*), muskrats (*Ondatra zibethicus*), mice (Heteromyidae), and shrews (*Soricidae* spp.) (Palmer 1988).

The northern goshawk is fairly high in the food web; its predators are large avian species such as the bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) (Bosakowski *et al.* 1992).

5 Juniper/Mountain Mahogany

5.1 Curl-leaf Mountain Mahogany (*Cercocarpus ledifolius*)

A native, xerophytic, evergreen shrub or small tree, curl-leaf mountain mahogany grows up to 35 feet (10.6 m) tall and 3 feet (0.9 m) in diameter (Davis 1990). The thick, tortuous, leaf-scarred branches arise from a short trunk and form a round or umbrella-shaped crown. Leaves are broadly elliptic to lanceolate, 0.5 to 1 inch (12–25 mm) long, leathery, somewhat resinous, and curled under at the margins. Flowers are borne singly or in rows of three in the leaf axils. Achenes retain their long, plumose styles. The roots of curl-leaf mountain mahogany play a key role in its ability to inhabit water- and nutrient-deficient substrates. Dealy (1978) suggested that a combination of initial rapid root growth and slow top growth might help curl-leaf

mountain mahogany out-compete its associates.

Curl-leaf mountain mahogany can be extremely long-lived, with some trees in Nevada aged at over 1,350 years. In Idaho, curl-leaf mountain mahogany plants at least 150 years old were found; older stems had rotten cores that made accurate aging impossible (Scheldt and Tisdale 1970).

Curl-leaf mountain mahogany occurs throughout the Rocky Mountains and Intermountain West in shrub ecotones or mountain brush communities, in open forests, on ridgetops, and on rock outcrops (Davis 1990). Curl-leaf mountain mahogany usually occurs in isolated, pure patches that are often very dense. In mid-elevation forests, it does not develop dense canopies. It is commonly associated with limber pine (*Pinus flexilis*), lodgepole pine (*P. contorta*), ponderosa pine (*P. ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), Englemann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and white fir (*A. concolor*) (Bradley *et al.* 1992); it may also occur with quaking aspen (*Populus tremuloides*) and whitebark pine (*Pinus albicaulis*) above 9,000 feet (2,750 m).

As a codominant member of the sagebrush-forest ecotone in Idaho, curl-leaf mountain mahogany is associated with snowberry (*Symphoricarpos* spp.), mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), green rabbitbrush (*Chrysothamnus viscidiflorus*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg bluegrass (*Poa secunda*), Idaho fescue (*Festuca idahoensis*), and Columbia needlegrass (*Stipa columbiana*) (Scheldt and Tisdale 1970).

Curl-leaf mountain mahogany is good forage for all classes of browsing animals in both summer and winter (Stanton 1974, Davis

1990). It is one of the few browse species that meets or exceeds the protein requirements for wintering big game animals (Davis 1990). In Idaho, curl-leaf mountain mahogany is very palatable to bighorn sheep and mountain goats (Dittberner and Olson 1983). In mature stands, much of curl-leaf mountain mahogany foliage is out of reach of browsing animals but provides excellent winter cover (Stanton 1974).

Curl-leaf mountain mahogany may be planted to help stabilize soil in disturbed areas such as roadcuts and mine spoils (Hungerford 1984). Because of its tolerance to heat and drought, curl-leaf mountain mahogany can be used for water-efficient landscaping in arid environments (Gutknecht 1989).

Fire usually kills curl-leaf mountain mahogany. Only lightly seared curl-leaf mountain mahogany survived. Intense heat alone may cause mortality in curl-leaf mountain mahogany by searing green growth.

Curl-leaf mountain mahogany seedlings establish after fire, although establishment may be slow. A curl-leaf mountain mahogany stand near MacKay, Idaho, had burned around 1900. In 1968, the stand contained plants ranging from 8 to 54 years of age (Scheldt and Tisdale 1970). A stand that burned in 1965 showed no signs of regeneration by 1968. However, Collins (1980) described excellent seedling emergence in post-fire year one after a 1979 wildfire in the Salmon National Forest, possibly due to an unusually wet growing season.

6 Whitebark Pine

6.1 Whitebark Pine (*Pinus albicaulis*)

Whitebark pine is a slow-growing, long-lived, ectomycorrhizal, native conifer characteristic of the tree line (Ahrensleger 1987). Trees

often reach 400 to 700 years of age. The oldest known cored tree is 750 years old and is in Mount Robson Provincial Park, British Columbia (Arno and Hoff 1990). In Crowsnest Forest, Alberta, the largest whitebark pine is 121 feet (37 m) high and 26 feet (792 cm) in dbh (Day 1967). The largest reported whitebark pine in the United States is in the Sawtooth Range of central Idaho; it is 69 feet (21 m) high and 9.5 feet (2.9 m) in dbh (Pitel and Wang 1980, Arno and Hoff 1990).

Trees in well-developed stands are 49 to 66 feet (15–20 m) tall and 23 to 35 inches (60–90 cm) in diameter (Ahrens-lager 1987). Growing at the uppermost limits of growth, trees usually are dwarfed or contorted. At the upper tree line, this species takes on a spreading growth form and grows in isolated cushions of “alpine scrub” between 1 and 3.3 feet (0.3–1 m) tall (Ahrens-lager 1987).

Whitebark pine trees commonly have two or more trunks that are often partially fused at the base. Electrophoretic evidence revealed that two or more trunks of what appears to be a single tree are indeed separate trees with distinct genotypes. This finding supports the idea that several mature trees can arise from single seed caches (Luckman *et al.* 1984) and that seeds cached by Clark’s nutcrackers are instrumental in establishing trees (Steele *et al.* 1983). On most sites, trees develop a deep and spreading root system (Arno and Hoff 1990).

The minimum seed-bearing age of whitebark pine is between 20 and 30 years, and the interval between large seed crops is 3 to 5 years (Ahrens-lager 1987). On most sites, significant amounts of seed occur only on trees older than 80 years (Tomback 1986). Large seed crops are produced at irregular intervals, interrupted by smaller crops and crop failures (Lanner 1980). Cone production fluctuates widely between years, and

variations in seed crops may play an important role in the initial establishment of a stand (Ahrens-lager 1987).

Whitebark pine grows on dry, rocky sites on high mountains between 5,900 and 9,940 feet (1,800–3,030 m). It is characteristic of the tree line, where it forms dense krummholz thickets. The dispersal of whitebark pine seeds by Clark’s nutcrackers strongly affects the distribution and abundance of this species (Tomback 1978). Trees occur on dry, rocky, subalpine slopes and exposed ridges. Stands are generally open, with undergrowth of low shrubs, forbs, and grasses (Arno 1986). Sites where whitebark pine occurs as a climax species are drier than sites where it is seral.

Whitebark pine is important in areas where the mean annual precipitation is 23.5 to 31.5 inches (60–80 cm) (Arno and Hoff 1990). The climate is characterized by cool summers and cold winters with deep snowpack. Trees have high frost resistance and low shade tolerance. Trees are also found predominately on acidic substrates, although they have also been reported on calcareous ones. Most soils under whitebark pine stands are Inceptisols (Ahrens-lager 1987).

In upper-elevation subalpine forests, whitebark pine is generally seral and competes with and is replaced by more shade-tolerant trees. Subalpine fir, a very shade-tolerant species, is the most abundant associate and most serious competitor of whitebark pine. Although whitebark pine is more shade tolerant than lodgepole pine and subalpine larch (*Larix lyallii*), it is less shade tolerant than Engelmann spruce and mountain hemlock (*Tsuga mertensiana*) (Ahrens-lager 1987). Whitebark pine is the potential climax species on high, exposed tree-line sites and exceptionally dry sites (Arno and Hoff 1990). It sometimes acts as a pioneer species in the invasion of meadows and burned areas (Forcella and Weaver 1977). On dry, wind-

exposed sites, the regeneration of whitebark pine may require several decades, even though it is often the first tree to become established (Weaver and Dale 1974, Arno and Hoff 1990).

The distribution of seral whitebark pine is strongly affected by the dispersal of seeds by Clark's nutcrackers (Tomback 1978). The fact that bird dispersion of seed occurs allows whitebark pine to be more widespread as a seral species. The dispersal of seeds by them throughout subalpine habitats is partly responsible for the status of whitebark pine as a pioneer and post-fire invader (Steele *et al.* 1983). Additional birds that feed on whitebark pine seeds include Williamson's sapsucker, white-headed woodpecker, mountain chickadee, white-breasted nuthatch, Cassin's finch, red crossbill, pine grosbeak, and blue grouse (Tomback 1978, 1981, 1982).

Bears are also known to regularly eat pine seeds in spring (March to June) and fall (September and October). Most whitebark pine seed eaten by grizzly and black bears are from red squirrel cone caches. Rodents, such as red squirrels, Douglas squirrels, ground squirrels, and chipmunks, store large quantities of intact cones in middens at the base of trees or underground in caches. Although deer mice cannot gnaw the cones, they eat and cache loose seeds (Kendall 1981, Tomback 1982).

Whitebark pine survives where tree growth is limited and provides hiding and thermal cover for wildlife (Ahrensleger 1987). Cavity-nesting birds use tree trunks and snags. Mule deer, elk, and predatory animals also use whitebark habitat (Pfister *et al.* 1977, Tomback 1981).

An assessment of the interior Columbia River basin found that the area of whitebark pine cover types has declined 45% since the turn of the century (Keane 1995). Most of this loss

occurred in the more productive, seral whitebark pine communities: 98% of them have been lost. Practically all of the remaining whitebark pine stands are old. Daubenmire and Daubenmire (1968) found that squirrel pressures on seed crops and blister rust damage are factors in the decline of whitebark pine populations in Idaho and Washington. In addition, regeneration of whitebark pine is sporadic. Rust infection rates in the Sawtooth National Recreation Area in central Idaho are generally light, but low elevations may harbor some heavily infected sites (Smith 1995). Mortality and rust infection levels decline in the drier areas to the south. In addition, successional replacement due to fire exclusion has also contributed to whitebark pine decline (Keane *et al.* 1994, Arno 1995). Whitebark pine cannot maintain its functional role in mountain ecosystems unless areas suitable for its regeneration are available across the landscape (Arno 1995).

6.2 Clark's Nutcracker (*Nucifraga columbiana*)



The Clark's nutcracker is distinctive in appearance and behavior and not easily

confused with any other species within its range. The sexes are similar in appearance. The bird is light to medium gray, with varying amounts of white around the eyes, on the forehead, and on the chin. The tail and wings are glossy black, with white at the base of the tail and secondary wing feathers and around the vent. The pointed bill is black and accompanied with short nasal bristles.

Pine seeds are the primary food for both the adults and nestlings, although the bird is known to eat insects, acorns, berries, snails, carrion and sometimes eggs of small birds (Mulder *et al.* 1978, Tomback 1978, Tomback and DeWolfe 1981). The Clark's nutcracker is also aggressive enough to prey upon small vertebrates, such as ground squirrels (*Spermophilus* spp.), chipmunks (*Tamias* spp.), and voles (*Microtus*) (Mulder *et al.* 1978).

Several pines depend on nutcrackers for seed dispersal. One is the whitebark pine. The interaction between whitebark pine and the Clark's nutcracker is mutualistic and a result of coevolution (Tomback 1982). Clark's nutcrackers have evolved a sublingual throat pouch in which to carry pine seeds to sites where they cache them (Bock *et al.* 1973). The birds bury the pine seeds about 1 cm below the soil surface in groups of one to five. A nutcracker can carry as many as 150 seeds in its throat pouch and store 850 seeds per day. Over a 42-day period, one bird may cache as many as 32,000 seeds. Birds harvest and cache seeds in the late summer and fall for use during the following winter and spring. Nutcrackers store three to five times their energetic requirements, so more seeds are buried than recovered. Seed dispersal by the Clark's nutcracker has, therefore, resulted in ring tree cluster growths and altered the whitebark pine's genetic population structure compared with that of wind-dispersed pines (Furnier *et al.* 1987, Schuster and Mitton

1991, Carsey and Tomback 1994, Tomback and Schuster 1994).

As early as July, the nutcracker begins to eat unripe seeds from new pinecones, usually at upper montane or subalpine elevations. Storage of ripe pine seeds begins by early September; a few weeks later, many birds switch to new seed sources, usually migrating to lower elevations. The nutcracker may continue making seed stores through December. During winter, the bird harvests the seeds remaining in cones and uses the more accessible seed stores. Nesting begins as early as January or February, despite harsh winter weather. Both sexes participate in building the nest, incubating the eggs, and feeding the young (Mewaldt 1956). Females lay between two and six eggs that hatch in about 18 days (Mewaldt 1956). Fledglings leave the nest about 20 to 22 days after hatching (Mewaldt 1948). Although there is no data on survivorship, the bird is known to live for at least 17 years (Kennard 1975).

The Clark's nutcracker is moderately social and tends to form loose flocks (Tomback 1998). It is vigilant for predators during all activities and will mob avian predators like the red-tailed hawk (*Buteo jamaicensis*) and great horned owl (*Bubo virginianus*) (Johnson 1900). The species is also known to provoke and chase small raptors like the American kestrel (*Falco sparverius*) and sharp-shinned hawk (*Accipiter striatus*). The Clark's nutcracker is also relatively tolerant of people; in national parks, the bird frequents scenic turnouts, picnic areas, and campgrounds for food handouts from tourists.

There is little information on the causes of mortality for the Clark's nutcracker, although predation by raptors is one factor. Habitat loss and availability of seeds from large seeded conifers are probably the principal factors in regulating population size.

7 Aspen

7.1 Quaking Aspen (*Populus tremuloides*)

Quaking aspen is in subsection Trepidae of the genus *Populus*. It is a native deciduous tree that is small to medium-sized, typically less than 49 feet (15 m) tall and 16 inches (40 cm) in diameter (Hickman 1993). The quaking aspen has spreading branches and a pyramidal or rounded crown (Jones and DeByle 1985, Gleason and Cronquist 1991). The bark is thin. Leaves are orb- to ovately shaped, with flattened petioles. The fruit is a tufted capsule bearing six to eight seeds. A single female catkin usually bears 70 to 100 capsules. The root system is relatively shallow, with wide-spreading lateral roots and vertical sinker roots descending from the laterals. Laterals may extend over 98 feet (30 m) into open areas (Jones and DeByle 1985).

Quaking aspen forms clones connected by a common parent root system. It is typically dioecious, with a given clone being either male or female; however, some clones produce both stamens and pistils (Jones and DeByle 1985). Quaking aspen stands may consist of a single clone or aggregates of clones. Clones can be distinguished by differences in phenology, leaf size and shape, branching habit, and bark character and by electrophoresis (Perala 1990). In the West, quaking aspen stands are often even-aged, originating after a single top-killing event. Some stands, resulting from sprouting of a gradually deteriorating stand, may be only broadly even-aged (Jones and DeByle 1985). Clones east of the Rocky Mountains tend to encompass a few acres at most (Perala and Carpenter 1985), and aboveground stems are short-lived. Maximum age of stems in the Great Lakes states is 50 to 60 years. Clones in the West tend to occupy more area, and

aboveground stems may live up to 150 years (Johnston and Hendzel 1985).

Optimum conditions for germination and seedling survival include a moist mineral seedbed with adequate drainage, moderate temperature, and freedom from competition (McDonough 1979). In various collections, seeds have germinated at temperatures from 32 to 102 °F (0–39 °C), with germination sharply reduced from 35.5 to 41 °F (2–5 °C) and progressively curtailed above 77 °F (25 °C) (Faust 1936).

Seedlings may reach 6 to 24 inches (15–61 cm) in height by the end of their first year, and roots may extend 2 to 10 inches (5–25 cm) deep and up to 16 inches (41 cm) laterally. Roots grow more rapidly than shoots; some seedlings show little top-growth until about their third year. During the first several years, natural seedlings grow faster than planted seedlings but not as fast as sprouts do. High mortality characterizes young quaking aspen stands regardless of origin. In both seedling and sprout stands, natural thinning is rapid. Stems that occur below a canopy die within a few years (Perala 1990).

Quaking aspen is the most widely distributed tree and a major cover type in North America. Distribution is patchy in the West, with trees confined to suitable sites. Quaking aspen occurs in a large number of other forest cover types over its extensive range. It grows on moist upland woods, dry mountainsides, high plateaus, mesas, avalanche chutes, talus, parklands, gentle slopes near valley bottoms, and alluvial terraces and along watercourses. In the Rocky Mountains, quaking aspen groves are scattered throughout Engelmann spruce-subalpine fir (*Picea engelmannii*-*Abies lasiocarpa*) forests. Prostrate quaking aspens occur above the timberline (Perala and Carpenter 1985). Throughout its range, quaking aspen occurs in mid- to upper-

elevation riparian zones (Franklin and Dyrness 1973, Perala 1990). Quaking aspen grows on soils ranging from shallow and rocky to deep loamy sands and heavy clays. Good quaking aspen sites are usually well drained, loamy, and high in organic matter and nutrients (Perala 1990). Cryer and Murray (1992) stated that stable quaking aspen stands are found on only one soil order, mollisols, and a few soil subgroups, of which Agric Pachic Cryoborolls and Pachic Cryoborolls are dominant. The best stands in the Rocky Mountains and Great Basin are on soils derived from basic igneous rock such as basalt and from neutral or calcareous shales and limestones. The poorest stands are on soils derived from granite.

Quaking aspen is not shade tolerant (Perala 1990), nor does it tolerate long-term flooding or waterlogged soils (Perala 1990). Even if quaking aspen survives flooding in the short term, stems subjected to prolonged flooding usually develop a fungus infection that greatly reduces stem life (and renders the wood commercially useless) (Davidson *et al.* 1959). Quaking aspen readily colonizes after fire, clear-cutting, or other disturbances.

Quaking aspen is seral to conifers in most of its range in the West and some portions of its eastern range. Still, quaking aspen is apparently stable on some sites. These stands can remain stable for decades but eventually deteriorate. Deteriorating stands are often succeeded by conifers, but shrubs, grasses, and/or forbs gain dominance on some sites. Succession to grasses and forbs is more likely on dry sites and more common in the West than in the East.

Quaking aspen forests provide important breeding, foraging, and resting habitat for a variety of birds and mammals. Wildlife and livestock utilization of quaking aspen communities varies with species composition of the understory and relative age of the

quaking aspen stand. Young stands generally provide the most browse. Quaking aspen crowns can grow out of reach of large ungulates in 6 to 8 years (Patton and Jones 1977). Although many animals browse quaking aspen year-round, it is especially valuable during fall and winter, when protein levels are high relative to other browse species (Tew 1970).

Quaking aspen is palatable to all browsing livestock and wildlife species (DeByle 1985). The buds, flowers, and seeds are palatable to many bird species including numerous songbirds and grouse. Elk browse quaking aspen year-round, feeding on bark, branch apices, and sprouts. Quaking aspen is important forage for mule and white-tailed deer. Deer consume the leaves, buds, twigs, bark, and sprouts. New growth on burns or clear-cuts is especially palatable to deer. Quaking aspen is valuable moose browse for much of the year (Brinkman and Roe 1975). Moose utilize it on summer and winter ranges. Young stands generally provide the best quality moose browse. However, researchers in Idaho found that, in winter, moose browsed mature stands of quaking aspen more heavily than they browsed nearby clear-cuts dominated by quaking aspen sprouts (Ritchie 1978).

8 Mountain Brush

8.1 Antelope Bitterbrush (*Purshia tridentata*)

Antelope bitterbrush is a native, deciduous shrub (Blauer *et al.* 1975). The fruit is an achene, 0.13 to 0.5 inch (3–13 mm) long. Antelope bitterbrush has two common ecotypes, both present throughout its range: multiple-stemmed, decumbent plants and single-stemmed, columnar plants (Blauer *et al.* 1975, Murray 1983, Bunting *et al.* 1985, Richardson *et al.* 1986). Plants may reach 12

to 15 feet (3.6–4.5 m) high but usually grow to 3 or 4 feet (0.9–1.2 m) (Berry 1963). The decumbent form is more prevalent at higher elevations. Antelope bitterbrush is long-lived. Nord (1965) reported a 115-year-old plant that was 10 inches (25 cm) high and spread over 7 square feet (1.8 m²). At a lower elevation, Nord (1965) found a 128-year-old plant that was 12 feet (3.6 m) high and 20 feet (6 m) across.

Antelope bitterbrush has a long taproot or taproots that extend as long as 15 to 18 feet (4.5–5.4 m) (Noste and Bushey 1987) and few shallow roots (Baker and Torrey 1979).

Antelope bitterbrush sometimes has nitrogen-fixing root nodules, a result of a symbiotic association with *Frankia* spp. actinomycetes (Murray 1983, Righetti *et al.* 1986). Degree of nodulation depends on site conditions including soil moisture content and salinity, presence of inoculants, and available nitrogen (Righetti *et al.* 1983, Righetti *et al.* 1986). Presence of nodules, even in high numbers, does not necessarily indicate that significant amounts of nitrogen are being added to the soil (Ritchie 1978).

Antelope bitterbrush occurs from British Columbia east of the Cascade Range through Washington and Oregon; in the Klamath, North Coast, Cascade, and Sierra Nevada ranges of California; southeast into western Montana and throughout the Rocky Mountains; in the Great Basin; and in Arizona and New Mexico (Blauer *et al.* 1975, Murray 1983). It is distributed over approximately 340 million acres (Furniss 1983).

Antelope bitterbrush appears in several mesic habitat types. Plant communities with antelope bitterbrush include range types such as antelope bitterbrush-bluebunch wheatgrass (*Pseudoroegneria spicata*) and antelope bitterbrush-Idaho fescue (*Festuca idahoensis*), other steppe vegetation, and tree-dominated types such as ponderosa pine

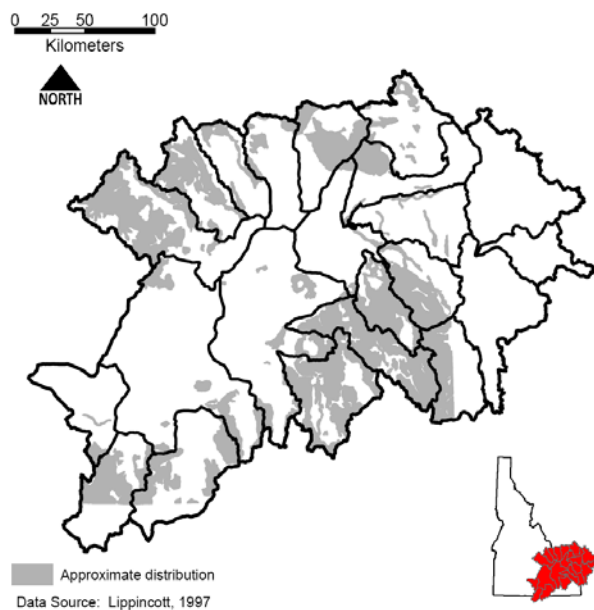
(*Pinus ponderosa*) forest and juniper (*Juniperus* spp.) woodland (Richardson *et al.* 1986). At Craters of the Moon National Monument, Idaho, antelope bitterbrush appears with wheatgrass (Triticeae), cheatgrass (*Bromus tectorum*), Indian ricegrass (*Achnatherum hymenoides*), and basin wildrye (*Leymus cinereus*) (Barrington *et al.* 1988). In the Wyoming mountain shrub community, antelope bitterbrush appears with big sagebrush, bluebunch wheatgrass, spike fescue (*Leucopoa kingii*), Ross sedge, and needle and thread (*Hesperostipa comata*) (Cook *et al.* 1994).

Antelope bitterbrush is important browse for wildlife and livestock (Murray 1983, Noste and Bushey 1987, Vander Wall 1994). Pronghorn (Young 1989), mule deer (Gullion 1964, Williams and Aldon 1976), elk (Hobbs *et al.* 1981), bighorn sheep, and moose utilize antelope bitterbrush extensively (Murray 1983). Mule deer use of antelope bitterbrush peaks in September, when antelope bitterbrush may compose 91% of the diet (Austin and Urness 1983). Winter use is greatest during periods of deep snow (Shaw and Monsen 1983). Domestic livestock and mule deer may compete for antelope bitterbrush in late summer, fall, and/or winter (Clements and Young 1997). Cattle prefer antelope bitterbrush from mid-May through June and again in September and October (Shaw and Monsen 1983). Antelope bitterbrush seed is a large part of the diet of rodents (Wagstaff 1980), especially deer mice and kangaroo rats (Noste and Bushey 1987).

Antelope bitterbrush supports several insect populations (Giunta *et al.* 1978), some of which eat the seeds or cotyledons (Giunta *et al.* 1978). Especially important are Pogonomyrmex ants, which stash seeds and are therefore important to natural regeneration (Evans *et al.* 1983), and tent caterpillars, which often cause antelope bitterbrush die back (Noste and Bushey 1987).

Ungulates, birds, and rodents use antelope bitterbrush for cover (Parker 1975, Griffith and Peek 1989). Mule deer preferred antelope bitterbrush habitat during winter in central Washington, maybe because of height and large crown of antelope bitterbrush (Carson and Peek 1987). Pronghorn prefer shrubs up to 2 feet tall (0.6 m), so tall, decadent, fire-excluded stands of antelope bitterbrush are not good pronghorn habitat (Young 1989). Sage grouse use short (12-inch [30.5 cm]) antelope bitterbrush for cover in Idaho (Klebenow 1969, Marks and Marks 1987), Oregon (Range et al. 1981), and Wyoming (Klott and Lindzey 1990). Antelope bitterbrush and other shrubs provide important cover for Lewis's woodpeckers (Koehler 1981).

8.2 Green-tailed Towhee (*Pipilo chlorurus*)



The green-tailed towhee is fairly common throughout much of its range. The bird spends much of its time on or near the ground in thick, shrubby habitats. Green-tailed towhees are about 7 inches (18 cm) long and weigh about 1 ounce (29 g) (Dunning 1993). Adults have a long greenish tail, olive green

upperparts, gray breast, white throat outlined in black, and reddish brown cap.

The species breeds in the United States from the Northwest to the Midwest and migrates south to winter in California, Arizona, New Mexico, Texas, and Mexico. In the northern Rocky Mountains, the green-tailed towhee breeds mainly south of the Snake River Plain, east through south-central Idaho counties, and north to Clark County in eastern Idaho (Burleigh 1972, Stephens and Sturts 1998). Green-tailed towhees also breed in most of Wyoming and in southwest and south-central Montana (Oakleaf et al. 1992).

The age of the bird at first breeding is unknown, but the species is an annual breeder (Dobbs et al. 1998). Female green-tailed towhees lay between 2 and 5 eggs each year, with 4 being the usual number (Norris 1968). The species will renest as many as four times after a nest failure, usually beginning to build replacement nests within a couple of days of a failure (Dotson 1971). Chicks hatch after an incubation period of about 12 days (Martin and Li 1992). Only the female incubates the egg, and the males occasionally feed incubating females (Dotson 1971). Both parents feed the nestlings; only the female alternates brooding and foraging activity (Dobbs et al. 1998). Fledglings depart the nest 11 to 14 days after hatching, and the parents continue to feed them for up to 2 weeks (Dotson 1971). The maximum age recorded for a banded green-tailed towhee was over 7 years (Klimkiewicz and Futcher 1987).

The green-tailed towhee scratches the ground for insects, seeds, and berries; drinks morning dew from leaves; and occasionally visits feeding stations. Major food items for the bird are weed seeds and insects. Insect species eaten by the towhee include beetles (Coleoptera), bees and wasps (Hymenoptera), butterflies and moths (Lepidoptera), grasshoppers and crickets (Orthoptera), true

bugs (Hemiptera), and flies (Diptera) (Norris 1968, Dotson 1971, Oberholser 1974). Stomach contents of two green-tailed towhees were 29% animal matter and 71% vegetable matter (Bryant 1911).

Predators of the green-tailed towhee adults and juveniles include the sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*A. cooperii*), northern goshawk (*A. gentilis*), peregrine falcon (*Falco peregrinus*), American kestrel (*F. sparverius*), red-tailed hawk (*Buteo jamaicensis*), and long-eared owl (*Asio otus*) (Dotson 1971, Lima 1993). Other predators of towhee nests include the Steller's jay (*Cyanocitta stelleri*), red squirrel (*Tamiasciurus hudsonicus*), least chipmunk (*Eutamias minimus*), long-tailed weasel (*Mustela frenata*), black-billed magpie (*Pica pica*), striped skunk (*Mephitis mephitis*), spotted skunk (*Spilogale putorius*), and gopher snake (*Pituophis catenifer*) (Dotson 1971, Dobbs *et al.* 1998).

8.3 Mule Deer (*Odocoileus hemionus*)



The mule deer is a popular game species in Idaho. Prior to the settlement of the West in

the late 1800s and early 1900s, mule deer were not as abundant as they are currently (IDFG 1990). Intense grazing by domestic animals, as well as fire suppression, changed plant communities once dominated by grasses to ranges dominated by shrubs. This habitat change to shrub-dominated ranges in combination with reduced livestock grazing, reduced competition from other wild ungulates due to hunting, and regulated deer harvest promoted the growth of mule deer populations (IDFG 1990).

The mule deer mating season usually begins in mid-November and continues through mid-December (Snyder 1991a). The gestation period lasts 203 days, with most young born between May and June (Lippincott 1997). Some July and August births also occur in some areas. Mature females commonly have twins, while yearlings have only single fawns. Weaning begins at about five weeks and is usually completed by the sixteenth week. Female mule deer usually breed at 2 years of age, while males may not mate until they are at least 3 or 4 years old due to competition with older males. The life span of a female mule deer can be as long as 22 years, while males may live as long as 16 years. Males begin to shed their antlers in December, though shedding can continue into March; mature and less healthy males might shed their antlers earlier.

Mule deer are most likely to be found in open forested regions or on the plains and prairies (Snyder 1991a). In the mountainous regions of the West, they prefer rocky or broken terrain at elevations near or at the subalpine zone (Carpenter and Wallmo 1981). They are also found in alpine, montane, and foothill zones. Mule deer seek shelter at lower elevations when snows become deep. In the mountains of the Southwest, mule deer are found in lower-elevation shrublands, while white-tailed deer occupy the higher-elevation montane areas. In open prairie regions, mule

deer tend to concentrate in river breaks and brushy stream bottoms (Mackie *et al.* 1987). In the high ranges of the Rocky Mountains, mule deer migrate during winter, sometimes moving 50 to 100 miles (80 to 160 km) (Mackie *et al.* 1987).

Mule deer are better adapted to open areas than white-tailed deer are, although cover becomes important in winter (Snyder 1991a). Areas where cover can prevent snow from accumulating beyond 12 inches (30 cm) are most beneficial (Hanley 1984, Nyberg 1987). Wallmo and Schoen (1980) reported that mule deer could cope with snow up to 24 inches (60 cm) if not dense or crusty. Leckenby *et al.* (1982) and Black *et al.* (1976) listed optimal cover attributes for the Great Basin shrub-steppe region, including estimates of tree heights and canopy closure for thermal, hiding, fawning, and foraging cover. They estimated the proportions of cover and forage at 55% forage, 20% hiding cover, 10% thermal cover, 10% fawn-rearing cover, and 5% fawn habitat.

Mule deer are primarily browsers, feeding on several thousand different plant species across their range (Snyder 1991a). They are capable of altering or severely damaging plant communities through overbrowsing (Reed 1981). Mule deer consume leaves, stems, and shoots of woody plants most often during summer and fall, while grasses and forbs compose the bulk of spring diets. However, feeding behavior is quite variable in any given location. Some of the most common foods are rabbitbrush (*Chrysothamnus* spp.), mountain mahogany (*Cercocarpus* spp.), snowberry (*Symphoricarpos* spp.), buffaloberry (*Shepherdia* spp.), ceanothus (*Ceanothus* spp.), rose (*Rosa* spp.), serviceberry (*Amelanchier* spp.), sagebrush (*Artemisia* spp.), sumac (*Rhus* spp.), common chokecherry (*Prunus virginiana*), willow (*Salix* spp.), Gambel oak (*Quercus gambellii*), mockorange (*Philadelphus lewisii*), ninebark

(*Physocarpus* spp.), antelope bitterbrush (*Purshia tridentata*), mariposa (*Calochortus elegans*), juniper (*Juniperus* spp.), yucca (*Yucca* spp.), euphorbia (*Euphorbia* spp.), manzanita (*Arctostaphylos* spp.), lechuguilla (*Agave lechuguilla*), western yarrow (*Achillea millefolium*), red huckleberry (*Vaccinium parvifolium*), swordfern (*Polystichum munitum*), milkvetch (*Astragalus* spp.), and dandelion (*Taraxacum officinale*). Grasses include bluegrasses (*Poa* spp.), wheatgrasses (*Agropyron* spp.), and bromes (*Bromus* spp.) (Wallmo and Regelin 1981, Gruell 1986, Mackie *et al.* 1987, Happe *et al.* 1990).

Mule deer predators include people, domestic dogs (*Canis familiaris*), coyotes (*Canis latrans*), wolves (*Canis lupus*), black bears (*Ursus americanus*), grizzly bears (*U. arctos*), mountain lions (*Felis concolor*), lynx (*Lynx canadensis*), bobcats (*F. rufus*), and golden eagles (*Aquila chrysaetos*) (Mackie *et al.* 1987).

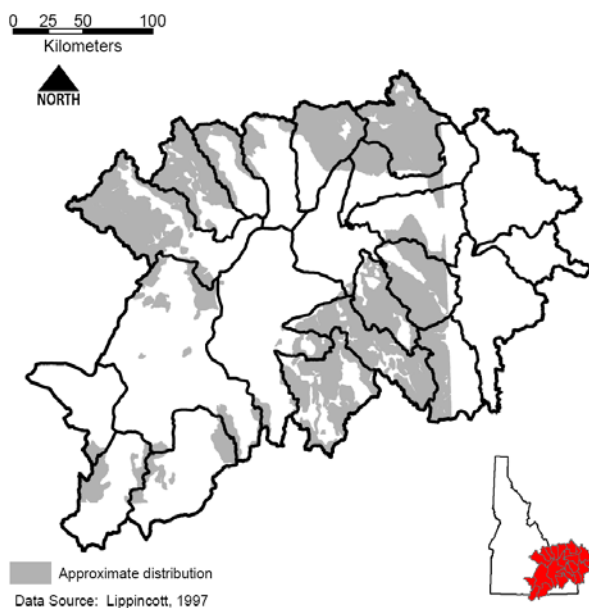
The effects of logging on mule deer populations vary between and within regions; therefore, it is difficult to generalize conclusions (Lyon and Jensen 1980). Site-specific studies are required to determine logging effects, although many studies confirm that slash depth is a major factor limiting mule deer use of harvested areas (Lyon and Jensen 1980, Hanley 1984). Studies in Alaska have shown that black-tailed deer avoid second growth forests after 20 to 30 years and instead turn to “over-mature” forests (older than 300 years) because these forests provide more browse than younger stands (Wallmo and Schoen 1980, Hanley 1984). Happe *et al.* (1990) have shown that, in coastal forests, forage in old growth has higher crude protein values than forage in clear-cuts. Tannin astringency of browse, which reduces digestive protein, is higher in clear-cuts than in old growth forests. Hanley (1984) recommended scattering clear-

cuts in old growth in irregular shapes and spreading them over a wide elevational range.

A study in Colorado showed that, following a treatment in lodgepole pine-spruce-fir forests of alternating clear-cuts with uncut strips, mule deer increased after 10 years. Strips 100 feet (30 m) wide produced the best results (Wallmo 1969). Wallmo and Schoen (1980) listed management guidelines for timber harvesting that benefit deer in the western United States. However, they stated that some of these guidelines are based on speculation and all contradict claims that large clear-cuts are better for mule deer.

Mule deer are vulnerable to a variety of viral, fungal, and bacterial diseases (Hibler 1981). Epizootic hemorrhagic disease (EHD) resides in a small portion of the deer population and is spread from deer to deer by *Culicoides* gnats. The areas most affected include lower elevations along the Salmon River near White Bird and Riggins. Mule deer tend to inflict heavy crop damage, as well as damage to hayfields, stackyards, orchards, and reforestation projects (Snyder 1991a). Mule deer are often attacked and killed by domestic dogs, and several hundred thousand deer are killed by vehicles each year (Reed 1981). Mule deer are not as tolerant of human activity and not as adaptable to disturbances as white-tailed deer are (Reed 1981).

8.4 Rocky Mountain Elk (*Cervus elaphus nelsoni*)



The Rocky Mountain elk is Idaho's premier big game species (IDFG 1991). In the 1800s, elk were among the most widespread and abundant large animals in northwestern North America, but by the end of the century, the elk population was reduced to low numbers due mostly to unregulated harvest and habitat destruction. In Idaho, however, elk populations have increased as a result of habitat changes and protection. In addition, wildfires in north and central Idaho created extensive brush fields, which provided abundant forage for elk, resulting in population increases (IDFG 1991).

Because elk have historically had a wide distribution, their preferred habitat also varies widely (Skovlin 1982). Populations in the mountain tend to inhabit coniferous forests associated with rugged, broken terrain or foothill ranges (Snyder 1991b). During summer, elk spend most of their time in high mountain meadows of alpine or subalpine zones or in stream bottoms (Adams 1982). Studies of elk slope preferences indicate that elk use a variety of slope percentages,

although they most frequently chose slopes in the 15 to 30% class (Skovlin 1982). Elk may use more open areas during spring and summer because of earlier spring green-up (Edge *et al.* 1987). During hot summer months, elk seek shaded, cool habitats (Kuchler 1964). Elk need cover for protection against heat and extreme cold, as well as for hiding and calving. Ideal cover is grassland or meadows interspersed with forests that have large amounts of edge (Skovlin 1982). Elk use of open areas tends to decrease at 100 m from cover. Calving cover requirements vary from place to place and within populations (Skovlin 1982). Security or hiding cover is necessary in places of human disturbance (Peek 1982).

Rocky Mountain elk are mostly crepuscular to nocturnal. Diurnal feeding is more common in summer than in winter (Snyder 1991b). Also, feeding periods are more prolonged in winter and concentrated in morning and evening (Snyder 1991b). In Idaho, elk herds move to lower elevations in winter to feed. Elk are ruminant herbivores; their food habits are extremely variable throughout their range.

Some elk populations prefer to graze, while others rely more heavily on browse. Grasses and forbs are preferred during spring and early summer, and woody browse is preferred during winter. Elk browse conifers in areas where snow has covered other forage. Some important elk foods include eriogonum (*Eriogonum* spp.), tidytips (*Layia* spp.), blazing-star (*Mentzelia* spp.), scalebud (*Anisocoma acaulis*), five hook bassia (*Bassia hyssopifolia*), alkali mallow (*Sida hederacea*), black alfalfa (*Medicago sativa*), antelope bitterbrush (*Purshia tridentata*), greasewood (*Sarcobatus vermiculatus*), galleta (*Hilaria jamesi*), knotgrass (*Paspalum distichum*), bigleaf sandwort (*Arenaria macrophylla*), spotted cat's-ear (*Hypochoeris radicata*), buckthorn plantain (*Plantago lanceolata*), trefoil foamflower (*Tiarella trifoliata*),

cowparsnip (*Heracleum lanatum*), sedges (*Carex* spp.), wildrye (*Elymus* spp.), maple (*Acer* spp.), huckleberry and blueberry (*Vaccinium* spp.), larkspur (*Delphinium* spp.), western goldthread (*Coptis occidentalis*), lupine (*Lupinus* spp.), penstemon (*Penstemon* spp.), clover (*Trifolium* spp.), wheatgrass (*Agropyron* spp.), brome (*Bromus* spp.), bluegrass (*Poa* spp.), sagebrush (*Artemisia* spp.), ceanothus (*Ceanothus* spp.), currant (*Ribes* spp.), and quaking aspen (*Populus tremuloides*) (Nelson and Leege 1982).

Elk are gregarious, although some bulls may be solitary (Snyder 1991b). Males shed their antlers in March and April. Mature males defend the female herds during the rut season that extends from September through to October. Older, dominant males do most of the mating. Females breed at 2 years of age. Most of the births occur in the late spring and are usually a single calf, but twins are common. Gestation lasts between 249 and 262 days (Snyder 1991b).

Elk predators include people, wolves (*Canis lupus*), coyotes (*Canis latrans*), black bears (*Ursus americanus*), grizzly bears (*U. arctos*), and mountain lions (*Felis concolor*) (Taber *et al.* 1982). Elk can damage a range from overgrazing, as well as damage tree plantations, crops, orchards, and haystacks (Lyon and Ward 1982). Elk compete with cattle and may completely avoid using pastures grazed by livestock (Lyon and Ward 1982). Elk can suffer from fungal, bacterial, and viral diseases, including a parasitic meningeal worm (*Parelaphostrongylus tenuis*) carried by white-tailed deer and an arterial worm carried by mule deer.

Logging operations can negatively affect elk use of an area. Models have been developed to determine elk use of clear-cuts (Lyon 1976). Elk use increases in cutover areas as the vegetation exceeds 4 feet (1.2 m) in height and when slash in and around the cut is less

than 1.5 feet (0.5 m) deep. Elk move as far away from areas near active harvest operations as topography allows, such as over ridges (Lyon 1979, Edge and Marcum 1985). Neither an undisturbed forest adjacent to a harvest operation, nor long distances from a harvest operation are as effective as topographic features in providing security cover for elk during logging (Lyon 1979). Recommendations are to log summer range in winter or reduce the length of operation and the number of concurrent harvests in any one management unit. Habitat availability will be reduced for elk within 1,640 to 3,280 feet (500–1,000 m) of an active harvest operation (Edge and Marcum 1985).

Elk avoid well-traveled forest roads from spring through fall (Edge 1982). Less well-traveled roads may receive more use, but without tree cover, elk use will diminish within 2,460 feet (750 m). Recommendations for logging and road building in critical elk habitat are listed by several authors (Kuchler 1964, Edge 1982, Thomas *et al.* 1988). For comprehensive information on the effects of logging on elk in western Montana, refer to the final report of the Montana Cooperative Elk–Logging Study (Lyon *et al.* 1985).

Prescribed fire is used routinely to create or enhance elk habitat in many western states (Snyder 1991b). Historical evidence shows that early Native Americans used fire to attract ungulates (McCabe 1982). Fire can be used to rejuvenate aspen stands, encourage early spring green-up of grasslands by reducing litter, slow or prevent conifer dominance in important foraging areas, increase palatability of foods, reduce the height of browse species, and stimulate regeneration through sprouting or heat scarification of seed (Weaver 1987, Jourdonnais and Bedunah 1990). In Glacier National Park, fires increased carrying capacity on winter range by creating a mosaic of thermal and hiding cover and forage areas

(Martinka 1976). Prescribed burns in the Lochsa River drainage of Idaho produced the best results when conducted from the end of March until mid-May (Leege 1968, Leege and Godbolt 1985). Hot summer fires are needed to germinate redstem ceanothus (*Ceanothus sanguineus*), an important forage species (Weaver 1987).

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APPENDIX 3-1—OVERVIEW OF THE MAJOR CAUSES LIMITING THE HABITATS AND FISH AND WILDLIFE IN THE UPPER SNAKE PROVINCE

1. Altered Hydrologic Regime

Hydrologic regimes play a major role in determining the biotic composition, structure, and function of aquatic, wetland, and riparian ecosystems. An estimated 25% of the area in the Upper Snake province is highly impacted by altered hydrologic regimes with most impacts occurring in the American Falls and

Lake Walcott watersheds (Table 1). The most severely impacted watersheds in terms of altered hydrology include American Falls, Lake Walcott, Upper Snake–Rock, Portneuf, Blackfoot, Willow, Teton, Beaver–Camas, and the Upper and Lower Henrys Fork watersheds (Figure 1). Areas occupied by riparian/herbaceous wetlands and mountain brush appear to be highly impacted by altered hydrologic regimes (Table 2).

Table 1. Comparing the relative percentages of area impacted by altered hydrologic regimes for each watershed in the three subbasins of the Upper Snake province. (Source: ICBEMP 1997.)

Snake Headwaters Subbasin Relative Category	Major Hydrologic Unit (Watershed) ^a				
	GHB	GVT	PAL	SAL	SHW
Very high	<1		8		<1
High	3	7	10	29	2
Moderate	<1		6	12	12
Low	19	<1	30	38	7
Very low	77	93	46	21	79

^a GHB= Greys–Hoback watershed; GVT= Gros Ventre watershed; PAL=Palisades watershed; SAL=Salt watershed; SHW=Snake Headwaters watershed.

Upper Snake Subbasin Relative Category	Major Hydrologic Unit (Watershed) ^a											
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL
Very high	22	31	3	68	24	61	20	62	5	76	21	27
High	46	55	19	31	46	22	31	11	69	15	16	64
Moderate	5	1	7		3	4	8	2		<1	7	
Low	26	11	40	<1	3	7	39	14	22	5	34	9
Very low	<1	2	31		25	6	1	11	4	4	22	<1

^a AMF=American Falls watershed; BFT=Blackfoot watershed; GSE=Goose watershed; IFA= Idaho Falls watershed; LHF=Lower Henrys Fork watershed; Portneuf watershed; RFT=Raft watershed; TET=Teton watershed; UHF=Upper Henrys Fork watershed; LWT=Lake Walcott watershed; WIL=Willow watershed.

Closed Basin Subbasin Relative Category	Major Hydrologic Unit (Watershed) ^a				
	BCM	BCK	BLR	LLR	MDL
Very high	56	<1	7	<1	35
High	30	23	3	14	20

Closed Basin Subbasin Relative Category	Major Hydrologic Unit (Watershed) ^a				
	BCM	BCK	BLR	LLR	MDL
Moderate			11	10	3
Low	14	46	49	28	21
Very low		30	31	47	20
^a BCM=Beaver-Camas watershed; BCK=Birch watershed; Big Lost River watershed; Little Lost River watershed; Medicine Lodge watershed.					

Table 2. Relative percentages of impacts to focal habitat types by altered hydrologic regimes in the Upper Snake province. (Source GAP II, Scott *et al.* 2002)

Focal Habitat Type	High	Low	Medium	Very High	Very Low
Riparian/herbaceous wetlands	42	18	5	16	19
Open water	12	23	15	39	11
Shrub-steppe	23	38	6	17	17
Pine/fir forest	18	18	5	4	55
Juniper/mountain mahogany	27	38	16	10	9
Whitebark pine	1	24	7	<1	67
Aspen	36	27	3	13	22
Mountain brush	57	10	2	21	9

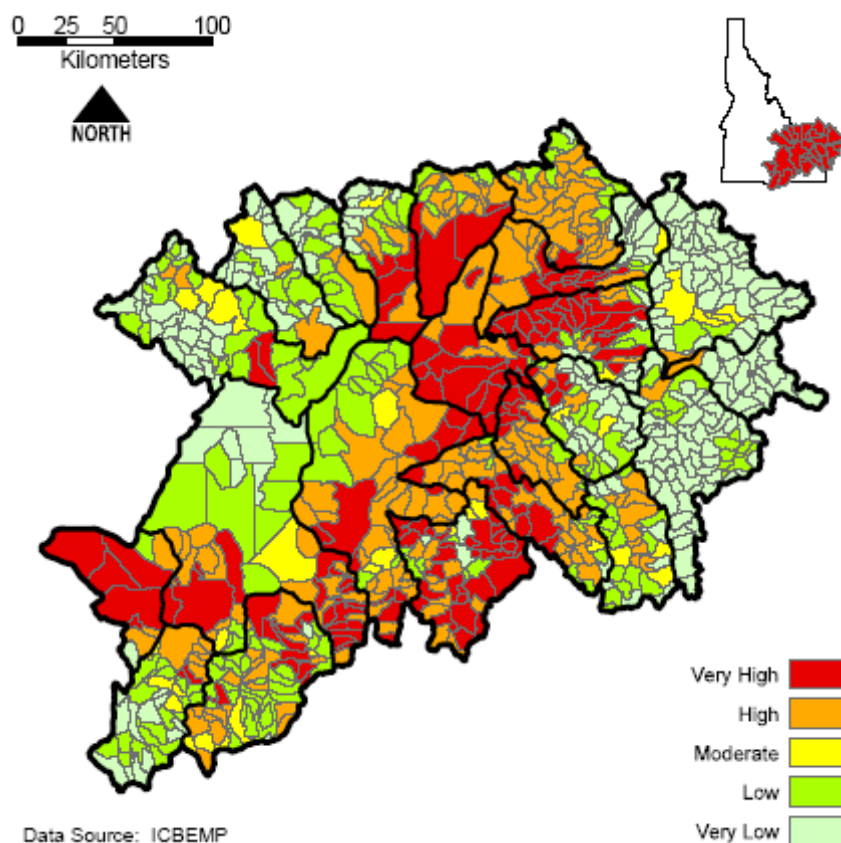


Figure 1. Relative impacts of altered hydrologic regimes in the Upper Snake province (ICBEMP 1997).

1.1 Habitat Loss and Modification

Human activities such as residential and commercial development, recreation, and resource extraction have changed, fragmented, and destroyed natural habitats. Forest and wetland losses increase overland flow and reduce filtration of sediments and pollutants, increasing the likelihood that pollutants will reach streams, rivers, and estuaries (USEPA 2001).

Habitat modification is less obvious, but detrimental nonetheless. For example, when communities build roads over streams, they modify the stream habitat. Road culverts can prevent fish passage and seriously impact fish populations. Road culverts that block fish passage in the Upper Snake province are shown in Figure 2. We estimated 227 road culverts in the Upper Snake province, and of the culverts surveyed for fish passage, only 75 allow passage for juvenile fish, and 1 culvert allows passage for adult fish (Table 3).

Table 3. Information on fish passage at road crossings in the Upper Snake province. This inventory represents only the state of available information at the time this report was prepared, and may or may not reflect the appropriate proportions of culverts in a given watershed. Watersheds not included in this table have no inventoried culverts.

Life Stage	Status	Watershed														Total
		SHW	GVT	GHB	PAL	SAL	UHF	TET	BFT	PTF	LWT	RFT	GSE	BCM	LLR	
Juv	Allows fish passage	3	5	61		5							1			75
	Passage unknown											1	1		1	3
	No fish passage	7	11	80	8	2	2	1	1	2	1	7	10	2	15	149
	Total	10	16	141	8	7	2	1	1	2	1	8	12	2	16	227
Adult	Allows fish passage														1	1
	Passage unknown											2	1			3
	No fish passage				8	1	2	1	1	2	1	6	9	2	15	48
	Total				8	1	2	1	1	2	1	8	10	2	16	52

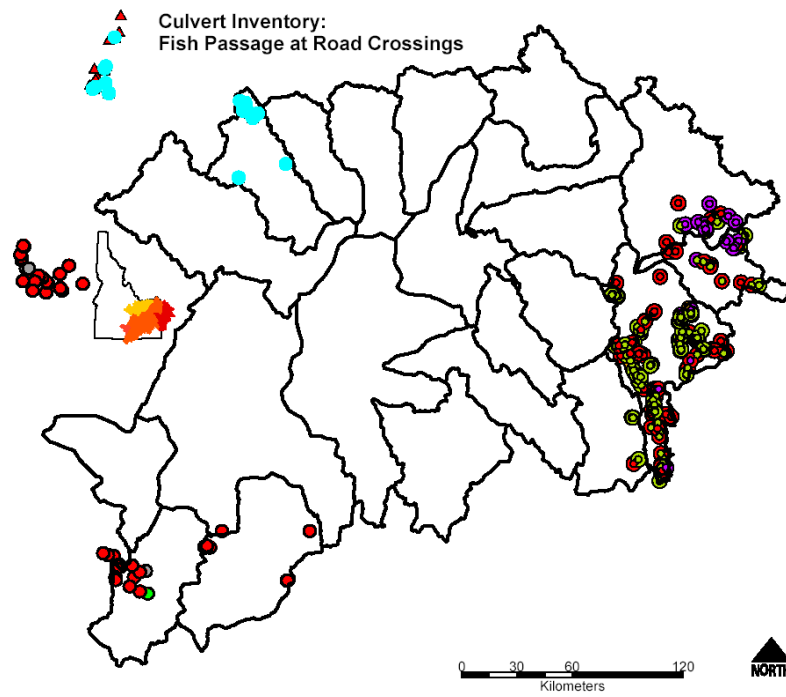


Figure 2. Inventory for road culverts surveyed in the Upper Snake province (National Forest Assessments 2003). Many road culverts remain to be surveyed in the province.

Farm, forestry, and other rural road construction; streamside vehicle operation; and stream crossings can result in significant soil disturbance and create a high potential for increased erosion processes and sediment transport to adjacent streams and surface waters. Road construction involves activities such as clearing existing native vegetation along the road right-of-way; excavating and filling the roadbed to the desired grade; installing culverts and other drainage systems; and installing, compacting, and surfacing the roadbed.

Although most erosion from roadways occurs during the first few years after construction, significant impacts may result from maintenance operations using heavy equipment, especially when the road is located adjacent to a water body. In addition, improper construction and lack of maintenance may increase erosion processes and the risk for road failure (USEPA 2001).

1.2 Hydromodification

If stream flows are lowered, fluctuate, or blocked by physical barriers, these changes

can affect many plant and animal species (USFS 1994). These changes can also affect recreational opportunities. Hydromodification is widespread due to efforts to capture, control, store, and divert water. These alterations support drinking water supplies, hydropower, irrigation, flood control, manufacturing uses, and recreation. Few human actions have more significant impacts on a river system than dam construction. Dams change upstream and downstream habitats, water temperatures, water quality, and sediment movement. They also block or slow the movement of materials and organisms throughout a watershed (USEPA 2001) and increase flooding and subsequent loss of property.

More than 19,900 points of water diversion are present in the Upper Snake Province (Figure 3). The majority of these diversions occur in the Big Lost (3,800), Portneuf (3,100), Teton (2,150) and Raft (2,100) watersheds. The Birch watershed has the fewest water diversions in the province, with 100.

IDWR Irrigation Points of Diversion - Surface Water

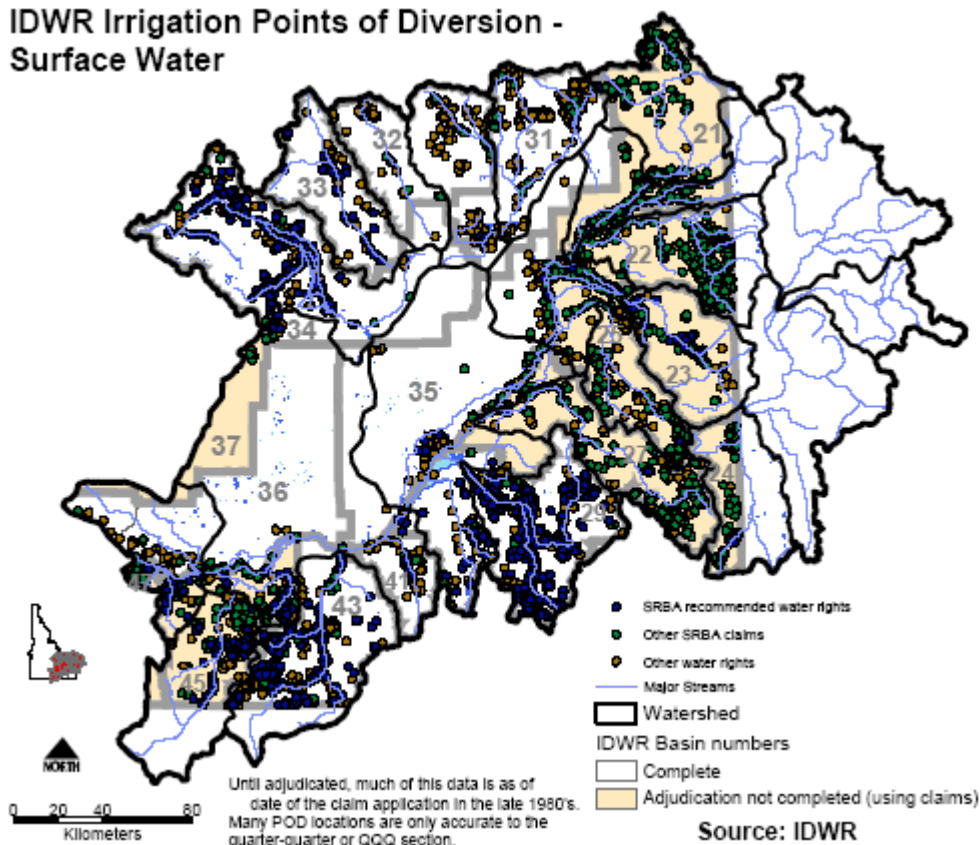


Figure 3. Locations of water diversions in the Upper Snake province (IDWR 2003).

Channelization, which is river and stream channel engineering undertaken for the purpose of flood control, navigation, drainage improvement, and reduction of channel migration potential includes activities such as straightening, widening, deepening, or rating existing stream channels, as well as clearing or snagging operations (Brookes 1990). These forms of hydromodification typically result in more uniform channel cross-sections, steeper stream gradients, a reduction in average pool depths, and altered stream/river flow (USEPA 1993).

Channel-modification activities deprive wetlands of enriching sediments, change the ability of natural systems to both absorb hydraulic energy and filter pollutants from surface waters, and cause interruptions in the

different life stages of aquatic organisms (Sherwood *et al.* 1990). A frequent result of channelization and channel-modification activities is a diminished suitability of instream and riparian focal habitat for fish and wildlife. Hardening of banks along waterways eliminates instream and riparian habitat, decreases the quantity of organic matter entering aquatic systems, and increases the movement of nonpoint source pollutants (USEPA 1993).

Increased or fluctuating temperatures can harm fish and other aquatic organisms whose life cycles and breeding success are inextricably linked to water temperature. Thermal modification can eliminate fish species and other aquatic organisms from streams (USEPA 2001).

Completed channel-modification projects usually require regularly scheduled maintenance to preserve them. These maintenance activities may result in continual disturbance of instream and riparian habitat. In some cases, substantial displacement of instream habitat due to the magnitude of the changes in surface water quality; morphology; and composition of the channel, stream hydraulics, and hydrology can occur (USEPA 1993).

The magnitude of stream alteration activities within the Upper Snake province may be examined in terms of the number of alteration permits issued by the U.S. Army Corps of Engineers and the Idaho Department of Water Resources (Figure 4). A total of 2,048 stream alteration permits are issued to participants in the Upper Snake subbasin; 520 are issued to participants in the Closed Basin subbasin; and 291 to participants in the Snake Headwaters subbasin.

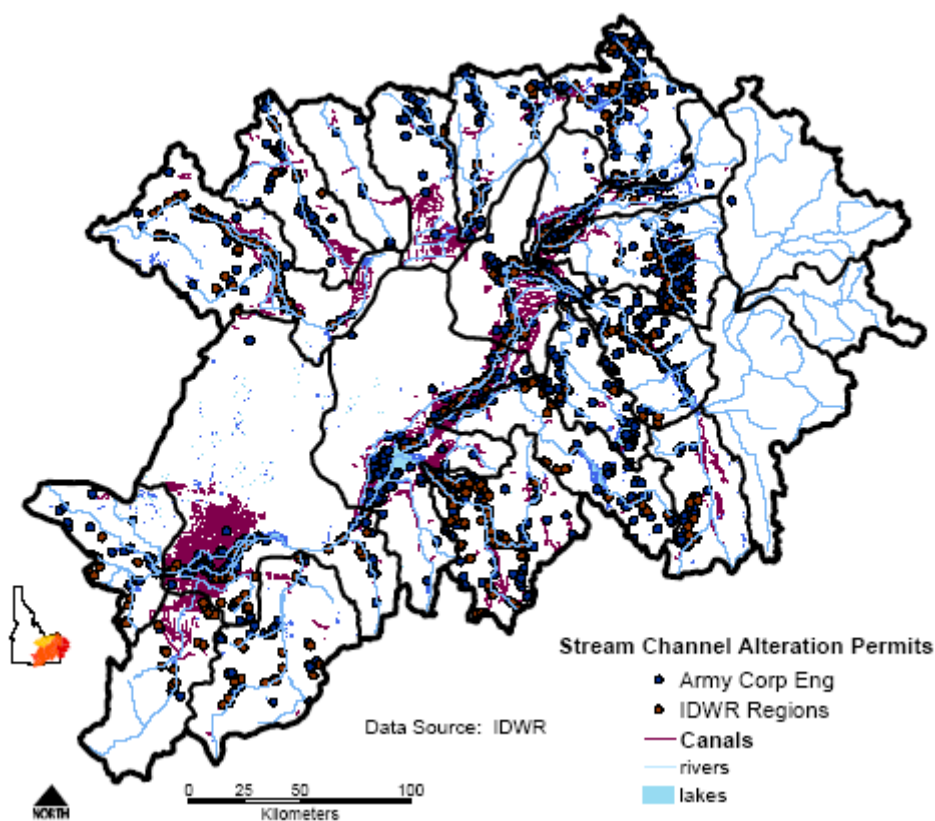


Figure 4. Channelization in the Upper Snake province (IDWR 2003).

Instream hydraulic changes can decrease or interfere with surface water contact to stream bank areas during floods or other high-water events. Channelization and channel modification activities that lead to a loss of surface water contact in stream bank areas also may result in reduced filtering of pollutants by streamside area vegetation and

soils. Areas of the stream bank that are dependent on surface water contact (i.e., riparian areas and wetlands) may change in character and function as the frequency and duration of flooding change. Drainage rates from streamside areas were 2.6 times higher in the channelized area than in undisturbed areas during preliminary project activities,

and 5.3 times higher following construction (Erickson *et al.* 1979). Schoof (1980) reported several other impacts of channelization, including drainage of wetlands; reduction of oxbows and stream meander; clearing of floodplain hardwood; lowering of groundwater levels; and increased erosion (USEPA 1993).

Channelization and channel-modification projects can also lead to an increased quantity of pollutants and accelerate the rate of delivery of these pollutants to downstream sites. Alterations that increase the velocity of surface water or flushing of the streambed leads to pollutant transport downstream at possibly faster rates. Urbanization has been linked to downstream channelization problems (Anderson 1992).

1.3 Sediment Impaired Waterways

One of the more significant changes in instream habitat associated with

channelization and channel modification is in sediment supply and delivery. These changes in sediment supply can include shifts in erosion and deposition areas and increased sedimentation in some areas (Hynson *et al.* 1985, Merigliano 1996). Excessive volumes of sediments entering water bodies can diminish water clarity, alter habitats, impair fish spawning success, and increase treatment costs for drinking water. Timber harvest, mining, agriculture, and construction may cause excessive sedimentation. The removal of vegetation and manipulation of soils by these activities allows wind or water to carry loosened sediments to nearby water bodies. Increases in impervious surfaces decrease infiltration of rainwater into soils and increase surface runoff. These increases in surface runoff increase soil erosion and sediment transport to streams, rivers, and lakes (USEPA 2001).

Approximately 20% of the streams, a total of 71 waterways (2,104 km), in the Upper Snake subbasin are sediment impaired (Table 4).

Table 4. Total lengths (km) of streams impacted by sediments in the Upper Snake province (ICBEMP 1997, USEPA 1998).

Watershed	Total Stream Length (km)	Stream Length (km) Impacted by Sediments	% of Streams Affected by Sediments (by length)
Snake Headwaters Subbasin			
Greys–Hoback	Little Granite Creek	12	1
Gros Ventre	Gros Ventre River	27	5
Salt	Sage Creek	14	1
Snake Headwaters	Pacific Creek	21	2
Upper Snake Subbasin			
American Falls	American Falls Reservoir	37	15
	Bannock Creek	79	
	Bannock Creek, West Fork	6	
	McTucker Creek	4	
	Moonshine Creek	2	
	Rattlesnake Creek	3	

Watershed	Total Stream Length (km)	Stream Length (km) Impacted by Sediments	% of Streams Affected by Sediments (by length)
Blackfoot	Angus Creek Bacon Creek Blackfoot River Corral Creek Diamond Creek Dry Valley Creek Kendall Creek Lanes Creek Rawlins Creek Sheep Creek Slug Creek Timothy Creek Trail Creek Wolverine Creek	12 10 140 25 29 16 5 27 14 13 33 10 11 17	37
Goose	Goose Creek Trapper Creek	53 27	7
Idaho Falls	Snake River Willow Creek	174 123	61
Lake Walcott	Rock Creek, East Fork Raft River Rock Creek Rock Creek, South Fork	18 106 20 47	22
Portneuf	Bell Marsh Creek Dempsey Creek Garden Creek Gibson Jack Creek Goodenough Creek Hawkins Creek Marsh Creek Mink Creek Pebble Creek Pocatello Creek Portneuf River Rapid Creek Toponce Creek Twentyfourmile Creek Walker Creek	10 20 27 11 11 22 85 17 15 8 153 18 13 21 10	30
Raft	Cassia Creek Sublett Creek	37 11	4
Teton	Darby Creek Fox Creek Packsaddle Creek South Leigh Creek Spring Creek Teton River Teton River, South Fork	5 7 16 17 44 63 32	16

Watershed	Total Stream Length (km)	Stream Length (km) Impacted by Sediments	% of Streams Affected by Sediments (by length)
Upper Henrys	Henrys Fork	24	3
Upper Snake–Rock	Dry Creek, West Fork	10	3
Willow	Brockman Creek Corral Creek Cranes Creek Grays Lake Outlet Hancock Creek Hell Creek Homer Creek Lava Creek Long Valley Creek Meadow Creek Mill Creek Sellars Creek Seventy Creek Tex Creek	20 7 22 63 8 22 28 11 10 69 10 13 5 18	50
Closed Basin Subbasin			
Birch	Birch Creek	90	12
Beaver–Camas	Beaver Creek Camas Creek	50 79	14
Big Lost	Antelope Creek Big Lost River Big Lost River, East Fork Cherry Creek Cherry Creek, Middle Fork Muldoon Canyon Star Hope Creek Twin Bridges Creek Wild Horse Creek	71 53 21 41 6 15 25 14 21	12
Little Lost	Badger Creek Deer Creek Dry Creek Little Lost River Sawmill Creek, Main Fork Sawmill Creek Wet Creek	33 8 59 4 8 27 35	19
Medicine Lodge	Edie Creek Irving Creek Medicine Lodge Creek Warm Springs Creek	12 10 42 31	16

2. Land-Use Conversion/ Development/ Fragmentation

The Columbia River basin ecosystem escaped significant human land-use impact until the nineteenth century when settlers and their livestock began to move into the region during the late 1800s.

A major population boom occurred after World War II and has continued since, particularly in metropolitan areas. These urban populations have tapped the water and energy resources of the region and contributed to heavy recreational use, particularly at popular destinations. With more and more people claiming their share of the region's water, energy, and recreational resources, conflicts between mutually exclusive uses such as eco-tourism, recreational off-road vehicles, and ranching are becoming widespread and chronic (Reisner 1993, Ringholz 1996, Talbot and Wilde 1989).

The population of the Columbia River basin has increased sixfold since the beginning of the twentieth century and has more than doubled since the mid-1960s. This growth rate is two-and-a-half times greater than the nation's rate of 39% for that same period.

Population growth in some areas of the Columbia River basin is now outpacing growth in the western United States as a whole, as people flee the urbanization of the Pacific Coast to the intermountain west (USFS 1996).

Idaho is the fastest growing area in the Columbia River basin, with a population growth rate of 28.5%, followed by Washington and Oregon with population growth rates of 21.1 % and 20.4%, respectively (CensusScope 2003). Teton County in eastern Idaho saw its population rise from 3,439 people in 1990 to 6,000 people in 2000, an increase of 74% in just ten years (CensusScope 2003).

Recreation, tourism and quality of life issues play a significant role in population increases across the region. The population growth trend and its related development directly challenge community and environmental quality in many ways. Communities throughout the basin are struggling to deal with the impacts of this population growth to agricultural lands, water quality, forests, wildlife and habitat (Worster 1985).

In the Upper Snake province, the majority of the population resides in the Salt, Idaho Falls, American Falls, Teton, and Portneuf watersheds (Table 5 and Figure 5).

Table 5. Percentage population density classifications by watershed for the three subbasins in the Upper Snake province (ICBEMP 1997).

Snake Headwaters Subbasin Population Density Classification (population per square mile)	Major Hydrologic Unit (Watershed) ^a				
	GHB	GVT	PAL	SAL	SHW
Extremely High ($x > 300$)			<1	11	<1
Very High ($100 < x < 300$)	10	3	1	21	4
High ($60 < x < 100$)	15	23	8	55	76
Medium ($10 < x < 60$)	58	66	74	13	20
Low ($1 < x < 10$)	17	9	17		
Very Low ($x < 1$)				11	<1

^a GHB= Greys-Hoback watershed; GVT= Gros Ventre watershed; PAL=Palisades watershed; SAL=Salt watershed; SHW=Snake Headwaters watershed.

Upper Snake Subbasin Population Density Classification (population per square mile)	Major Hydrologic Unit (Watershed) ^a											
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL
Extremely High ($x > 300$)	1	<1		7	<1	7		5				
Very High ($100 < x < 300$)	17	9	14	36	16	21	15	15	<1	13	9	1
High ($60 < x < 100$)	8	19	12	19	18	19	14	19	<1	24	9	17
Medium ($10 < x < 60$)	73	70	74	37	29	52	65	57	22	63	40	53
Low ($1 < x < 10$)	<1	3	<1	2	37	<1	6	4	78	<1	42	28
Very Low ($x < 1$)	<1		<1			<1						

^a AMF=American Falls watershed; BFT=Blackfoot watershed; GSE=Goose watershed; IFA= Idaho Falls watershed; LHF=Lower Henrys Fork watershed; Portneuf watershed; RFT=Raft watershed; TET=Teton watershed; UHF=Upper Henrys Fork watershed; LWT=Lake Walcott watershed; WIL=Willow watershed.

Closed Basin Subbasin Population Density Classification (population per square mile)	Major Hydrologic Unit (watershed) ^a				
	BCM	BCK	BLR	LLR	MDL
Extremely High ($x > 300$)			<1		
Very High ($100 < x < 300$)			1		
High ($60 < x < 100$)	1	2	10	8	6
Medium ($10 < x < 60$)	19	83	67	77	84
Low ($1 < x < 10$)	79	15	21	15	10
Very Low ($x < 1$)					

^a BCM=Beaver-Camas watershed; BCK=Birch watershed; Big Lost River watershed; Little Lost River watershed; Medicine Lodge watershed.

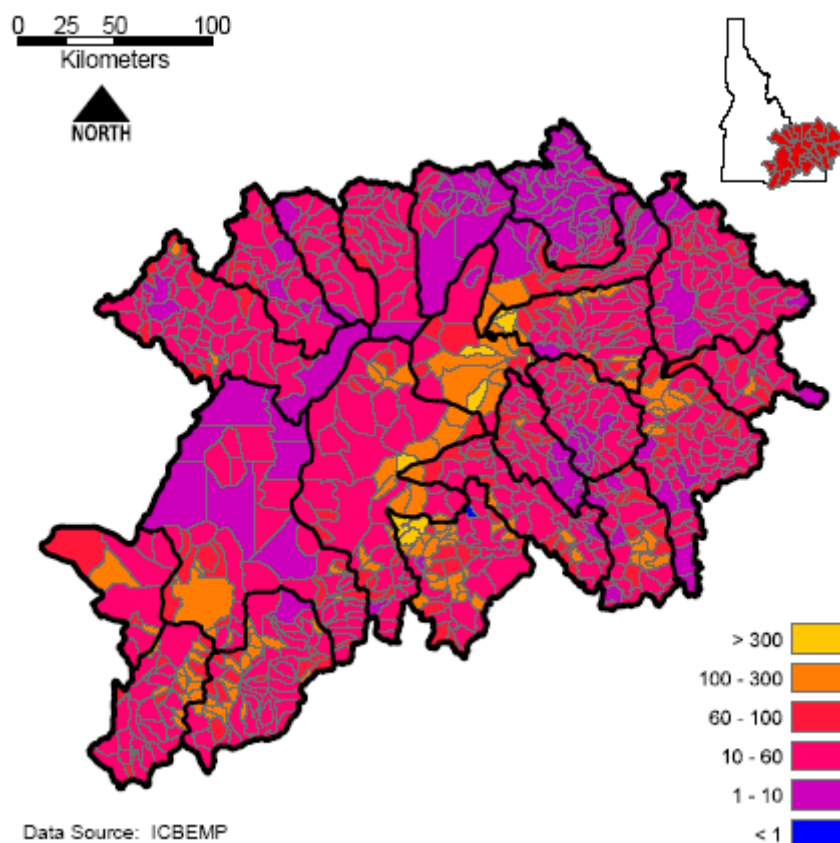


Figure 5. Relative population densities in the Upper Snake province (ICBEMP 1997).

2.1 Development

Land conversion on the urban fringe, also called “sprawl”, is an important issue to address because it has a number of impacts on the natural environment and human activity (Figure 6). Farm and ranch lands, forests, and other open space are transformed into subdivisions, ranchettes, shopping areas with expansive parking lots, and roads. This carves

away at wildlife habitat and frequently diminishes wetland/riparian areas. The Natural Resources Conservation Service estimates that 6,461,210 hectares (15,965,998 acres) were converted in the western states between 1992 and 1997. They further estimate that 2,234,658 hectares (5,521,960 acres) of conversion, or about one-third, occurred in non-metropolitan areas (NRCS 2001).

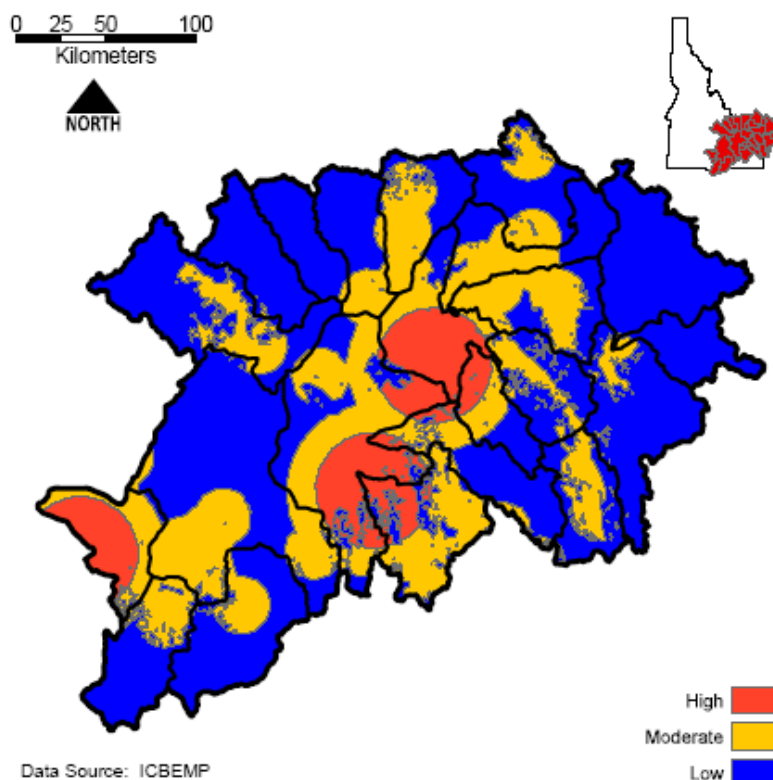


Figure 6. Areas of urban sprawl in the Upper Snake province (based on data collected in 1994 and adjusted by road density [ICBEMP 1997]).

Urban lands grew in Idaho from an estimated 222,658 hectares (550,200 acres) in 1982 to 305,497 hectares (754,900 acres) in 1997. This growth affected primarily natural resource lands (cropland, pastureland, rangeland and forestland) and is a 37% increase in urban lands. From 1982 to 1997, conversions of resource lands to urban lands were estimated at 38,161 hectares (94,298 acres) of cropland; 16,551 hectares (40,898 acres) of pastureland; 9,388 hectares (23,198 acres) of rangeland; and 15,620 hectares (38,598 acres) of forestland. This is an estimated total of 79,720 hectares (196,992 acres) removed from the rural land base for urban uses. The rate of conversion increased from an estimated 4,552 hectares (11,248 acres) per year between 1982 and 1992 to

6,701 hectares per year from 1992 to 1997. This is an increase of 47.2%. The rate of increase was highest on rangeland, followed by pastureland, cropland, and then forestland (Table 6).

Utility Corridors—Human desire to develop relatively secluded areas is generally immediately followed by the introduction of utility corridors for energy supply. These corridors physically fragment ecosystems and habitats by directly removing native vegetation. Additionally, corridors serve as a vector for invasive species, and enhance the potential for human activities. Figure 7 illustrates present and proposed utility corridors in the Upper Snake Province.

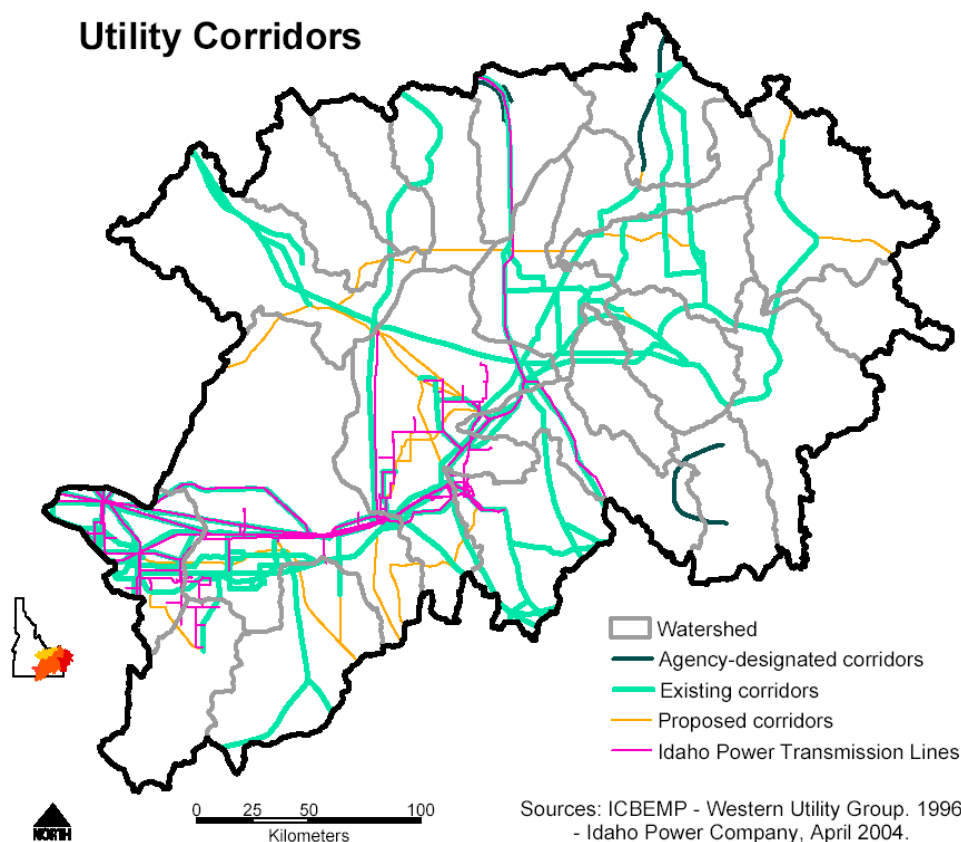


Figure 7. Established and proposed utility corridors in the Upper Snake Province (ICBEMP: Western Utility Group, 1995; Idaho Power Company, 2004).

Table 6. Estimated conversion rates of natural resource lands to urban lands in Idaho, 1982 to 1992 vs. 1992 to 1997, in hectares per year (NRCS 2001).

Natural Resource Land Type	1982-1992	1992-1997	% Change
Cropland	2,278	2,930	+28.6
Pastureland	1,019	1,513	+48.4
Rangeland	360	1,109	+207.9
Forestland	894	1,149	+28.5
Total	4,552	6,701	+47.2

Habitat fragments when new developments (sprawl) divide undisturbed habitats. The resulting fragmentation is particularly harmful to wide ranging species that rely on large territories to draw food and cover. Without adequate continuous habitat, a population of large, wide-ranging animals will eventually

disappear from an area, with harmful ripple effects felt throughout the ecosystem (NRCS 2001). Sprawl inevitably translates into more roads, which in turn open up previously undisturbed habitat and open space to additional development.

2.2 Fragmentation

Habitat fragmentation involves the division of large, contiguous areas of habitat into smaller patches have isolated from one another (Figure 8, Table 7). Some habitats (lakes, riparian zones, archipelagos) are naturally fragmented. Some habitat fragmentation results from natural processes such as fires, floods, and insect outbreaks. Habitat fragmentation is an increasingly important issue in conservation biology during as human activities shape the environment and landscape (Weclaw 1998). A key hypothesis is that a reduction in the area of a habitat patch can decrease its suitability for animals to a disproportionately greater degree than the actual reduction in area (Johnson 2001). It is obvious that the numbers of a species are likely to decline if its habitat is reduced; fragmentation effects imply that the value of the remaining habitat also is diminished (Johnson 2001).

Three types of fragmentation effects have been distinguished: patch-size, edge, and isolation (Faaborg *et al.* 1993, Johnson and Winter 1999). Patch-size effects are those that result from differential use or reproductive success associated with habitat patches of different sizes (Johnson 2001). Some patch-

size effects may be induced by edge effects, including avoidance, reduced pairing success, predation, interspecific competition, prey availability, and parasitism that may differ near the edge of a habitat from in the interior of a patch (Faaborg *et al.* 1993). Finally, isolation from similar habitat can influence use of a particular habitat patch because of reduced dispersal opportunities. Each of these factors—patch size, edge effects, and isolation—affects the occurrence, density, or reproductive success of animals in a habitat patch.

Habitat fragmentation results in both biotic and abiotic changes to the landscape. Fragmentation affects predator-prey relationships, species composition, dispersal, density, distribution, and population genetics, as well as microclimate variables such as sunlight penetration and temperature (Whitcomb *et al.* 1981, Johnson and Temple 1990, Knopf 1994, Paton 1994, Donovan *et al.* 1995, Greenwood *et al.* 1995, Robinson *et al.* 1995, Weclaw 1998, Winter *et al.* 2000). Although there is insufficient evidence to suggest that habitat fragmentation is entirely undesirable (Schmiegelow *et al.* 1997) it often results in habitat loss that in turn has contributed to extinction of species (Turner 1996).

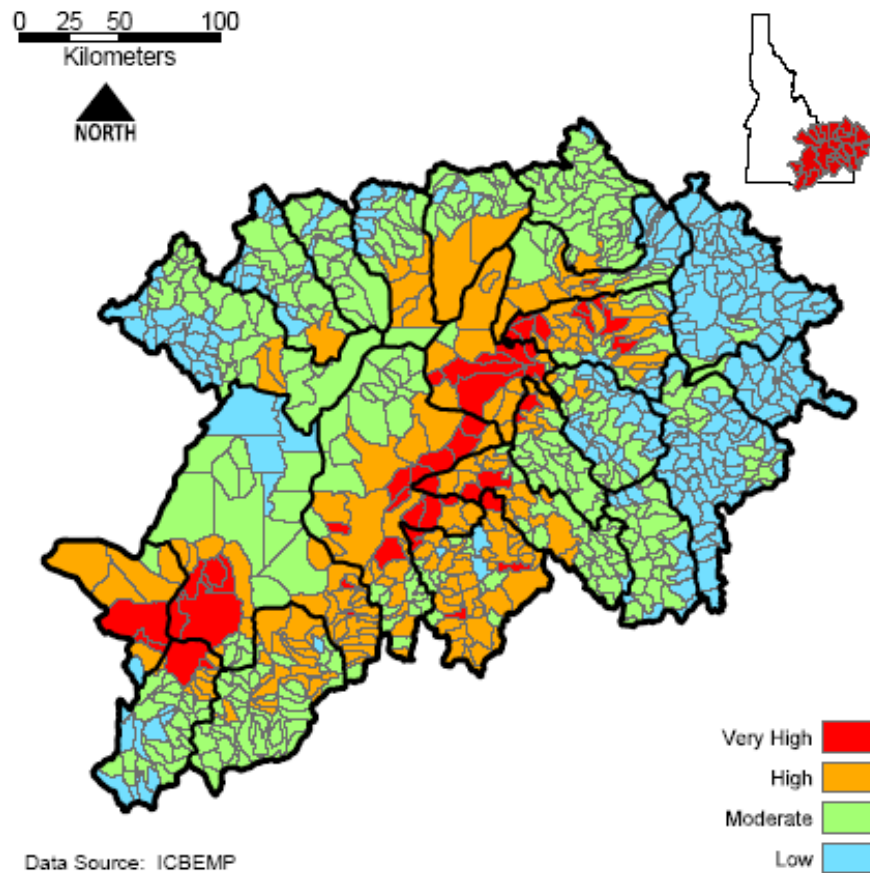


Figure 8. Estimated habitat fragmentation in the Upper Snake province (ICBEMP 1997).

Table 7. Relative percentages of habitat fragmentation by watershed in the Upper Snake province (Source: ICBEMP 1997).

Snake Headwaters Subbasin Relative Category	Major Hydrologic Unit (Watershed) ^a				
	GHB	GVT	PAL	SAL	SHW
Very high			<1		
High	<1		6		<1
Medium	22	7	41	72	5
Low	78	93	53	28	95

^a GHB= Greys-Hoback watershed; GVT= Gros Ventre watershed; PAL=Palisades watershed; SAL=Salt watershed; SHW=Snake Headwaters watershed.

Upper Snake Subbasin Relative Category	Major Hydrologic Unit (watershed) ^a											
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL
Very high	16	12	13	36	<1%	9		21		26	14	6
High	45	39	10	60	35	72	36	45	5	65	22	17
Medium	39	48	49	4	37	13	63	23	91	5	48	77

Low	<1%	2	28		28	6	1	11	4	4	16	<1%
^a AMF=American Falls watershed; BFT=Blackfoot watershed; GSE=Goose watershed; IFA= Idaho Falls watershed; LHF=Lower Henrys Fork watershed; Portneuf watershed; RFT=Raft watershed; TET=Teton watershed; UHF=Upper Henrys Fork watershed; LWT=Lake Walcott watershed; WIL=Willow watershed.												

Closed Basin Subbasin Relative Category	Major Hydrologic Unit (watershed) ^a				
	BCM	BCK	BLR	LLR	MDL
Very high					
High	50	<1	7	13	34
Medium	46	88	63	56	46
Low	4	12	30	31	20
^a BCM=Beaver-Camas watershed; BCK=Birch watershed; Big Lost River watershed; Little Lost River watershed; Medicine Lodge watershed.					

2.3 Impacts to Winter Range

Land development in big game winter range (i.e., shrub-steppe, native grasslands, and juniper/mountain mahogany habitat types) is a significant wildlife habitat issue, particularly for focal species such as mule deer and Rocky Mountain elk. Subdivision development in winter ranges constitutes a permanent loss of habitat and a permanent reduction in the carrying capacity of the land for big game. The loss of a habitat component already in short supply results in fewer deer and elk for hunters (Trent 2000).

Winter range provides two needs: shelter and food. Although food resources are important, they are not the single reason for winter range selection. Of equal, or more importance is the microclimate of the winter range and how it enhances the ability of animals to minimize their energy loss during a time of food shortage (Trent 2000).

Slope, elevation, aspect, and vegetative cover combine to make some places warmer, more

secure, and less snowy. Animals wintering in these areas do not deplete their fat reserves as quickly and are therefore more likely to survive the winter. When winter ranges are lost to subdivisions, this important “place” is lost and cannot be replaced or mitigated by enhancing vegetation in an adjacent area (Trent 2000).

2.4 Roads and Trails

Roads and trails have profound impacts on forest ecosystems. These include direct and indirect effects on individual plant and animal species, as well as broadscale changes in ecosystem structure and function. Askins (1994), Benninger-Truax *et al.* (1992), Ercelawn (1999), Lonsdale (1999), Neumann and Merriam (1972), and Saunders *et al.* (1991) summarize the following impacts of roads and trails:

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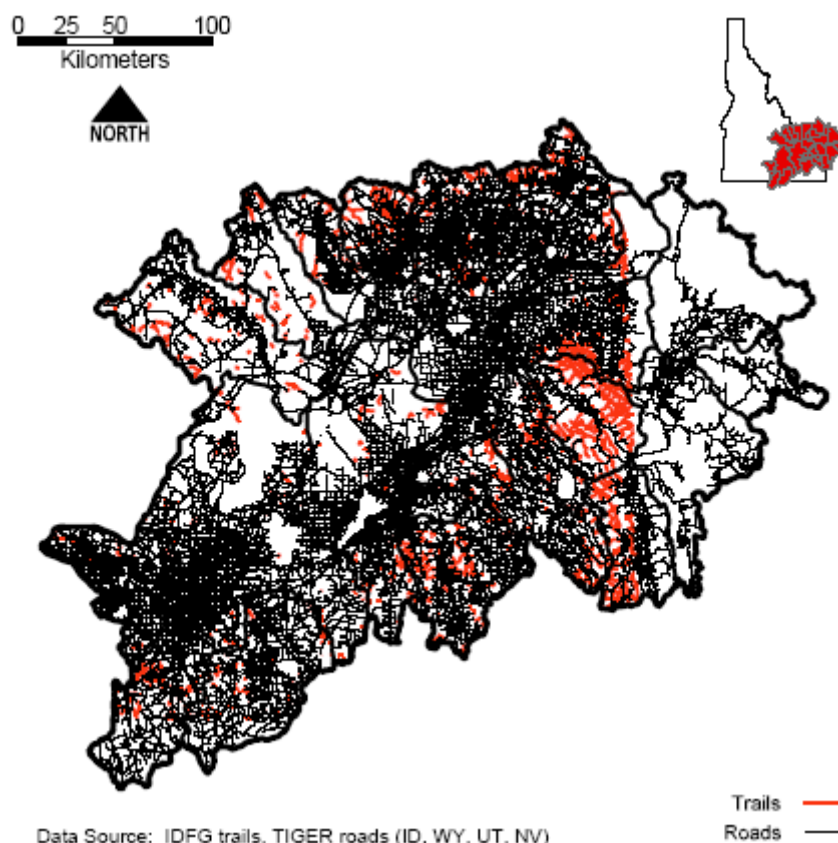


Figure 9. Distribution of roads and trails within the Upper Snake province (IDFG Trails, TIGER Roads [ID, WY, UT, NV] 2000).

- Create barriers to dispersal
- Create a significant source of direct mortality due to collisions
- Cause displacement of sensitive wildlife species
- Cause habitat loss
- Cause loss of ecological complexity
- Reduce reproductive success
- Act as a vector of disease, pest infestations, and/or invasive exotic plants and animals
- Cause degradation of ecosystem function
- Cause degradation of soil resources and water hydrology due to road-building, use, and maintenance activities
- Increase sediment and altered streamflows
- Increased disturbance and harvest of big game animals (both legally and illegally)

Recreational road and trail use is typically defined in terms of hiking, biking, horseback riding, ATVs, snowmobiles, hunting/fishing, and skiing. Impacts typically associated with these activities include trampling; habitat disturbance or modification due to noise, erosion, and soil compaction; introduction of invasive exotics; nutrient loading from animal and human waste; pollution from food waste, litter, and air quality; and increased access to the resource, and subsequent human conflict between competing resource user groups.

Trampling—The effects of trampling are usually limited to one meter from the trail's edge (Dale and Weaver 1974). Some plant species decrease near trails, especially woody plants since they are brittle (Tonnesen and

Ebersole 1997). Grasses and sedges are most tolerant of trampling (Dale and Weaver 1974). Trampling causes compaction of leaf litter and soil, and compaction by horses is greater than by hikers (Whittaker 1978). Trail width increases linearly with logarithmic increase in number of users (width doubles with 10-fold increase in use). Meadow trails are a little wider than forest trails, and trails with both horse and foot traffic are similar in width or slightly narrower than those receiving foot traffic alone. Additionally, trails used by horses and people are deeper than those used by people alone (Dale and Weaver 1974).

Disturbance—Based on an extensive review of the effects of noise and motion from recreationists on birds, Bennett and Zuelke (1999) concluded that disturbance from recreation clearly has at least temporary effects on behavior and movement of birds. Boyle and Samson (1985) documented that direct approaches caused greater disturbance than tangential approaches; rapid movement by joggers was more disturbing than slower hikers; children and photographers were especially disturbing to birds; horses did not seem to disturb birds; and passing or stopping vehicles were less disturbing than people on foot. Wildlife disturbance caused by off-road vehicle use is well documented (Olliff *et al.* 1999). With increasing performance capabilities of snowmobiles, year-round impacts become more pronounced because there are very few areas these newer machines cannot access (Olliff *et al.* 1999).

Nonnative Vegetation—Benninger-Truax *et al.* (1992) documented the introduction of exotics along trails by horses and people—notably where horse manure contained viable seeds of at least eight exotic species. Trail edges have been found to have significantly less native plant cover, and more exotic plant species (Benninger-Truax *et al.* 1992). ATVs have been documented to be a significant

factor in the spread of exotic weeds across the landscape (Griggs and Walsh 1981, Trunkle and Fay 1991, Ahlstrand and Racine 1993, Sheley *et al.* 2002).

Nutrient Enrichment—Nutrient enrichment from horse manure and urine likely favors invasion of weedy species along horse trails. Research has shown that experimentally fertilized grasslands undergo a dramatic species change resulting in increased abundance of nonnative grasses, decline of native grasses, and decreased diversity (Wedin and Tilman 1996).

Pollution—Air and water pollution from off-road vehicles can be severe. By design, off-road vehicles expel 20% to 30% of their oil and gasoline unburned into the air and water (Harrison 1976). ATV and snowmobile motors produce 118 times as many pollutants as automobiles on a per-mile basis (California Air Resources Board 1998). Pollution in the form of litter and waste becomes more marked as participation in off-road vehicles activities increases.

Roads and trails are found throughout the Upper Snake province (Figure 9). Every major watershed within the province has been accessed and impacted by roads. Although very few roads occur in the wilderness and protected areas (see Figure 1-16 in the assessment), access can still be gained through extensive trail systems (Figure 9).

3. Altered Fire Regime

Wildfires were once common occurrences throughout the grasslands and forests of the Columbia River basin. Frequent fires maintained an open forest structure in the region's middle-elevation forests, prevented tree encroachment into mountain meadows and grasslands, and in some areas replaced forested land with grassland (CPLUHNA 2003).

Prior to white settlement, fires likely burned through the region's extensive juniper woodlands every 10 to 30 years, the region's ponderosa pine communities every 1 to 47 years, Rocky Mountain lodgepole pine (*Pinus contorta*) every 25 to 300+ years, Rocky Mountain Douglas-fir (*Pseudotsuga menziesii*) every 25 to 100 years, quaking aspen every 7 to 100 years, and mixed conifer forests every 5 to 25 years. The much wetter and cooler spruce-fir forests atop the highest mountains and plateaus of the region probably went 150 years or more between fires (Fire Sciences Laboratory 2003), but these fires were generally stand-replacing events. Figure 10 illustrates the historical fire regime in the Upper Snake province.

The historical fire regimes changed dramatically with the arrival and settlement of Euro-Americans. Livestock grazing removed much of the grassy fuels that carried frequent surface fires or encouraged annual grasses, roads and trails broke up the continuity of forest fuels and further contributed to reductions in fire frequency and size. Also, the introduced exotic, cheatgrass (*Bromus tectorum*), resulted in unnatural shortened fire-return intervals. Because settlers saw fire as a threat, they actively suppressed it whenever they could. Fire suppression has been one of the great success stories of land management organizations. Over the last 100 years or so, public firefighting agencies such

as the U.S. Forest Service, Bureau of Land Management, Bureau of Indian Affairs, and National Park Service have developed an impressive array of firefighting technologies that have remarkably reduced acreage burned by wildfires (Pyne 1982).

Initially, fire suppression was very successful because of low fuel loadings, but without fires to consume them, large fuel loads have accumulated over time (CPLUHNA 2003). Because of heavy fuel accumulations, fires occurring now are more intense and difficult to contain. In recent years (see Figure 11), fires that burned tens and hundreds of thousands of acres have occurred in California, Idaho, Montana, Oregon, Washington, and Wyoming (Martin and Sapsis 1992, Agee 1993, Covington *et al.* 1994, Johnson *et al.* 1994). While most ecosystems occasionally experience very large fires (Romme and Despain 1989), the present-day frequency of large fires is increasing. Figure 12 shows current fire severity in the Upper Snake province, while Figure 13 depicts areas in the province that are most likely to experience severe burns. Table 8 compares the relative percentages of risk by altered fire regimes by watershed in the Upper Snake province. In addition, Figure 14 illustrates fire regime condition class, which is an approximation of ecosystem departure resulting from a change in fire regimes.

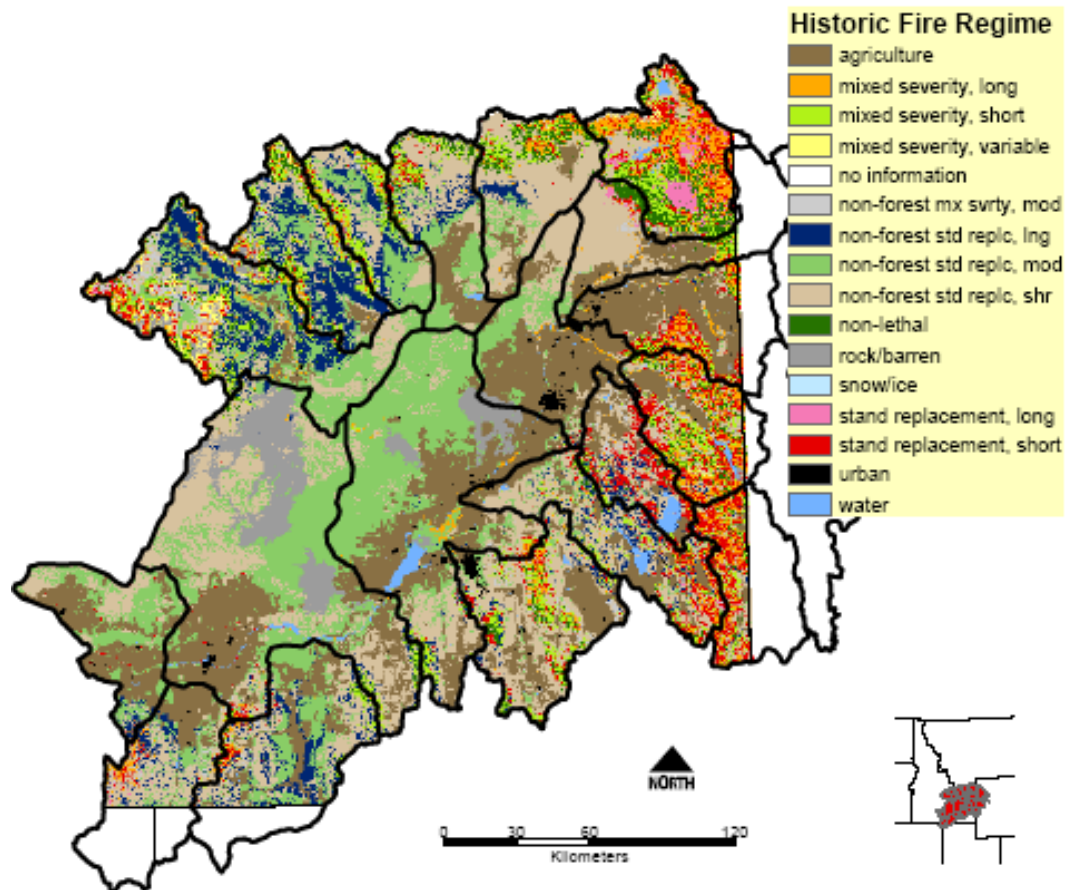


Figure 10. Historic fire regime in the Upper Snake province (Northern Regional National Fire Plan Cohesive Strategy Assessment Team, Flathead National Forest 2003).

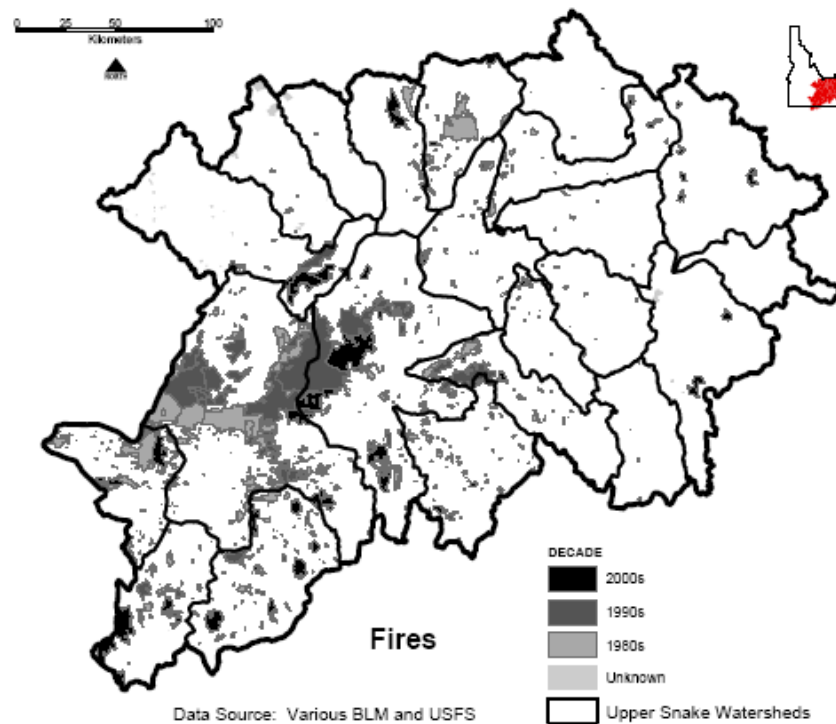


Figure 11. Locations of large (greater than 5-hectare) fires in the Upper Snake province between 1980 and 2000.

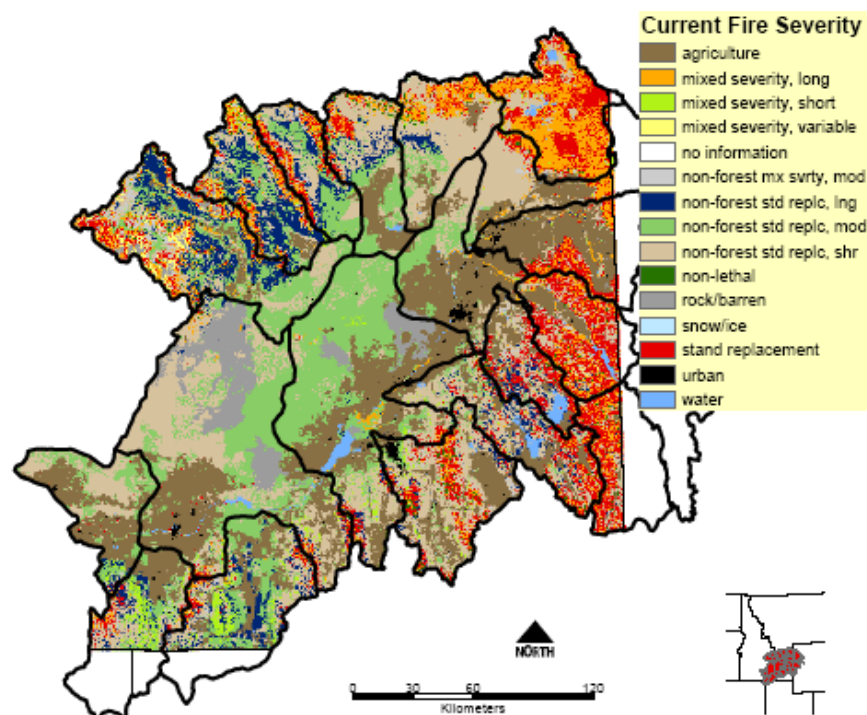


Figure 12. Current fire severity in the Upper Snake province by watershed (Northern Regional National Fire Plan Cohesive Strategy Assessment Team, Flathead National Forest[2003]).

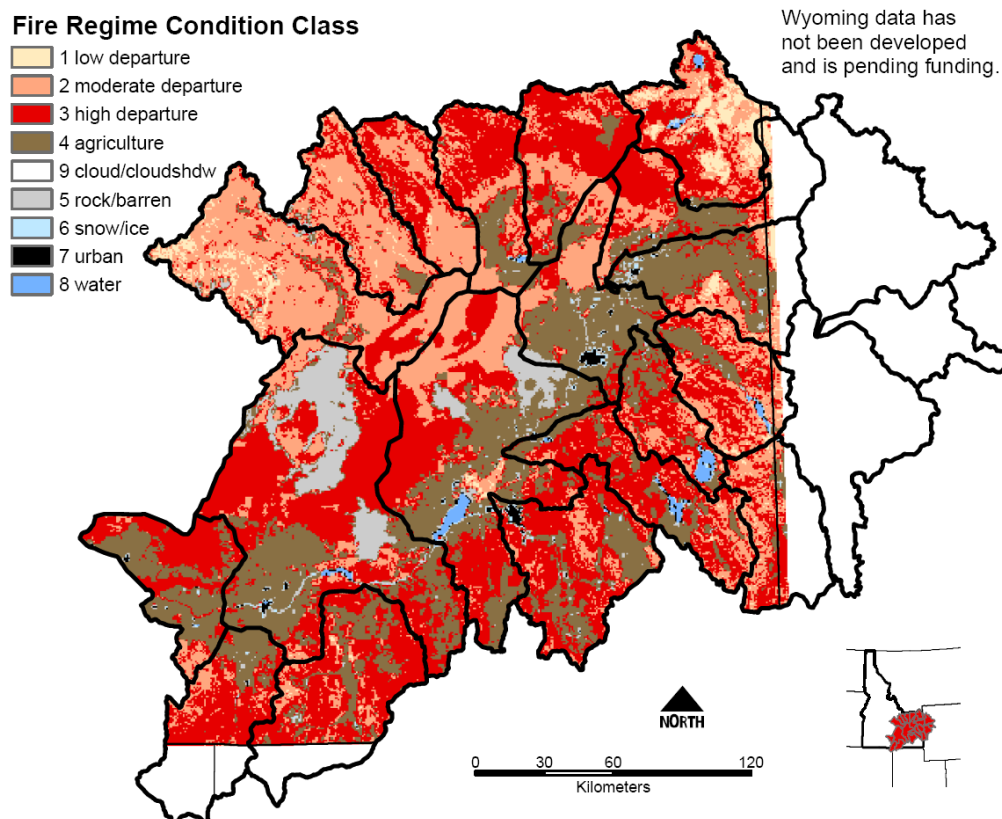


Figure 13. Probability of severe ecological fire effects in the BPW subbasins, Idaho. Fire regime condition class (FRCC) is an approximation of ecosystem departure resulting from a change in fire regimes. (Northern Regional National Fire Plan Cohesive Strategy Assessment Team, Flathead National Forest [2003]).

Table 8. Relative percentages of risk by altered fire regimes by watershed in the Upper Snake province (Northern Regional National Fire Plan Cohesive Strategy Assessment Team, Flathead National Forest). Note that data was only available for the state of Idaho, so areas are standardized to the applicable area. Other areas (agriculture, rock/barren, snow/ice, urban, water, clouds, and cloud shadow) are not included in the analyses.

Snake Headwaters Subbasin Relative Category	Major Hydrologic Unit (Watershed) ^a				
	GHB	GVT	PAL	SAL	SHW
% of watershed analyzed	?	?	94	53	?
Low risk	?	?	22	22	?
Moderate risk	?	?	31	34	?
High risk	?	?	33	36	?
No risk	?	?	22	8	?
Other	?	?	15	8	?

^a GHB= Greys-Hoback watershed; GVT= Gros Ventre watershed; PAL=Palisades watershed; SAL=Salt watershed; SHW=Snake Headwaters watershed.

Upper Snake Subbasin Relative Category	Major Hydrologic Unit (watershed) ^a											
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL
% of watershed analyzed	100	100	61	100	71	100	81	78	99	100	100	100
Low risk	2	8	7		9	5	6	15	45	1	1	5
Moderate risk	25	31	25	29	25	20	25	13	17	14	19	33
High risk	31	39	44	10	36	47	47	11	33	40	40	34
No risk	42	22	44	61	40	28	22	61	5	45	40	28
Other	41	22	23	61	30	28	23	61	5	45	40	28
^a AMF=American Falls watershed; BFT=Blackfoot watershed; GSE=Goose watershed; IFA= Idaho Falls watershed; LHF=Lower Henrys Fork watershed; Portneuf watershed; RFT=Raft watershed; TET=Teton watershed; UHF=Upper Henrys Fork watershed; LWT=Lake Walcott watershed; WIL=Willow watershed.												

Closed Basin Subbasin Relative Category	Major Hydrologic Unit (watershed) ^a				
	BCM	BCK	BLR	LLR	MDL
% of watershed analyzed	100	100	100	100	100
Low risk	6	11	19	15	5
Moderate risk	32	57	61	60	37
High risk	52	28	11	16	36
No risk	10	4	9	9	22
Other	11	3	9	9	22
^a BCM=Beaver-Camas watershed; BCK=Birch watershed; Big Lost River watershed; Little Lost River watershed; Medicine Lodge watershed.					

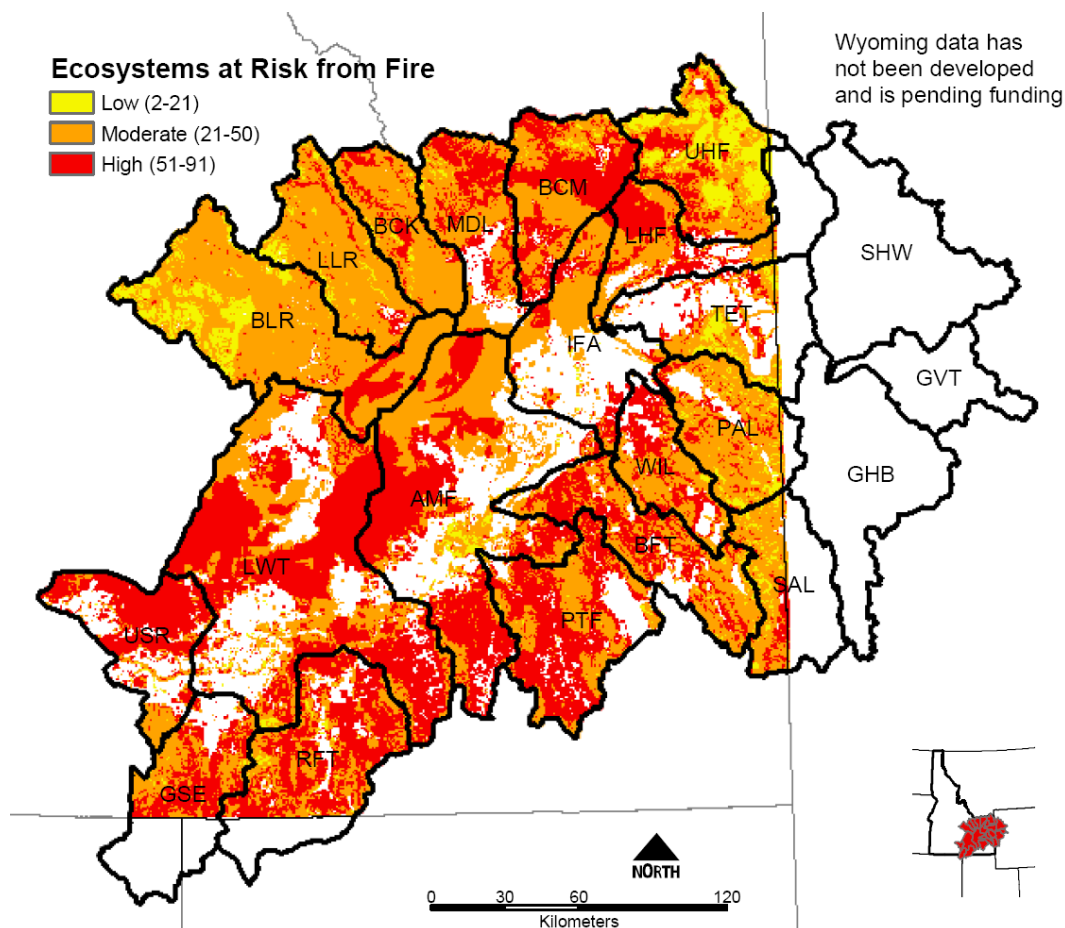


Figure 14. Predicted areas within the Upper Snake province most likely to have severe burns, taking into account FRCC, ignition probability and fire weather hazard (Northern Regional National Fire Plan Cohesive Strategy Assessment Team, Flathead National Forest).

Before the era of fire suppression, fires burned across the landscape at a variety of fire intensities, fire sizes, and fire return intervals based on localized climate, with fire return intervals on a cold/wet to warm/dry gradient. This created a mosaic of stand ages and a variety of vegetation conditions, from meadow and savannah to dense, old forest. Of the various frequencies and intensities of fire, it seems there are few that are entirely detrimental to all organisms. Natural landscapes are often created or maintained by burning, and the plants on these landscapes have ways of dealing with natural fire (INFMS 2003).

Each species has a unique set of characteristics that determines how it is affected by fire. Many plants have adapted to fire by evolving protective mechanisms such as thick bark. Fire may stimulate a positive response in other species, which may get bigger and produce more seeds. Even plants that are killed by fire may have coping mechanisms allowing the species to survive fire, even when individuals are burned. They may have hard seeds that survive until fire readies them to grow, or light, easily dispersed seeds that can quickly reinvade a burned area. Most employ some combination of these strategies (INFMS 2003).

The greatest effect of fire suppression on biological diversity is not on the diversity within a particular habitat (Whittaker 1977), but on the diversity of habitats across a landscape. Landscapes with high diversity resulting from fire perpetuate high species diversity by providing opportunities for the establishment and maintenance of early successional species and communities (Connell 1978, Reice 1994). Fire suppression, on the other hand, increases uniformity in habitats as competition eliminates early successional species, leaving only shade-tolerant understory plants to reproduce. Burned landscapes include habitat types dominated by early successional pines, shrubs, or herbaceous species, whereas unburned landscapes were more uniform in their cover of later successional fir-dominated communities (Stuart 2003).

Fire suppression has helped change the ecosystem dynamics of communities adapted to frequent, low-intensity wildfire. Complex landscapes are made simpler; some early and mid-successional plants and animals are extirpated; shade-tolerant tree populations rapidly expand; and the relative importance of fire as a disturbance agent is reduced, while the importance of insects and pathogens is elevated (Covington *et al.* 1994).

Sagebrush-steppe ecosystems of the Great Basin in the western United States are examples of fireprone ecosystems. Many wildlife species depend on sagebrush steppe ecosystems for survival (Knick and Van Riper III 2002). Unfortunately, a change in the natural fire regime is decreasing the extent of sagebrush ecosystems, and the populations of wildlife species that depend on sagebrush are undergoing steep declines because of habitat loss (Connelly *et al.* 2000, Pyke 2002).

Two major problems resulting from past fire suppression activities are common to the sagebrush ecosystem (Perryman 2003):

1. Longer time periods between fires (lengthened fire intervals) at higher elevations (higher precipitation zones) have allowed various junipers and/or pinyon pines and Douglas fir/lodgepole pine to encroach into mountain sagebrush-grassland communities. In the Great Basin, juniper and pinyon are relatively long-lived species (approximately 1,000 and 600 years, respectively). Depending on specific location, however, 66% to more than 90% of individual trees are less than 130 years old. Fire return intervals have increased from 12 to 25 years to over 100 years. These communities lose the perennial herbaceous understory as the canopy closes in large part because of competition from the encroaching conifers. This encroachment further leads to unmanageable fuel loads and very intense fires resulting in final loss or elimination of perennial herbaceous understory species, and loss of the original sagebrush habitat. Without a healthy herbaceous understory, these disturbed communities become susceptible to cheatgrass or other invasive species establishment, further reducing habitat quality for sagebrush obligates and other species—both wild and domestic—that utilize sagebrush habitats.
2. At mid- and lower elevations, longer fire intervals have created decadent, climax sagebrush systems that dominate very large areas on the landscape. These communities have lost the perennial herbaceous understory in large part because of competition from dense, competitive sagebrush plants. The shrub overstory in these systems is continuous and contiguous leading to fuel continuities that burn hotter and more extensively than normal. These areas have also been invaded by cheatgrass. This species is very successful because there are no perennial, herbaceous species with which

to compete. After extensive fires in these systems, cheatgrass proliferates even more because fire removes sagebrush (and other shrubs)—the only competitor in the system. As fire intervals become shorter because of the fuel loading of the annual brome, areas that a single generation ago were sagebrush grasslands could be converted to annual grasslands dominated by cheatgrass.

4. Grazing/Browsing

One of the most significant human-induced effects on the western landscape has been the widespread introduction of domestic livestock. Brought to the Southwest by the Spanish in the late 1500s, cattle and sheep only began to have a significant impact on the region's biota with their large-scale transportation into the region via the railroads in the late 1800s. By 1890, hundreds of thousands of cattle and/or sheep were grazing

on the rangelands of the west (CPLUHNA 2003).

By the time federal forest reserves were proclaimed in the 1890s, ranchers had become accustomed to unregulated use of public lands as range for livestock. As a result of these excessive stocking numbers, once rich grasslands were seriously degraded even before the end of the 1800s, after less than a human generation of use. By the early 1900s, overstocking of sheep in the region's highlands had brought forest regeneration to a halt. The fire ecology of the region's forests, particularly the once grass-rich ponderosa pine forests, was drastically altered, causing significant long-term changes to their structure and composition. By 1912, livestock pressures had penetrated the most remote, timbered, and mountainous areas. Over one hundred years later, the effects of intense grazing in the latter part of the 19th century can still be readily seen in many parts of the West (CPLUHNA 2003).

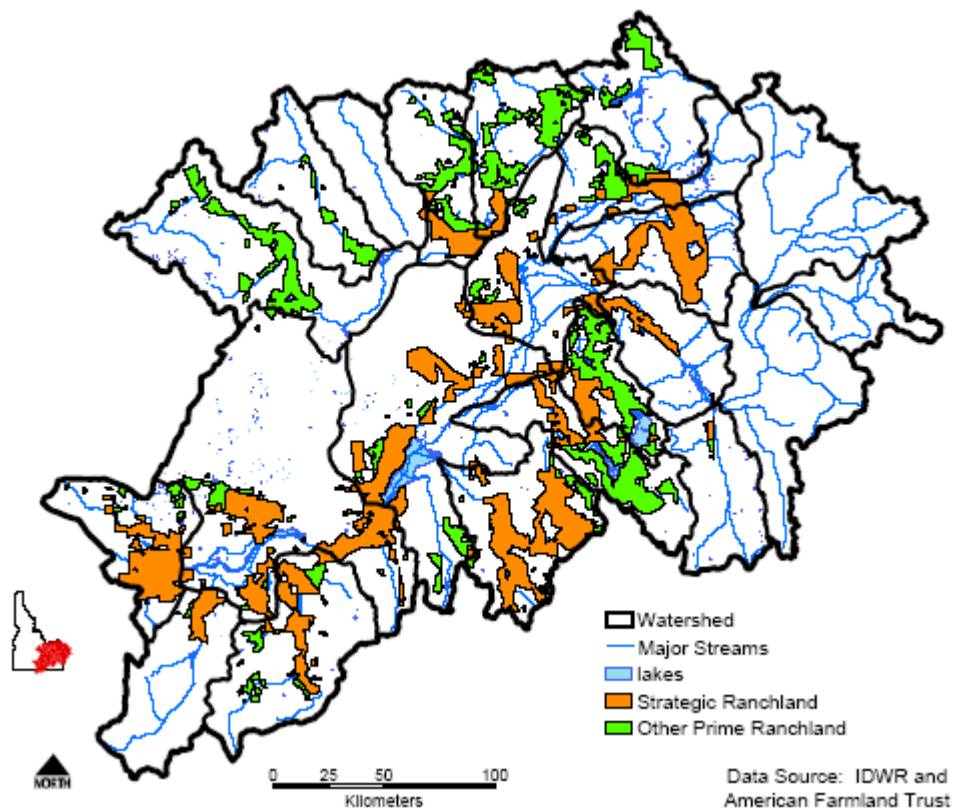


Figure 15. Land ownership and ranchland use in the Upper Snake province, Idaho (IDWR and American Farmland Trust 2003).

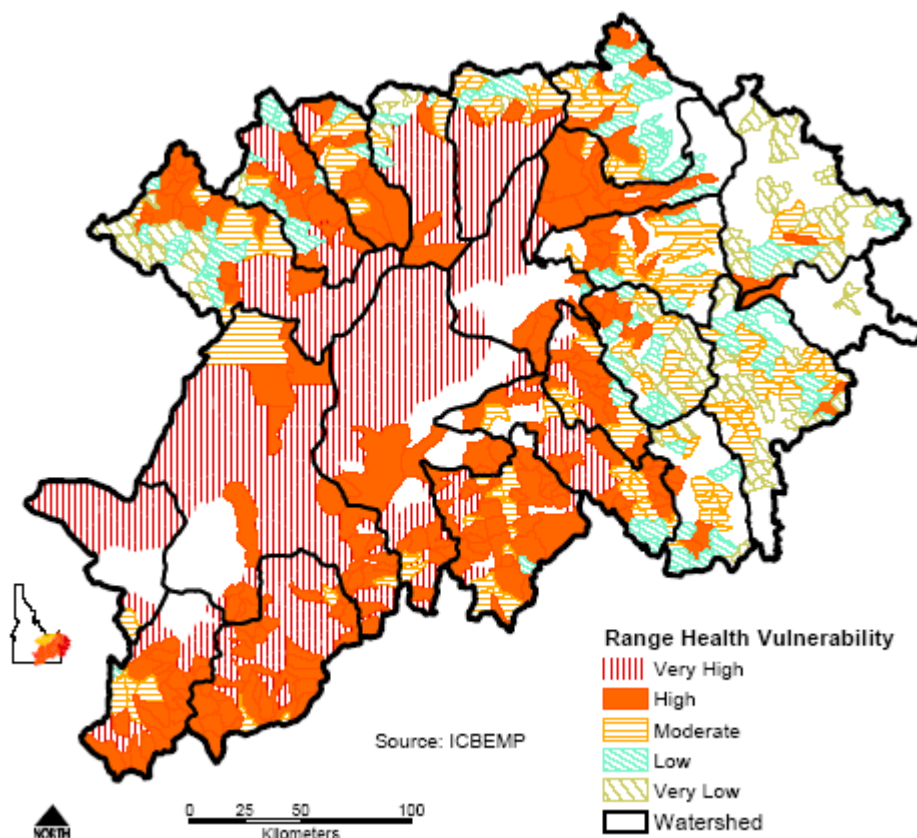


Figure 16. Rangeland condition in the Upper Snake province (ICBEMP 1997).

Livestock have played and continue to play an even more important role in changes to ecosystems in the West. Ninety-one percent of the public land in the western United States is grazed (Belsky and Blumenthal 1997) and 61% of the total area in the Upper Snake province is impacted by grazing and browsing by domestic animals (Figure 17 and Table 9). Undisturbed herbaceous ecosystems across the western United States are rare. Still, a precise determination of the ecological effects

of grazing often is difficult to obtain because ungrazed land is extremely rare; exclosures are small; exact figures on grazing intensities are scarce; and approaches to evaluate the effects of grazing are not standardized (Belsky and Blumenthal 1997, Flather *et al.* 1994, Fleischner 1994). For example, the status of grazing and browsing by domestic animals in the Upper Snake province is unknown for approximately 51% of the total area (Table 9 and Figure 17).

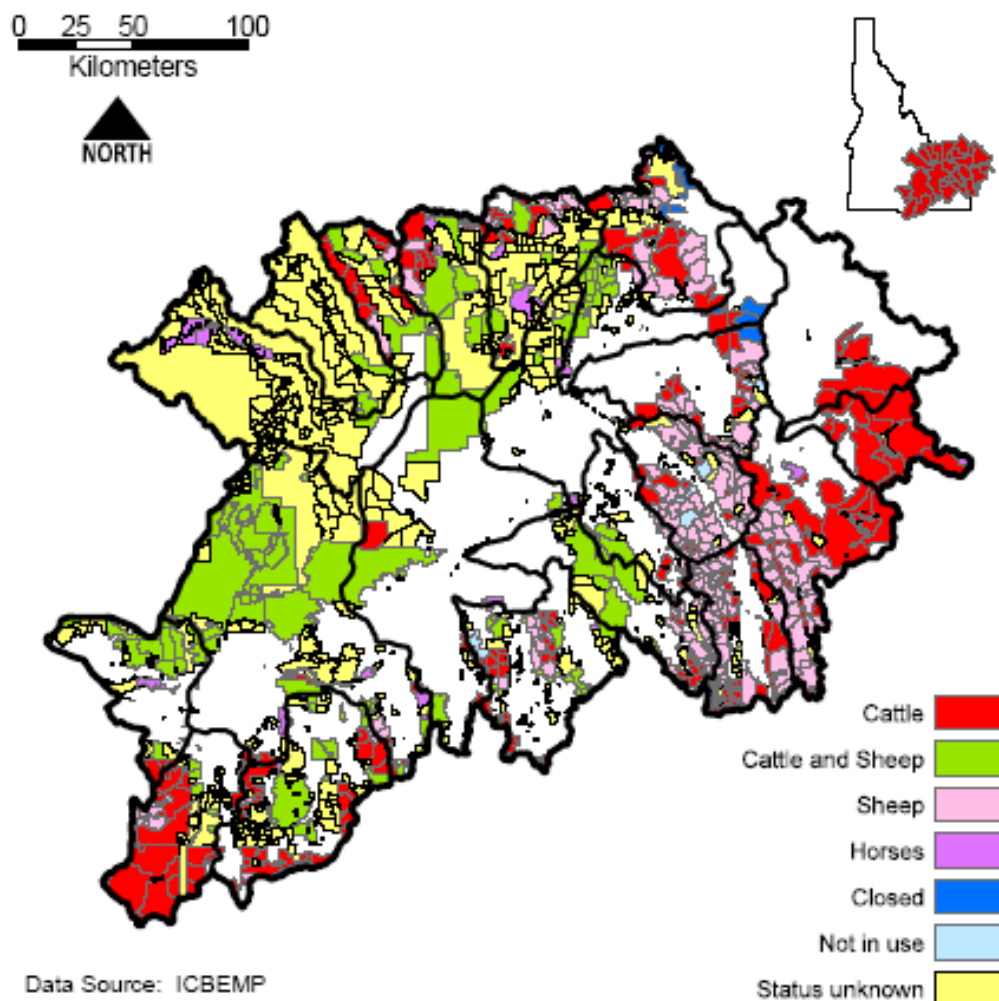


Figure 17. Occurrences of grazing and browsing activities by domestic animals in the Upper Snake province, Idaho (ICBEMP 1997).

4.1 Grazing/Browsing Activity in the Upper Snake Province

Grazing and browsing activities by domestic animals occur throughout the Upper Snake province (Table 9, Figure 17). The grazing and browsing status for many watersheds within the Upper Snake province are unknown, with exceptions being the Snake Headwaters and Gros Ventre watersheds. Comparatively, very little grazing activity (16%) occurs in the Snake Headwaters watershed, whereas, 82% of the Gros Ventre

watershed experiences grazing and browsing activities predominating by cattle.

Table 10 presents the percentage of area impacted by grazing for each of the eight focal habitats in the Upper Snake province. Grazing by cattle appears to have the greatest impacts in all the focal habitats, except for aspen habitats where sheep have a greater impact.

Table 9. Percentage of area impacted by grazing/browsing livestock by watershed in the Upper Snake province (Source: ICBEMP 1997, GAP II Scott *et al.* 2002).

Snake Headwaters Subbasin	Major Hydrologic Unit (watershed) ^a				
	GHB	GVT	PAL	SAL	SHW
Cattle	41	78	13	27	16
Cattle and sheep				<1	
Closed					<1
Horses	<1	2		<1	<1
Not in use			5		<1
Sheep	30	<1	54	40	<1
Status unknown	2	1	6	5	<1
Area ungrazed	26	18	22	28	84

^a GHB= Greys-Hoback watershed; GVT= Gros Ventre watershed; PAL=Palisades watershed; SAL=Salt watershed; SHW=Snake Headwaters watershed.

Upper Snake Subbasin	Major Hydrologic Unit (watershed) ^a											
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL
Cattle	3	5	54	<1	5	12	21	14	25	3	2	5
Cattle and sheep	16	24	4	10	14	8	15	<1	<1	26	37	12
Closed					5			3	5			
Horses	<1	<1		2	1	<1	<1	<1		2	1	
Not in use	<1					2		1				
Sheep	<1	13	5		1	6	2	17	24	<1	<1	6
Status unknown	11	15	17	23	7	13	23	5	19	17	25	9
Area ungrazed	70	43	20	65	66	59	39	59	25	52	34	67

^a AMF=American Falls watershed; BFT=Blackfoot watershed; GSE=Goose watershed; IFA= Idaho Falls watershed; LHF=Lower Henrys Fork watershed; Portneuf watershed; RFT=Raft watershed; TET=Teton watershed; UHF=Upper Henrys Fork watershed; LWT=Lake Walcott watershed; WIL=Willow watershed.

Closed Basin Subbasin	Major Hydrologic Unit (watershed) ^a				
	BCM	BCK	BLR	LLR	MDL
Cattle	11	25	<1	<1	14
Cattle and sheep	12	26	2	7	32
Closed					
Horses	5	<1	5		2
Not in use					
Sheep	8	7	<1	<1	9
Status unknown	60	32	85	92	43
Area ungrazed	4	9	8	0	0

^a BCM=Beaver-Camas watershed; BCK=Birch watershed; Big Lost River watershed; Little Lost River watershed; Medicine Lodge watershed.

Table 10. Percentage of area impacted by grazing domestic animals for each of the focal habitats in the Upper Snake province (Source: ICBEMP 1997, GAP II Scott *et al.* 2002).

Focal Habitat Type	Cattle	Cattle and Sheep	Sheep	Horses	Closed	Not in use	Status Unknown	Not Grazed
Riparian/herbaceous wetlands	19	4	8	<1	<1	<1	18	49
Open water	2	<1	<1	<1		<1	12	86
Shrub-steppe	13	24	3	2	<1	<1	36	22
Pine/fir forest	30	1	22	<1	2	<1	12	30
Juniper/mountain mahogany	26	18	<1	2		<1	30	24
Whitebark pine	14	<1	7	<1	<1	<1	65	13
Aspen	28	5	36	<1	1	1	9	20
Mountain Brush	5	25	2	<1		<1	42	25

4.2 Impacts to Riparian/Wetland Habitats

Riparian areas are critical ecosystems in the semi-arid landscape of the West, yet many have been seriously degraded and others entirely lost due to human activities and land use. The abundance of food, water, and shade, which attracts wildlife to these areas, also attracts livestock. Despite widespread recognition of the problem and attempts to remove or restrict livestock from riparian areas, riparian degradation due to overgrazing is a serious problem (Belsky *et al.* 1999).

The direct effects of livestock grazing on the wetland riparian habitats have been summarized as follows (Harper *et al.* 2003):

- Higher stream temperatures from lack of sufficient woody streamside cover
- Excessive sediment in the channel from bank and upland erosion
- High coliform bacterium counts
- Channel widening from hoof-caused bank sloughing and later erosion by water
- Change in the form of the water column and the channel in which it flows

- Change, reduction, or elimination of vegetation
- Elimination of riparian areas by channel degradation and lowering of the water table
- Gradual stream-channel trenching or braiding depending on soils and substrate composition, with concurrent replacement of riparian vegetation with more xeric plant species

Riparian systems at lower elevations are now increasingly characterized by a reduction of plant species diversity and density. Overgrazing of palatable native species such as willows and cottonwood saplings, combined with the introduction of less palatable nonindigenous species such as Russian olive (*Elaeagnus angustifolia*), has also contributed to changes in overall plant community structure. Road construction associated with grazing operations has caused additional degradation of riparian areas, especially through bank erosion. The carrying capacity of the habitat and fish survival have been reduced by land and water management activities within the province that have affected hydrology, sedimentation, habitat

distribution and complexity, and water quality (CBFWA 1999).

Livestock may directly affect fish through trampling or ingestion of adults, larvae, or eggs (Roberts and White 1992). Livestock waste is potentially poisonous to some fish (Cross 1971, Taylor *et al.* 1991), and may increase nitrogen levels, thereby affecting nutrient cycling and encouraging algae growth. High-quality freshwater habitats are critical to the long-term strength and persistence of native resident and anadromous salmonid populations in the Columbia River basin. These fish have generally fared best in areas least disturbed by humans. Grazing and browsing by domestic livestock have the potential to impact salmonid spawning and rearing success.

4.3 Impacts to Shrub-Steppe

Livestock may graze plants that are listed, forage for listed species, or provide cover or protection for listed species. Grazing can also affect the vegetative community and ecosystem functioning (Shreve 1931, Niering *et al.* 1963, Abouholder 1992, USFWS 1999).

Livestock grazing alters the species composition of communities, disrupts ecosystem functioning, and alters ecosystem structure (Fleischner 1994). The main direct impacts from cattle are the grazing of plants and trampling of vegetation and soil (Marlow and Pogacnik 1985). Grazing can alter the prey availability of certain predators by removing herbaceous vegetation, which serves as food, and cover for small mammals (Ward and Block 1995). Grazing can also alter fire regimes, a circumstance that is generally deleterious to ecosystem functioning (USFWS 1999).

A reduction in vegetation cover increases raindrop impact, decreases soil organic matter and soil aggregates, and decreases infiltration

rates (Blackburn 1984, Orodho *et al.* 1990). Other detrimental impacts include increased overland flow, reduced soil water content, and increased erosion (DeBano and Schmidt 1989, Guthery *et al.* 1990, Orodho *et al.* 1990). Continuous yearlong grazing can result in large bare areas around water sources and established trails to and from points of livestock concentrations (Platts 1990).

Watershed condition and function can be affected by impacts to vegetation and litter from livestock grazing (Gifford and Hawkins 1978, Busby and Gifford 1981, Blackburn 1984, DeBano and Schmidt 1989, Belnap 1992, Belsky and Blumenthal 1997). Heavy grazing effects are well known and can be severe (Guthery *et al.* 1990, Platts 1990).

4.4 Impacts to Forests

Over the last 100 years, the structure, composition, and dynamics of western, semiarid, interior forests have changed dramatically. These forests, dominated at low elevations by ponderosa pine (*Pinus ponderosa*) and at middle elevations by Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and western larch (*Larix occidentalis*), were once commonly described as open woodlands of widely spaced, majestic trees, underlain by dense grass swards (Cooper 1960, Peet 1988, Habeck 1990, Covington and Moore 1994). During the 1900s, most of these forests were clearcut, roaded, and fragmented so that only a small fraction of the original forests remains (Belsky and Blumenthal 1997).

Livestock grazing is occasionally mentioned as contributing to “forest health” problems, but it is simply noted as one of many factors reducing the frequency of surface fire (Belsky and Blumenthal 1997). Nevertheless, a large number of authors have suggested that fire began to decline in frequency and forests began to increase in density soon after

livestock were first introduced into the Interior West (Leopold 1924, Weaver 1950, Cooper 1960, Madany and West 1983, Peet 1988).

By the early 1800s in the Southwest, and the late 1800s in the Northwest, virtually all plant communities that supported grass and sedge production, including ponderosa pine and mixed-conifer forests, were heavily stocked with cattle and sheep (Savage and Swetnam 1990, Oliver *et al.* 1994). After they were clearcut and seeded with grasses, even previously dense forests provided “transitory” range for livestock. As shade, drought, water stress, and pests kill small and large trees alike, fuel loads increase. These woody fuels cause what otherwise might be low intensity surface fires to develop into intense conflagrations, resulting in high tree mortality (Belsky and Blumenthal 1997).

Herbaceous Understory

By grazing and trampling herbaceous species, livestock affect understory species composition directly; this differs from the more indirect effects they have on overstory trees (Belsky and Blumenthal 1997). Impacts vary with animal density and distribution: the more evenly grazers are distributed, the lower their impact on any given area (Gillen *et al.* 1984). Unfortunately, cattle show strong preferences for certain environments, leading to high use in some areas and little or no use in others (Belsky and Blumenthal 1997). This is particularly true in western, interior forests, where steep slopes and increasingly dense forests make much of the landscape unattractive (Clary 1975, Roath and Krueger 1982).

Understory Cover and Composition

Livestock also alter understory plant composition as animals select more palatable species, leaving the less palatable ones to

increase in dominance (Smith 1967, Hall 1976, Skovlin *et al.* 1976). The effects of livestock grazing on understory composition and biomass are sometimes difficult to distinguish from the effects of tree canopy closure (Smith 1967), which creates shadier, cooler, and moister conditions. However, when Arnold (1950) separated the effects of livestock grazing from those of tree canopy closure, he found that grazing alone was sufficient to reduce the cover of most native bunchgrass species.

Domestic livestock, as well as agriculture, logging, road construction, and other practices that disturb soils, have been instrumental in the establishment of alien weedy species in western forests (Franklin and Dyrness 1973, Johnson *et al.* 1994). Livestock act as vectors for seeds, disturb the soil, and reduce the competitive and reproductive capacities of native species. Exotic weeds have been able to displace native species, in part, because native grasses of the Intermountain West and Great Basin are not adapted to frequent and close grazing (Stebbins 1981, Mack and Thompson 1982). Consequently, populations of native species have been severely depleted by livestock, allowing more grazing-tolerant weedy species to invade. It is possible that in some areas aggressive alien weeds such as cheatgrass (*Bromus tectorum*) and Kentucky bluegrass (*Poa pratensis*) have permanently replaced native herbaceous species (Smith 1967, Laudenslayer *et al.* 1989).

Forest Soils and Plant Litter

By consuming aboveground plant biomass, domestic livestock also reduce the amount of biomass available to be converted into litter and, therefore, increase the proportion of bare ground (Belsky and Blumenthal 1997). Schultz and Leininger (1990) found, for example, that grazed areas of a riparian meadow had 50% lower litter cover and 400% more bare ground than ungrazed areas.

Johnson (1956) reported that litter biomass in a ponderosa pine/bunch grass ecosystem was reduced 40% and 60% by moderate and heavy livestock grazing, respectively. Such reductions in litter may have severe consequences on forested ecosystems because litter is critical for slowing overland flow; promoting water infiltration; serving as a source of soil nutrients and organic matter; and protecting the soil from freezing and the erosive force of raindrops (Thurrow 1991, Facelli and Pickett 1991).

4.5 Compaction and Infiltration

The rate at which water penetrates the soil surface governs the amount of water entering the ground and the amount running off. Livestock alter these rates by reducing vegetative and litter cover and by compacting the soil (Lull 1959). As a result, livestock grazing is usually associated with decreased water storage and increased runoff (Belsky and Blumenthal 1997). Lower soil moisture contents in turn reduce plant productivity and vegetative cover, creating negative feedback loops that further degrade both the plant community and sod structure (Belsky and Blumenthal 1997). These changes in soil structure may also lead to increased water stress and tree mortality during dry periods, exacerbating the water stress resulting from the higher tree densities. Therefore, disturbance and compaction of forest soils by cattle and sheep may contribute to the increased incidence of water-stress, tree mortality, and fire in western forests (Belsky and Blumenthal 1997).

4.6 Runoff and Erosion

As livestock reduce plant cover and compact the soil, the volume of overland water flow increases (Belsky and Blumenthal 1997). With increasing runoff, soil erosion also increases (Dunford 1954). Smith (1967), for example, found that grazed pastures in a

ponderosa pine/bunchgrass range lost 3 to 10 times more sediment than ungrazed pastures. The strong relationship between runoff and erosion was also demonstrated by Forsling (1931), who found that summer rainstorms on grazed subalpine hillsides accounted for 53 to 85% of annual sediment loss. Following elimination of livestock from the watershed, vegetative cover increased 150%, whereas the proportion of annual runoff from summer rainstorms dropped 72%, causing a corresponding 50% drop in sediment loss (Forsling 1931).

4.7 Big Game Impacts and Dietary Overlap with Livestock

Numerous studies have documented the impact of grazing and browsing by big game animals on habitats (Clark 2003). Heavy browsing by big game animals may inhibit shrub and grass cover, alter the plant composition, alter vegetative structure, prevent adequate plant reproduction, or cause direct mortality (Gaffney 1941, Korfhage *et al.* 1980, Edgerton 1987, Irwin *et al.* 1994, Nolte and Dykzeul 2000). Generally, big game impacts to habitat become significant when animals become so numerous as to exceed the carrying capacity of the habitat. This may occur at spatial and temporal scales depending on the season and the condition of the habitat (e.g., winter range or naturally or artificially altered habitat) (Begon and Mortimer 1986).

Dietary overlap between big game animals and livestock is subject to the specific forage components required by the animals and the timing of ungulate use. Dietary overlap between elk and cattle is most likely to occur on fall cattle range that is used by elk later in the year as winter range (Clark 2003). Dietary overlap between elk and domestic sheep occurs during the summer when both species

rely heavily on forbs; however, elk tend to be more selective between forb species than do sheep (Clark 2003). Elk tend to remain on a forb-dominated diet throughout the summer while sheep diets transition from forbs to grasses and browse as the season progresses (Clark 2003).

The diets of cattle and mule deer are most prone to overlap during the spring when mule deer diets contain a substantial amount of graminoids. However, spring mule deer diets are primarily dominated by forbs and browse, while spring cattle diets contain mostly graminoids. Consequently, the degree of diet overlap between cattle and mule deer is relatively small (Clark 2003). The diets of domestic sheep and mule deer overlap during the spring and fall when both ungulates are using browse and forbs. When browse is limited, both domestic sheep and mule deer rely heavily on graminoids (Clark 2003).

Winter bighorn sheep diets and summer-fall cattle diets have the greatest potential for overlap of any seasonal diet combination between these two ungulates. Under this combination, the diets of both cattle and bighorn sheep are dominated by graminoids. However, as with elk and cattle, the differences in seasonal habitat use displayed by cattle and bighorn sheep minimize the potential for dietary competition between these species (Clark 2003). Dietary overlap between domestic sheep and bighorn sheep is not as well understood (Clark 2003).

Dietary overlap between cattle and pronghorn is generally considered minimal, as the two ungulates do not share significant food sources or ranges (Clark 2003). Dietary overlap between domestic sheep and pronghorn is typically the highest during the spring and fall when both species are consuming sizable quantities of browse. However, as with cattle and pronghorn, the degree of similarity between the diets of

pronghorn and sheep is generally quite low (Clark 2003).

5. Timber Harvest

Logging began in the vast forests of the west in the 1870s and 1880s when materials and supplies were needed for construction of the transcontinental railroad. Subsequent settlement of the frontier by pioneers and immigrants increased the demand for timber products. In the early 1900s, new technologies allowed greater harvest on terrain previously unavailable for logging. In mid-century, dramatic increases in timber harvest and road building occurred in the National Forests and private lands throughout the West. An agricultural model of sustainable forestry favoring even-aged stands became the standard of timber-harvest operations. During this time, typical harvests removed one-third to two-thirds of the available volume. At these residual stocking rates, stem density increased while tree size and age decreased (CPLUHNA 2003).

Historically, the most important timber species in Idaho were ponderosa pine and western white pine (*Pinus monticola*). Both have declined since 1952, ponderosa pine by 40% and western white pine by 60%. Byler *et al.* (1994) estimated that the extent of western white pine might now be only 10% of what it was in 1900.

Timber harvest has occurred throughout the Upper Snake province (Figure 18, Table 11). Very low to medium harvest activities have occurred in the central Upper Snake subbasin and portions of the Snake Headwaters and Closed Basin subbasins, in the American Falls, Lake Walcott, and Upper Snake–Rock watersheds. The most intense timber harvest activities appear to have occurred in the Salt, Upper Henrys Fork, Willow, Beaver–Camas and Big Lost watersheds (Figure 18, Table 11).

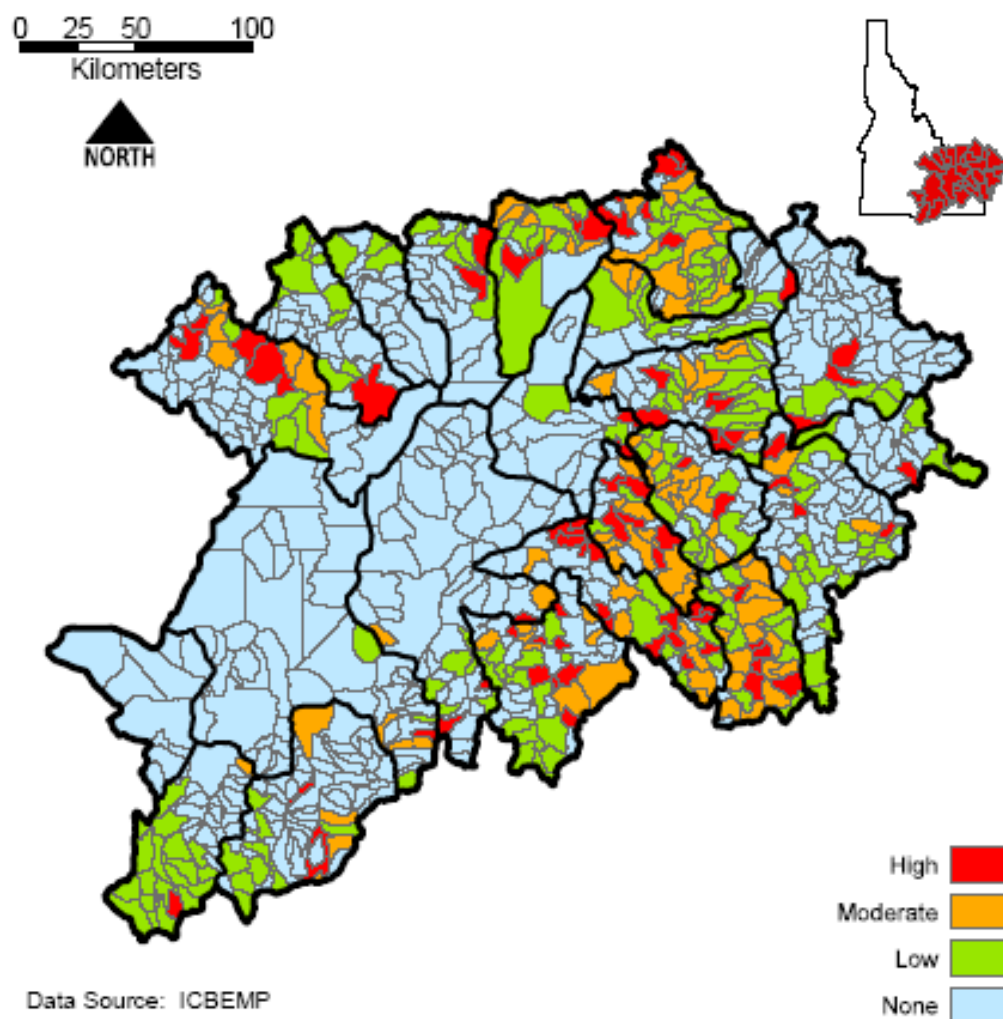


Figure 18. Relative timber harvest impacts in the Upper Snake province, Idaho (ICBEMP 1997).

Table 11. Comparing the relative percentages of timber harvest by watershed in the Upper Snake province (ICBEMP 1997).

Snake Headwaters Subbasin Relative Category	Major Hydrologic Unit (watershed) ^a				
	GHB	GVT	PAL	SAL	SHW
High	5	4	4	14	7
Low	7		24	49	
Medium	33	31	36	32	12
No harvest	56	65	36	5	81

^a GHB= Greys-Hoback watershed; GVT= Gros Ventre watershed; PAL=Palisades watershed; SAL=Salt watershed; SHW=Snake Headwaters watershed.

Upper Snake Subbasin Relative Category	Major Hydrologic Unit (watershed) ^a											
	AMF	BFT	GSE	IFA	LHF	PTF	RFT	TET	UHF	USR	LWT	WIL
High	2	24	2	3	3	10	5	14	15	<1	<1	25
Low	2	19	2		7	21	11	16	32		2	48
Medium	5	22	56	12	39	32	19	40	42	<1	3	5
No harvest	92	35	40	85	52	37	66	30	11	100	95	22

^a AMF=American Falls watershed; BFT=Blackfoot watershed; GSE=Goose watershed; IFA= Idaho Falls watershed; LHF=Lower Henrys Fork watershed; Portneuf watershed; RFT=Raft watershed; TET=Teton watershed; UHF=Upper Henrys Fork watershed; LWT=Lake Walcott watershed; WIL=Willow watershed.

Closed Basin Subbasin Relative Category	Major Hydrologic Unit (watershed) ^a				
	BCM	BCK	BLR	LLR	MDL
High	12		12	13	10
Low	14		14		
Medium	55	21	11	33	19
No harvest	19	79	62	54	71

^a BCM=Beaver-Camas watershed; BCK=Birch watershed; Big Lost River watershed; Little Lost River watershed; Medicine Lodge watershed.

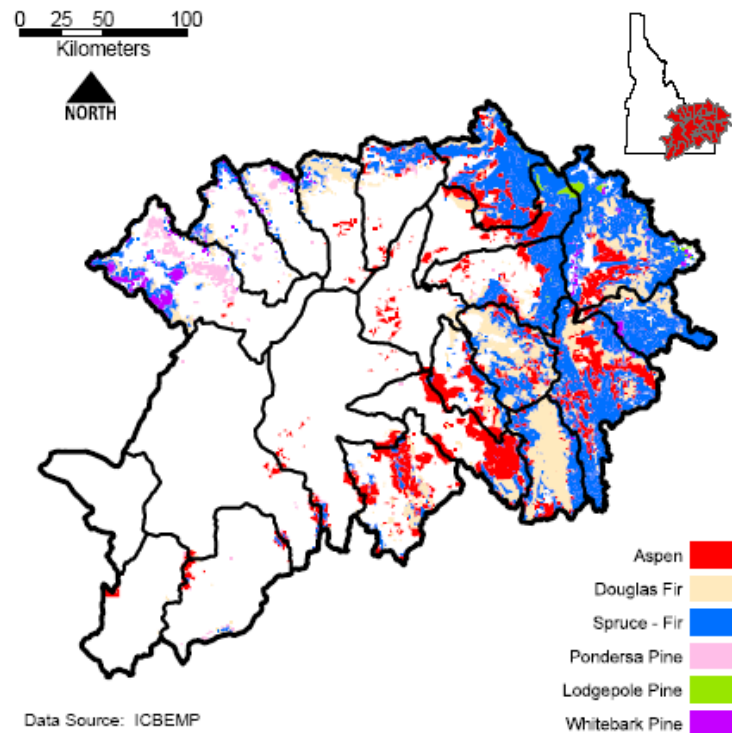


Figure 19. Historical forest species compositions in the Upper Snake province (ICBEMP 1997).

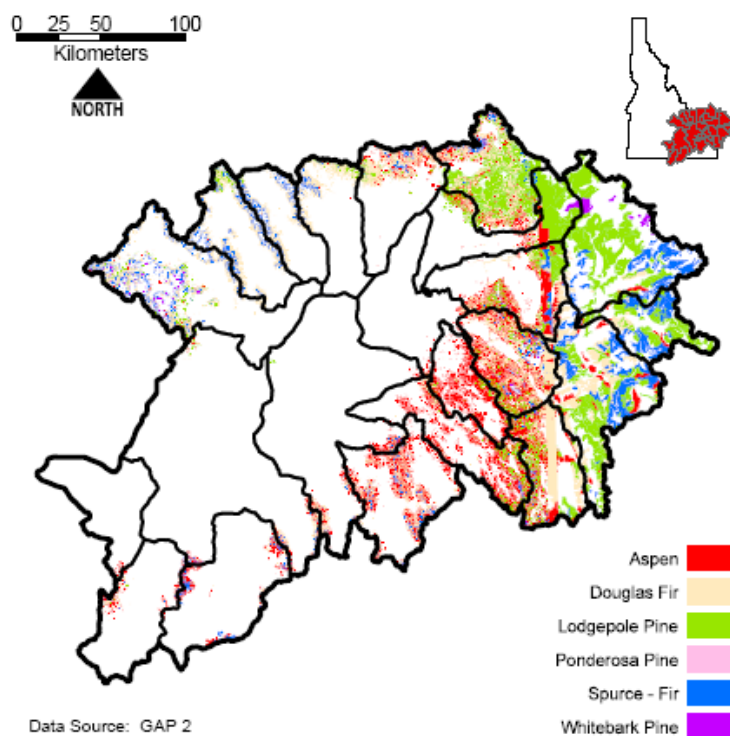


Figure 20. Current forest species compositions in the Upper Snake province (GAP II, Scott *et al.* 2002).

5.1 Effects of Timber Harvesting on Soil

Soil is a primary determinant of long-term site productivity, and timber harvest can produce a variety of changes in soil properties that affect long-term site productivity.

Timber harvest and subsequent site preparation usually result in microclimate changes that influence subsequent biological processes. The most important of these include changes in light, temperature, and moisture. Soil chemistry and microbial processes can be affected in either a beneficial or detrimental manner (Harvey *et al.* 1989).

Timber harvest can cause extensive losses and disturbances of surface organic matter. This potential has important implications for soil chemical, biological, and physical properties

(Harvey *et al.* 1987, Jurgensen *et al.* 1990). Timber harvest reduces soil organic matter both by physical loss at time of harvest and by increased microbial activity caused by soil disturbance (Jurgensen *et al.* 1990). Site-preparation techniques, particularly slash piling and windrowing, can cause productivity problems related to organic matter because of the disturbance of large areas of the forest floor (Harvey *et al.* 1987, 1989). Substantive losses of surface organic matter lead to declines in productivity (Powers 1991).

Forest management activities, especially timber harvest and road construction, have been shown to increase erosion rates on forest lands (Megahan 1991). Skid trails and other high-traffic areas are particularly susceptible to erosion (Cullen *et al.* 1991). Debris landslides and gullyng cause serious and long-term reductions in site productivity, but

the areas affected are small. Surface erosion occurs over much larger areas and reduces site productivity, but the magnitude of the reduction is poorly defined because of the compounding effects of compaction on logged areas and the water repellency of burned areas (Megahan 1991).

Timber harvest can affect both the processes and structures that result in fish habitat. Habitat alterations can adversely affect all life stages of fishes, including migration, spawning, incubation, emergence, and rearing (Lee *et al.* 1997). The effects of timber harvest on fish habitat are likely to be varied and dynamic.

Structure

Four major effects of timber harvest on stream structures can be summarized as follows (Chamberlin *et al.* 1991):

1. Increases in peak flows or the frequency of channel modifying flows from increased snowmelt or rain-on-snow events can increase bed scour or accelerate bank erosion.
2. Increases in sediment supply from mass movements or surface erosion, bank destabilization, or instream storage losses can cause aggradation, pool filling, and reduction in gravel quality.
3. Streambank destabilization from vegetation removal, physical breakdown, or channel aggradation adds to sediment supply and generally results in a loss of the channel structures that confine flow and promote the habitat diversity required by fish populations.
4. Loss of stable instream woody debris by direct removal, debris torrents, or gradual attrition as streamside forests are converted to managed stands of smaller

trees will contribute to loss of sediment storage sites, fewer and shallower scour pools, and less effective cover for rearing fish.

Streamflow

The hydrologic effects of timber management activities vary with many environmental factors, but Chamberlin *et al.* (1991) suggest that the following broad generalizations apply:

1. Harvest activities such as road building, falling, yarding, and burning can affect watershed hydrology and streamflow much more than can other management activities such as planting and thinning.
2. Clearcutting causes increased snow deposition in forest openings and advances the timing and rate of snowmelt. The effect lasts several decades until stand aerodynamics approach those of the surrounding forest. Snowmelt can be accelerated by large wind-borne energy inputs of warm rain falling on snow.
3. Harvested areas contain wetter soils than unlogged areas do during periods of evapotranspiration and therefore have higher groundwater levels and more potential late-summer runoff. The effects last 3 to 5 years until new root systems occupy the soil.
4. Road systems, skid trails, and landings accelerate slope runoff, concentrate drainage below them, and can increase soil water content.

Water Quality

Stream temperature is affected by eliminated streamside shading, disrupted subsurface flows, reduced stream flows elevated sediments, and morphological shifts toward wider and shallower channels with fewer deep

pools (Lee *et al.* 1997). Harvest activities that impose large oxygen demands on streams exacerbate the normal stresses that low flows place on fish (Chamberlin *et al.* 1991).

Sediment

Timber harvest can influence both upland erosional processes and the way that forest streams process sediment in their channels. Forest management activities that substantially change the magnitude, timing, or duration of sediment transport and overwhelm the ability of fish to cope with or avoid resulting stress are of most concern (Chamberlin *et al.* 1991). Roads and mass movements associated with roads are the largest sources of sediment production stemming from timber-harvest activities (Cook and O’Laughlin 2000).

Large Woody Debris

Because the supply of large woody debris to stream channels is typically a function of the size and number of trees in riparian areas, it can be profoundly affected by timber-harvest shifts in the composition and size of trees within the riparian area. Large woody debris influences channel morphology, especially in forming pools and instream cover, retaining nutrients, and storing and buffering sediment. Reduction in the amount of large woody debris within streams, or within the distance equal to one site-potential tree height from the stream, can reduce instream complexity. Large woody debris increases the quality of pools by providing hiding cover, slow water refuges, shade, and deep-water areas (Maser *et al.* 1988).

Roads

By far the greatest concerns about timber harvest and water quality result from the issue of roads. Serious degradation of fish habitat can result from poorly planned, designed,

located, constructed, or maintained roads. Roads directly affect natural sediment and hydrologic regimes by altering streamflow, sediment loading, sediment transport and deposition, channel morphology, channel stability, substrate composition, stream temperatures, water quality, and riparian conditions within a watershed (Chamberlin *et al.* 1991, Furniss *et al.* 1991, Lee *et al.* 1997).

5.3 Impacts to Wildlife

Timber harvest can have positive, negative, and neutral effects on wildlife habitat, depending on the life requirements of the species inhabiting the area (Cook and O’Laughlin 2000).

One important aspect of the relationship between wildlife and timber harvest is not how many trees are removed but how much vegetation remains as food and cover for the species inhabiting the area. Populations of animals of low mobility and specific habitat requirements (e.g., amphibians, reptiles, small birds, and small mammals) can be adversely affected at the time of a timber harvest, even if the cut is limited to a small area or a single tree. Highly mobile animals (e.g., large birds and mammals) are less affected. The age and size classes of trees that remain after harvest and their spatial relationship is important (Patton 1992)

6. Invasive/Exotics

Invasive plant and animal species—also referred to as exotics, nonnatives, introduced, or nonindigenous species—are organisms that have expanded beyond their native range or have been introduced from other parts of the world. Species are considered invasive if their presence in an ecosystem will cause environmental harm, economic harm, or harm to human health. Invasive species can displace native species, alter predator-prey

relationships, destroy crops, and decrease ecosystem resiliency (USEPA 2001). Some species were introduced into the wild intentionally, while others have been introduced unintentionally and expanded on their own. Invasive species are usually nonnative species, and they are often exotic species from another part of the world. Native species can also be characterized as invasive if they dominate their ecosystem because of human-induced changes to that ecosystem (USEPA 2001).

Twenty-three noxious weed species are known to occur within the Upper Snake province in Idaho (Appendix 1-6). In Wyoming, there are an estimated 46 species of noxious and exotic invasive weeds within the Snake Headwaters subbasin. The Gros Ventre, Greys–Hoback, and Snake Headwaters watersheds have the greatest number of noxious and exotic invasive weed species.

6.1 Impacts to Shrub-Steppe

A change in the natural fire regime is decreasing the extent of sagebrush ecosystems, and the populations of wildlife species that depend on sagebrush are undergoing steep declines because of habitat loss (Connelly *et al.* 2000). The invasion of cheatgrass is fueling larger and more frequent fires that are out-competing sagebrush as well as the associated forb and grass species that are native components of that ecosystem (Pyke 2002). It has been estimated that 25% of the original sagebrush ecosystem is now annual cheatgrass/medusahead (*Taeniatherum caput-medusae*)/rye grassland, and an additional 25% of the sagebrush ecosystem has only cheatgrass as an understory constituent (Perryman 2003).

6.2 Impacts to Riparian/Herbaceous Wetlands

A pest weed of Idaho's aquatic environment is the European purple loosestrife (*Lythrum salicaria*), which was introduced in the early 19th century as an ornamental plant (Malecki *et al.* 1993). Purple loosestrife is capable of invading many wetland types, including freshwater wet meadows, tidal and non-tidal marshes, river and stream banks, pond edges, reservoirs, and ditches. It has been spreading at a rate of 115,000 hectare per year and is changing the basic structure of most of the wetlands it has invaded (Thompson *et al.* 1987). Competitive stands of purple loosestrife have reduced the biomass of 44 native plants and endangered wildlife (Gaudet and Keddy 1988). Loosestrife now occurs in 48 states and costs \$45 million per year in control costs and forage losses (ATTRA 1997, Pimentel *et al.* 1999).

A second aquatic weed of concern in the Upper Snake Province is Eurasian watermilfoil (*Myriophyllum spicatum* L.). Eurasian watermilfoil forms large, floating mats of vegetation on the surface of lakes, rivers, and other water bodies, preventing light penetration for native aquatic plants and impeding water traffic. The plant thrives in areas that have been subjected to various kinds of natural and man-made disturbance.

6.3 Impacts to Pine/Fir Forests

An ecologically significant weed to forested habitats in the Upper Snake province is the spotted knapweed (*Centaurea maculosa*). This species infests a variety of natural and semi-natural habitats including barrens, fields, forests, prairies, meadows, pastures, and rangelands. It out-competes native plant species, reduces native plant and animal biodiversity, and decreases forage production

for livestock and wildlife. Spotted knapweed may degrade soil and water resources by increasing erosion, surface runoff, and stream sedimentation. It has increased at an estimated rate of 27% per year since 1920 and has the potential to invade about half of all rangeland (35 million acres) in Montana alone (Carpinelli 2003). Spotted knapweed is capable of establishing itself into undisturbed sites; however, disturbance allows for rapid establishment and spread.

6.5 Impacts to Whitebark Pine

The two most serious factors limiting whitebark populations in the Pacific Northwest are altered fire regimes (discussed elsewhere) and the exotic, invasive fungus whitebark pine blister rust (*Cronartium ribicola*).

Although currents and gooseberries (also known as *Ribes*) are not impacted by whitebark pine blister rust, these plants serve as alternate hosts for the fungus (Ellis and Horst 1998). On the pine in spring, pycnial spores give rise to aecial spores, which may fly 640 to 1,280 km to infect the leaves of *Ribes* plants. On the alternate host plant, two spore stages follow, which give rise to another airborne spore stage, which infects the pine again (Ellis and Horst 1998).

Although whitebark pine blister rust can damage all North American white pine species, whitebark pine is the most vulnerable, with fewer than one in 10,000 trees resistant to blister rust. Because whitebark pine cones form in the top third of the tree and blister rust tends to kill trees from the top down, a tree's ability to produce seed is eliminated by the rust long before the tree dies (Kendall 1995).

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APPENDIX 4-1—UPPER SNAKE PROVINCE PROJECT INVENTORY

The purpose of the project inventory is to provide a generalized picture of the types of fish and wildlife restoration activities that are currently being conducted in the watershed, along with information as to who is responsible for funding the projects. The information presented here was collected from technical and planning team participants through the project inventory website or through direct submission. Additional information was collected from websites of funding and implementation agencies and through interviews of nonparticipants. Due to the size of the Salmon subbasin and the number of agencies, nonprofit organizations, and private parties actively engaged in fish and wildlife restoration activities, it is unlikely that all activities implemented within the last 5 years have been captured here. However, we believe that the information provided here covers the broad scope of most of the current types of activities taking place.

One of the challenges in building the project inventory is finding summarized descriptions of the work. Some agencies have summary tables of their projects, while others have full descriptions of work proposed or to be done. The various natural forests are examples of that. Some forests have tables listing their projects, while others have pages of scoping documents.

Other projects are part of an overall work effort. Examples are Idaho Department of Fish and Game's habitat improvement projects through the Wildlife Management Areas (WMA) and Habitat Improvement Program (HIP). The work is described in terms of regions, costs, and numbers and types of sites, but not specific watersheds. In the Wyoming watersheds, the primary activities were planning and monitoring. The State of Wyoming and the Bureau of Land Management both had major planning

projects for the water resources and land management in the Snake River watersheds.

The other side of that is in cases of small projects. We acquired data from the Bureau of Land Management (BLM) Challis office describing many small projects (those were summarized in our tables). Many of them were low cost and low time expenditure projects like trough or fence installations and maintenance on existing features.

There are also programs that affect the environment such as the noxious weed control programs. The weed control program is conducted by weed control districts composed of communities, counties, or regions. Other weed control projects are conducted outside of the weed control program by the other resource management agencies.

Redundancies in listings also occur because many projects are joint ventures and are listed by each organization. For some organizations, the land holdings are the projects. The Nature Conservancy is an example. Each of their lands is listed as a project. There may be some detail about the restorative or maintenance activities, but not always. The same is true of some regional organizations that establish conservation easements. One such organization is the Teton Regional Land Trust. Their members have contributed funds and set aside properties for conservation. Sometimes there is work done, other times, land is just protected from development.

Table 1. Snake Headwaters subbasin project inventory list, Upper Snake province.

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										SHW	GV/T	GHB	PAL	SAL
Rainey Creek Enclosure	Snake, Headwater	Ongoing	1958	1996	Idaho Dept. of Fish and Game	IDFG		There is a striking difference in the shrub height and density between the two grazing treatments: Symphoricarpos oreophilus, Purshia tridentata and Rosa sp. are denser and stature is twice as tall within the section that all grazing is excluded. Also, the treatment that excludes only livestock has much more hedging of Juniper; there is no hedging within the portion that all grazing is excluded.	This is a two-way enclosure erected by the Forest Service and the Idaho Fish and Game in 1958 to "study big game winter range problems". The enclosure is about 5 acres; half excludes all ungulate grazing and the other half excludes only livestock. The enclosure lies on a rounded SE-facing slope and is dominated by Juniperus scopulorum, although shallower soil in the upper part supports Cercocarpus ledifolius instead of Juniper. Understory is a mixture of low shrubs and Agropyron spicatum.				x	
Federal Aid in Fish Restoration: Job Numbers 6-- b, -c1, -c2,-d	Snake, Upper	Complete d	1987	1988	Idaho Dept. of Fish and Game	IDFG							x	
Federal Aid in Fish Restoration: Project 7. Irrigation Diversion Fish Loss Reduction: Subproject 1. South fork Snake River Canal Investigations	Snake, Headwater	Complete d	1996	1997	Idaho Dept. of Fish and Game	IDFG		The number of sample sites needs to increased to variety of streams with different lifecycles, diversion location, and evaluation of mortality needs to be expanded to include fish of all sizes that should be uniquely marked.					x	

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										SHW	GVT	GHB	PAL	SAL
Sport Fish Restoration: Project 3: Wild Trout Investigations. Subproject 1. Whirling Disease Studies. Subproject 2. Evaluations of Salmonid Restricted Harvest Regulations Permitting the Use of Bait.	Snake, Upper	Ongoing	1996	1997	Idaho Dept. of Fish and Game	IDFG		1. Conduct additional sentinel tests in other drainages testing positive for Myxobolus cerebralis. 2. Quantify spore loading and percent of infection of salmonids in drainages testing positive for MC. 3. Surface water from Loving Creek at Hayspur Fish Hatchery is positive for MC and should not be used for rearing any trout for release in MC negative waters in Idaho. 4. Continue population estimates to monitor year class and population trends in selected positive waters.	Sport Fish Restoration: Project 3: Wild Trout Investigations. Subproject 1. Whirling Disease Studies. Subproject 2. Evaluations of Salmonid Restricted Harvest Regulations Permitting the Use of Bait.				x	
BLUE GULCH #13 FENCE	Snake, Upper	Ongoing	1998		Bureau of Land Management	BLM			COOPERATIVE PROJECT WITH IDFG AND PHEASANTS FOREVER. CONSTRUCT 3-WIRE FENCE AROUND PERIMETER OF SIKES ACT WILDLIFE TRACT TO PROTECT UPLAND BIRD HABITAT.				x	
DEAN SITE EXCLOSURE	Snake, Upper	Ongoing	1998	1999	Idaho Department of Fish and Game Conservation Data Center	IDFG		The enclosure was probably heavily grazed prior to fencing. This area was first fenced in 1969 as a primitive recreation site. A pit toilet was installed in 1970. Vandalism at the site, including having the outhouse pulled over, resulted in the recreation	A pump house is within the enclosure that pumps water up over the ridge somewhere. The water is taken from the uppermost spring, but appears to be a small amount.				x	
Trail Identification Signs		Completed	2003	2003	Bonneville	RAC Title II							x	
Upper Rainey Creek Trailhead Rehabilitation		Completed	2003	2003	Bonneville	RAC Title II							x	

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										SHW	GVT	GHB	PAL	SAL
Copenhagen Basin Parking Lot Toilet		Approved	2002	2002	Bear Lake/Franklin	RAC Title II								x
Noxious Weed Control		Approved	2002	2002	Caribou	RAC Title II								x
Willow Flat Trail		Approved	2002	2002	Bear Lake/Franklin	RAC Title II								x
Idaho Habitat Management	Southeast	Ongoing	2003	2004	IDFG	IDFG			Annual budget for WMA				x	x
Habitat Improvement Projects (HIP)	Southeast	Ongoing	2002	2003	IDFG	IDFG	feed, cover, and riparian condition		Food plot, shrub and tree planting, fencing, and wetland creation.				x	x
DEQ 319 projects		Ongoing	2003	2004	DEQ	DEQ				x	x	x	x	x
Palisades Creek	Bonneville County				Idaho Department of Fish and Game, Partners for Fish and Wildlife Project	USFWS		Fish passage restoration					x	

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										SHW	GVT	GHB	PAL	SAL
River at a Crossroads: Development in the 100-Year Floodplain of the South Fork Snake River	South Fork Snake River	Complete	2002	2003	Greater Yellowstone Coalition	Greater Yellowstone Coalition		This study was conducted by GYC to assess the number of human-built structures in the 100-year floodplain of the South Fork Snake River. Using GIS technology and county land use records, GYC determined the amount of growth and development located within the floodplain in Bonneville county. The study also discusses the threats posed by floodplain development including bank stabilization projects and the removal of cottonwoods and other riparian vegetation. Recommendations are given at the end of the published study document.	The results of the study show that the South Fork is indeed threatened by development within its floodplain. The recommendations include the adoption of a new floodplain ordinance that prohibits the construction of new buildings in the FEMA designated 100-year floodplain, prohibition of new bank stabilization and stream channelization projects, and prohibition of the clearing of mature riparian vegetation.				x	
Spring Creek Watershed Assessment	Upper Snake Headwaters	to begin this summer pending funding	2004	2006	Teton Science Schools	awaiting EPA funding		addressing issues of development and habitat impact		x				
The Effects of Residential Development on Avian Community Structure Along the Snake River in Jackson Hole, Wyoming.	Upper Snake Headwaters	in progress	2000		Teton Science Schools	federal, private, non-profit grants		assessing impacts of human development and activities on avian habitat		x				
USGS-NAWQA	Snake Headwaters	ongoing	1995		USGS	Grand Teton National Park			NAWQA program sampling being done at the Snake River at Flagg Ranch and the Snake River at Moose, giving an upstream/downstream snapshot of water quality.	x				

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										SHW	GVT	GHB	PAL	SAL
Cutthroat Trout Inventory	Snake Headwaters	ongoing	1999	2005	Grand Teton National Park	NPS, USFS, WYG&F, TU, One-Fly		Our original goal was to document the geographic distributions of Snake River and Yellowstone cutthroat trout over 5 years in an estimated 2,400 km (1,500 mi) of fish bearing streams between Palisades Reservoir and Jackson Lake, Wyoming. We have surveyed approximately 2,590 km (1,609 mi) in 6-years. Portions of two drainages, the Salt River and Buffalo Fork River, remain to be completed. Our original concerns regarding project feasibility have been addressed; these related specifically to sampling logistics, timing of stream occupancy by fishes, capture technique, and cutthroat trout identification. Further sampling above Jackson Lake Dam will provide a continuous and seamless coverage between the NPS and USFS units.	Sampling results to date have supported our systematic approach as opposed to a random, or stratified random sample scheme. When sampling across an environmental gradient, or the logistical demands or cost of systematic sampling approaches that of random sampling, systematic sampling should be pursued (Krebs 1998). This is particularly applicable in the case of Snake River and Yellowstone cutthroat trout in the Snake River headwaters, where we have documented an elevation gradient, with Yellowstone cutthroat trout occupying the upper reaches of streams, Snake River cutthroat trout typically present throughout the occupied length of streams and an area of phenotypic overlap generally being observed at mid-elevations. One final note is the capture of cutthroat trout in GTNP exhibiting spotting and coloration similar to Bonneville cutthroat trout, O. c. utah, in streams with no documentation of historical stocking. ur surveys indicate trout occupy approximately 60% of the perennial stream length sampled, and cutthroat trout are present in 92% of the perennial stream length occupied by trout. Yellowstone cutthroat trout were present in approximately 16% of perennial stream length, where as Snake River cutthroat trout were present in 78%; unidentifiable juvenile cutthroat trout occupied 12% of perennial streams. Yellowstone cutthroat trout occur almost exclusively in sympatry with Snake River cutthroat trout. Allopatric Yellowstone cutthroat trout were present in 4 streams (total 1.35 km or <1% of the total stream length occupied by trout). In addition, our systematic sampling scheme has documented the introduction of fathead minnow, Pimephalas promelas, in the Snake River Canyon, the first recorded collection of leatherside chub, Gila copei, in GTNP and the BTNF since the 1950's, and confirmation of the spatial extent of non-native trout (e.g., brook trout and rainbow trout). Furthermore, we have documented range expansion of non-native trout, as well as their natural extirpation. Rainbow trout were captured in <1.0 km of 1 stream throughout the survey area, although rainbow-cutthroat trout hybrids were present in approximately 13.1 km (<1% of the total stream length occupied by trout) of 4 streams; rainbow trout nor rainbow-cutthroat hybrids are known to have displaced cutthroat trout within the surveyed area. Brook trout were present in approximately 15% of the perennial stream	x				

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
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Eagle and Sage Grouse Inventory	Snake Headwaters	ongoing	2002	2005	Greater Yellowstone I&M Network	NPS			Science and Resource Management (S&RM) at Grand Teton National Park (GRTE) received funding from the Inventory and Monitoring (I&M) program to conduct 2 sets of bald eagle and sage grouse surveys. These surveys were to identify new bald eagle nest sites and active sage grouse leking areas within the park. In the spring of 2001, high priority eagle nesting habitat was surveyed by helicopter. Eight historical eagle nests and one new nest were located. Also during that spring, suitable sage grouse breeding sites were searched from a fixed-winged airplane, however no new sites were found. Although using fixed winged aircraft is an economical and effective means for surveying sage grouse, they can not fly as low as helicopters and hovering over areas of suitable habitat is not possible. In the spring of 2003, funding for the second eagle flight was used to cover the cost of contracting a helicopter for grouse surveys. One new breeding site was located with 6 males actively strutting. Both new eagle nest and sage grouse breeding sites identified during this project will be monitored in the future as part of S&RM's monitoring program.	x				
Wilson Ditch	Snake Headwaters	ongoing	2002	2005	Grand Teton National park	NPS, RM- CESU, GYCC	Large irrigation diversion removes SRC from the Snake River and strands them when irrigation ceases		Project is working on design for fish screens on the diversion.	x				

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										SHW	GVT	GHB	PAL	SAL
BarBC Spring Creek Restoration	Snake Headwaters	Complete	2003	2003	Grand Teton National Park	NPS, Jackson Hole One-Fly, WYG&F	Area impacted by old fish hatchery	Fish populations need to be monitored in the future to see if there is the expected increase in cutthroat trout spawning	Prior to the dedication of Grand Teton National Park, a fish hatchery was constructed on the East Fork of Upper Bar B C Spring. Dams were constructed on the East Fork, near the hatchery site, to provide rearing ponds. There is evidence that some of the channel above and below the rearing ponds was widened for some unknown purpose. After the hatchery was abandoned, the dams were left intact and sediment continued to accumulate in the ponds. In 1984, in cooperation with Grand Teton National Park, Wyoming Game and Fish Department personnel used a backhoe to remove three of the dam structures, excavate sediments and expose gravels to a limited extent. The work was accomplished on the section of the creek adjacent to and below the hatchery site. The Wyoming Game & Fish Department recommended the project be continued on the East and Main Forks in an attempt to establish a spawning run similar to that in the lower reach of the West Fork. Breeching of the last dam structure was accomplished by hand about ten years ago. This project consisted of removal of sediments; narrowing of the channel to a natural width; reclamation of natural gravels or replacement using commercial washed gravels where natural gravels can not be reclaimed; placement of overhead cover (trees) for protection of spawning fish and escape cover for fry.	X				

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										SHW	GVT	GHB	PAL	SAL
Jackson Lake Fisheries Evaluation	Snake Headwaters	complete	2003	2004	Grand Teton National Park	NPS, USGS, WYG&F			Personnel from the Wyoming Game and Fish Department (WG&F) have entered historical field data into a database and have completed their summary of Jackson Lake Fisheries. "ABSTRACT: Jackson Lake provides a unique angling resource in the Snake River Drainage of Wyoming and management has varied considerably over time. Trend netting, trophy lake trout (LAT) Salvelinus namaycush nett, LAT tagging, programmed and spot creel, and productivity data were summarized for Jackson Lake form 1971-2003. The decrease in relative weight for LAT less tan 20 in., low numbers of stocked LAT in the creel, and no apparent correlation between numbers stocked and trend netting catch per unit effort for ALT indicates that LAT stocking in Jackson Lake should be phased out." Reconnaissance of Jackson Lake was also performed by boat in August 2003. USGS personnel were accompanied by Rob Gipson, WG&F. He identified the locations of annual netting operations currently being performed by the WG&F, and the locations of historical netting operations. The USGS personnel drafted multiple research strategies to accomplish the goals of this project and met with the WG&F personnel again to discuss questions related to specific techniques used during netting operations.	X				
Map and Measure Diversions	Snake Headwaters	ongoing	2003	2005	Grand Teton National Park	NPS, TU	Several headwater drainages (Gros Ventre, Spread Creek) dry out during the summer due to extensive irrigation withdrawals .		Existing irrigation ditches have been mapped and matched with existing water rights as adjudicated by the State Engineer. An interactive database has been created. Flow will be measured in ditches this summer.	x				

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										SHW	GVT	GHB	PAL	SAL
Snake River Hydrology/Geom orphology	Snake Headwaters	Ongoing	2003	2007	Grand Teton National Park, Utah State University	NPS, JH One-Fly, USGS	Jackson Lake Dam has had unknown impacts on the Snake River due to changes in flow regimes	Will be installing field studies to further evaluate the mechanisms involved in sediment and bedload transport and to make recommendations for adaptive management of the dam.	Dr. Jack Schmidt, Utah State University has completed a draft report which includes an analysis of the hydrologic change and variability that have occurred on the Snake River near Moran during the last century, using daily USGS stream-flow data and synthetic natural stream-flow data representative of unregulated conditions that has been compiled by the USBR. "ABSTRACT: The hydrologic regime of the modern Snake River is substantially different from the estimated natural flow regime and from the regulated flow regime that existed prior to 1957, based on analysis of the record of stream flow near Moran, immediately downstream from Jackson Lake Dam, and comparison with the unregulated flow regime, as estimated by the Bureau of Reclamation. Today's late spring floods are much lower and late summer flows are much higher than if the dam did not exist. Today's fall and winter flows are approximately what they would be if there were no dam, and they are much higher than prior to 1957 when base flows were very low. Today's flood regime is much lower than those prior to 1957 but occur in a more "natural" season. Analyses were based on three techniques: traditional comparison of mean daily and instantaneous stream flow, continuous wavelet analysis, and analysis using the Indicators of Hydrologic Alteration software. The utilization of mean daily discharge data and the Bureau of Reclamation's estimated unregulated stream flow represent new contributions to the study of stream flow alteration in Grand Teton National Park."	x				
Two Ocean Creek Fish Passage	Snake Headwaters	Complete	2003	2004	Grand Teton National Park	NPS, Jackson Hole One-Fly, WYG&F	Existing culvert prevented fish from returning to Two Ocean Lake	Need to monitor fish passage through new structures	Work was completed on April 22, 2004. Two rock weirs were installed below the existing culvert to improve fish passage. Streambanks were revegetated with native willows.	x				

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										SHW	GVT	GHB	PAL	SAL
Effects of Lake Drawdown on Park Resources	Snake Headwaters	ongoing	2004		Grand Teton National Park	NPS, RM-CESU	Fluctuating lake levels affect a variety of park resources.		A workshop is scheduled for June 7-9th to establish a set of research priorities for Jackson Lake.	x				
Elk Ranch Reservoir Restoration	Snake Headwaters	ongoing	2004		Grand Teton National park	NPS	This reservoir was used as mitigation for improvement to JL Dam. The headgates are in disrepair. Restoration of native vegetation was never completed. Reservoir serves as trumpeter swan nesting area.		Project not yet funded.	x				

Table 2. Upper Snake subbasin project inventory list, Upper Snake province.

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Fish Populations in the Sage Creek-Smoky Creek Drainages, Caribou County, Idaho	Snake, Headwater	Complete d	1979	1979	Idaho Dept. of Fish and Game	IDFG		The fish populations will have to be monitored in the future in order to assess any impacts from the mining operation.	The project collected baseline data on fish populations in order to assess the effects of a phosphate mine in this drainage.							x						
GOOSE CREEK MESA	Snake, Upper	Complete d	1984	1998	Idaho Department of Fish and Game Conservation Data Center	IDFG		The area has been grazed historically by sheep and cattle. There is no evidence of cutting within the site. The site is an established RNA on the Burley Resource Area.	The site is grazed by cattle. The site is within an area of non-intensive to intensive rangeland management.											x		
Federal Aid in Fish Restoration: Project 8. Hatchery Trout Evaluations. Subproject 1. Sterile Trout Investigations	Snake, Upper	Ongoing	1996	1997	Idaho Dept. of Fish and Game	IDFG		The angler survey needs to be extended a number of years to draw any conclusions. The hatchery fish trained to recognize bait items lost the ability in about a week. None of the treatments produced sterile fish in significant numbers, and new or refined treatments should be investigated in the future.								x						

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
BLUE GULCH #27 FENCE	Snake, Upper	Ongoing	1998		Bureau of Land Management	BLM			COOPERATIVE PROJECT WITH IDFG AND PHEASANTS FOREVER. CONSTRUCT 3- WIRE FENCE AROUND PERIMETER OF SIKES ACT WILDLIFE TRACT TO PROTECT UPLAND BIRD HABITAT.										x			
Back Country Weed Treatment		Complete d	2003	2003	Bonneville	RAC Title II				x												
Bear Lake Trail Maintenance		Approved	2003	2003	Bear Lake/Caribou	RAC Title II										x						
Blackfoot River Road Hardening		Complete d	2003	2003	Caribou	RAC Title II										x						
Ecology of Montane Wetlands		Complete d	2003	2003	Fremont/Teton	RAC Title II								x								
Highlands Herbicide Weed Control		Approved	2003	2003	Caribou	RAC Title II										x						
Huffman Spring		Approved	2003	2003	Oneida	RAC Title II													x			
Morgan Summitt Parking Area		Complete d	2003	2003	Madison	RAC Title II								x								
Pritchard Creek Restoration		Complete d	2003	2003	Bonneville	RAC Title II				x												
Sawtell Creeks Habitat Improvement		Approved	2003	2003	Fremont	RAC Title II					x											

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Thunder Mountain Trail Relocation		Approved	2003	2003	Bonneville	RAC Title II				x												
Trail Creek Cedron Bridge		Approved	2003	2003	Teton	RAC Title II							x									
Ecology of Montane Wetlands in the Caribou-Targhee NF		Complete d	2002	2002	Fremont	RAC Title II					x											
Fall Creek Road & Trailhead Improvement		Complete d	2002	2002	Bonneville	RAC Title II				x												
Garden Creek Fish Passage		Complete d	2002	2002	Bonneville	RAC Title II				x												
Golden Lake Culvert Replacement		Complete d	2002	2002	Fremont	RAC Title II					x											
Golden Lake Culvert Replacement		Complete d	2002	2002	Fremont	RAC Title II					x											
Mesa Marsh Noxious Weed Inventory and Control		Complete d	2002	2002	Fremont	RAC Title II						x										
Mesa Marsh Noxious Weed Managment Area		Complete d	2002	2002	Fremont	RAC Title II						x										
1135 restoration	Pocatello, PORTNEUF RIVER	Complete d		1997	Army Corp of Engineers	Army Corp of Engineers											x					

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										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
site protection	FORT HALL LANDMAR K, SNAKE RIVER	Complete d		1997	Army Corp of Engineers	Army Corp of Engineers										x						
flood control	above Blackfoot, SNAKE RIVER	Complete d	1996	1996	Army Corp of Engineers	Army Corp of Engineers										x						
flood control	Bancroft, PORTNEUF RIVER DRAINAGE	Complete d		1995	Army Corp of Engineers	Army Corp of Engineers											x					
channel clearing	HEISE- ROBERTS, Snake River	Complete d	1954	1994	Army Corp of Engineers	Army Corp of Engineers				x												
RIRIE DAM AND LAKE	Willow Creek	Complete d		1994	Army Corp of Engineers	Army Corp of Engineers				x												
pre-auth study	Ririe, RIRIE GROUNDW ATER STUDY	Complete d		1990	Army Corp of Engineers	Army Corp of Engineers				x												
pre-auth study	Idaho, OAKLEY WESTSIDE CHANNEL	Complete d		1989	Army Corp of Engineers	Army Corp of Engineers														x		
pre-auth study	Idaho, RIRIE	Complete d		1988	Army Corp of Engineers	Army Corp of Engineers				x												
pre-auth study	Bingham County, SNAKE RIVER	Complete d		1988	Army Corp of Engineers	Army Corp of Engineers										x						

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
pre-auth study	Idaho, TETON RIVER	Complete d		1988	Army Corp of Engineers	Army Corp of Engineers							x									
term 1986	Blackfoot River, BLACKFO OT DAM AND RESERVOI R MODIFICA TION	Complete d		1986	Army Corp of Engineers	Army Corp of Engineers									x							
study	Fremont County, HENRYS FORK RIVER	Complete d		1986	Army Corp of Engineers	Army Corp of Engineers					x											
pre-auth study	Madison County, SOUTH FORK TETON RIVER	Complete d		1986	Army Corp of Engineers	Army Corp of Engineers							x									
pre-auth study	Cassia County, CASSIA CREEK	Complete d		1985	Army Corp of Engineers	Army Corp of Engineers														x		
dams/not done	Idaho, RAFT RIVER	Complete d		1985	Army Corp of Engineers	Army Corp of Engineers												x				
debris removal	Idaho, RAPID CREEK	Complete d		1985	Army Corp of Engineers	Army Corp of Engineers										x						
pre-auth study	Bancroft, SQUAW CREEK	Complete d		1985	Army Corp of Engineers	Army Corp of Engineers										x						

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
emergency flood control	RIVERSIDE , SNAKE RIVER	Completed		1977	Army Corp of Engineers	Army Corp of Engineers				x												
flood hazard report	Rexburg-Sugar City, TETON RIVER	Completed		1977	Army Corp of Engineers	Army Corp of Engineers							x									
floodplain study	McCammon, PORTNEUF RIVER	Completed		1976	Army Corp of Engineers	Army Corp of Engineers										x						
	Vicinity of Shoshone, DIETRICH AND MILNER-GOODING CANAL DIVERSIONS	Completed		1974	Army Corp of Engineers	Army Corp of Engineers											x					
floodplain study	Vicinity of Inkom, PORTNEUF RIVER	Completed		1974	Army Corp of Engineers	Army Corp of Engineers										x						
flood control	LAVA HOT SPRINGS, PORTNEUF RIVER, LAVA HOT SPRINGS	Completed		1973	Army Corp of Engineers	Army Corp of Engineers										x						
	near Rexburg, LYMAN CREEK	Completed	1970	1971	Army Corp of Engineers	Army Corp of Engineers							x									

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage											
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR
floodplain study	Pocatello, PORTNEUF RIVER	Complete d		1970	Army Corp of Engineers	Army Corp of Engineers											x				
floodplain study	Vicinity of Pocatello, PORTNEUF RIVER AND TRIBUTAR IES	Complete d		1970	Army Corp of Engineers	Army Corp of Engineers											x				
channel repairs	IDAHO, PORTNEUF RIVER AND MARSH CREEK	Complete d	1963	1969	Army Corp of Engineers	Army Corp of Engineers											x				
flood control	Snake River, HEISE- ROBERTS AREA	Complete d	1949	1968	Army Corp of Engineers	Army Corp of Engineers											x				
channel repairs	IDAHO, PORTNEUF RIVER AND MARSH CREEK	Complete d	1966	1968	Army Corp of Engineers	Army Corp of Engineers											x				
Idaho Habitat Management	Magic Valley	Ongoing	2003	2004	IDFG	IDFG			Annual budget for WMA									x	x	x	
Idaho Habitat Management	Southeast	Ongoing	2003	2004	IDFG	IDFG			Annual budget for WMA					x	x	x	x				
Idaho Habitat Management	Upper Snake	Ongoing	2003	2004	IDFG	IDFG			Annual budget for WMA	x	x	x	x								

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Habitat Improvement Projects (HIP)	Magic Valley	Ongoing	2002	2003	IDFG	IDFG	feed, cover, and riparian condition		Food plot, shrub and tree planting, stubble, wetland creation, nesting, cover and riparian enhancement.									x	x	x		
Habitat Improvement Projects (HIP)	Southeast	Ongoing	2002	2003	IDFG	IDFG	feed, cover, and riparian condition		Food plot, shrub and tree planting, fencing, and wetland creation.					x	x	x	x					
Habitat Improvement Projects (HIP)	Upper Snake	Ongoing	2002	2003	IDFG	IDFG	feed, cover, and riparian condition		Food plot, shrub and tree planting, fencing, and wetland creation.	x	x	x	x									
Teton River Riparian Restoration	Teton River	Ongoing	2003	2004	USFWS	USFWS		Improve Yellowstone cutthroat trout habitat at five locations on the Teton River. Objectives: overhanging protective vegetation; large woody debris; stabilization of streambank; plants native willows/vegetation in riparian area; fence streambank														
Tex Creek I, II	Tex Creek I, II	Ongoing		2004	RMEF, IDFG	RMEF, IDFG				x												
South Hills, Sugarloaf Mountain	South Hills, Sugarloaf Mountain	Completed	2003	2003	Mule Deer Foundation	private, BLM	feed, cover, and riparian condition		native cover planting, seedlings									x				
DEQ 319 projects		Ongoing	2003	2004	DEQ	DEQ				x	x	x	x	x	x	x	x	x	x	x	x	x

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
								Winter translocation efforts to address trumpeter swan over-crowding in the Island Park area of Idaho began in 1990. Dispersing the wintering population and establishing secure use of other parts of southeastern Idaho might lessen population impacts on habitat and concern over die-offs in Island Park because of disease or starvation. Dispersal to more southerly wintering areas could also increase early spring food resources for the resident segment of the southern Idaho nesting population. Winter translocation efforts up to this time, however, have not adequately achieved the goal of dispersing the population to new wintering grounds. During the winters of 2001-2003 a multi-agency group trapped and translocated cygnets from Harriman State Park (HSP). Trapping and translocating cygnets without accompanying adults from the traditional wintering grounds has not been attempted prior to this project. A control group of marked cygnets was released at Harriman and all other trapped cygnets were released in the Bear River and Bear Lake area. Project objectives are to:1)Determine survival of marked cygnets released at the														

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Amphibian monitoring		Ongoing	2003	2013	IDFG	IDFG		Basic amphibian surveys and monitoring across the region. Survey three sites each year focusing on high mountain lakes and wildlife management areas.		x	x	x	x	x								
Ashton Groundwater Protection	Lower Henry's Fork		2000	2003	IDEQ - Idaho Falls	319 Program	Water Quality		soil vadose zone monitoring to measure the amount of water leached below the root zone during the irrigation seasons. Spring and fall soil sampling			x										
Blackfoot Southeast Pond Project	Blackfoot River		2002	2003	Blackfoot City Engineer, Public Works	319 Program	Water Quality	Stormwater Retention Pond	water quality							x						
Blackfoot Southwest Pond Project	Blackfoot River		2002	2003	Blackfoot City Engineer, Public Works	319 Program	Water Quality	Stormwater Retention Pond	water quality							x						
Cedar Draw Coulee	Lake Walcott		2003	2004	Twin Falls Canal Company	319 Program	Water Quality	This Coulee drains 9,000 acres of agricultural land and introduces nitrogen, phosphorous, bacteria, and pesticides to return flow irrigation water. BMPs to be installed include a series of three serpentine shaped ponds that will be interconnected with riparian wetland areas.	Water Quality										x			

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Edson Fichter	Portneuf River		2003	2004	Idaho Fish and Game	319 Program	Water Quality	BMPs to be installed include revetments, seeding along stream bank, restoration of 700 feet of meandering stream channel, installation of 300 feet of pipe to convey water to a settling pond, installation of a small settling pond.	water quality								x					
H17 Drain	Lake Walcott		2001	2002	Burley Irrigation District	319 Program	Water Quality	Sediment basin installed at the bottom end of a six-mile long irrigation canal. The basin is 200 feet long and 50 feet wide. This facility captures sediment from return irrigation water prior to discharge to Goose Creek and Snake River.	Water Quality									x				
Kinsey Corral	Lake Walcott		2003	2004	Twin Falls NRCS	319 Program	Water Quality	fencing, corral relocation	Bacteria and sediment by IDEQ								x					
Main Purrine	Lake Walcott		2003	2004	Twin Falls Canal Company	319 Program	Water Quality	12,000 acres of agricultural land are drained into the Main Perrine Coulee resulting in sediment, nitrogen, phosphorous, and pesticide contamination. BMPs to be implemented include a concrete diversion structure, a large (8 acre) settling pond and several wetlands. These features will treat 80 to 90% of all the water coming through Main Perrine Coulee.	UI & IDEQ BURP									x				

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Pocatello (1st Street Stormwater Wetland)	Portneuf River		1997	1998	City of Pocatello, Public Works	319 Program	Water Quality	This storm water BMP is successfully capturing and treating storm water runoff from a large portion of Pocatello’s city streets resulting in cleaner water being discharged to the Portneuf River.	Idaho State University monitored for sediment, phosphorous and bacteria several years after the project was completed								x					
Pocatello (North City Park Wetland)	Portneuf River		2002	2004	City of Pocatello, Public Works	319 Program	Water Quality	One small catchment basin has been constructed, A conveyance pipeline and infiltration sump have been installed, A large bioinfiltration/wetland basin could be constructed in an oxbow to the Portneuf River	Water Quality, plant survival								x					
Raft River	Raft River		1999	2003	IASCD	319 Program	Water Quality	Rock crossings, Rock drop structures (20), Stream bank stabilization (revetments), Diversion structures (12), Weirs (12), Concrete irrigation return flow structures, Plantings including willows and grass, Grazing management	Photo points, BURP assessments, soil moisture analysis										x			
Rapid Creek Restoration (Upper)	Portneuf River		2001	2004	Idaho Soil Conservation Commission	319 Program	Water Quality	Water well and pump, Corral reclamation and berms, Pipeline, Water troughs, Fencing - 1500 feet, Stream bank restoration and vegetation	Pre-project sampling was conducted along Rapid Creek by ISCC. The same sample locations will be used for post project monitoring for a three year period. After three years sampling will be conducted every other year								x					

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage													
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR		
Rock Creek Rehabilitation	Lake Walcott		2001	2003	Twin Falls County Parks and Waterways Department	319 Program	Water Quality	Two storm water detention ponds, Stream bank stabilization- sloping, geo-matting, seeding, Trees, shrubs, Sprinkler system, Installation of 5000 yards of topsoil, Removal of old concrete from a two acre area, Installation of two pedestrian bridges across rock Creek	Photopoints										x				
Sheridan Creek, Diversion 10 Restoration	Upper Henry's		1996	2003	NRCS, HFF, Sheridan Valley Grazing Association, Idaho Fish and Wildlife Foundation, IDL, IDFG, USFS, CSCD	60% 319 Program, the other 40% will be funded through landowners, Henry's Fork Foundation, and the Henry's Fork Council, IDPR(Harri man State Park)	Water Quality	Stream bank stabilization, fencing, grazing plans, weed control, Nine large diversions, 14 miles of fencing, 10 rock check dams, six culverts, numerous rock drop structures, 0.5 mile of riparian plantings along stream banks, One water well	BURP monitoring will be collected along Sheridan Creek every five years and annual photo points will be revisited		x												

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IEA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Twentyfour Mile Creek TMDL Implementation	Portneuf River		2000	2005	Soda Springs Soil Conservation Commission, Caribou Soil Conservation District	60% of this project will be funded by the 319 monies. The other 40% will come from funding from local entities, both in kind and monies, including landowners, EQUIP funds, CRP funds, and WQPA funds	Water Quality	Stream bank stabilization, fencing, grazing plans, weed control	Parameters sampled for include discharge, temperature, sediment, nutrient and bacteria, photopoints.								x					
Bergman Ditch Replacement – Improved irrigation water delivery – Squirrel Creek State Agricultural Water Quality Project (SAWQP)	Upper Henry's		1994	1994	Private landowners, Squirrel Creek Irrigation and Canal Company, Natural Resources Conservation Service (NRCS)	Yellowstone Soil Conservatio n District (YSCD)					x											

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Diamond D Ranch Management Improvement – Riparian exclusion fencing on Targhee and Howard creeks, monitoring of rest-rotation grazing, and improved irrigation efficiency	Upper Henry's		1995	1995	NRCS; U.S. Department of Agriculture, Forest Service (USFS); Henry’s Lake Foundation (HLF); The Nature Conservancy (TNC); IDFG; Idaho Soil Conservation Commission (ISCC); Island Park Sportsmen Association (IPSA); Howard Creek Ranch	Idaho Department of Fish and Game (IDFG), Diamond D Ranch					x											
Rocky Mountain Trumpeter Swan Relocation and Range Expansion Project – Hazing to disperse wintering swans from the Henry’s Fork area	Upper Henry's		1995	1995	U.S. Bureau of Reclamation (BoR), U.S. Geological Survey (USGS), IDFG	U.S. Fish and Wildlife Service (USFWS)					x											
Henry’s Lake SAWQP – Fifteen-year project to protect riparian areas and prevent shoreline erosion	Upper Henry's		1995	1995	Private landowners, NRCS	Yellowstone Soil Conservation District (YSCD)					x											

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Publication of A Homeowner’s Handbook for Living in Teton Valley	Teton River		1995	1995	World Wildlife Fund, Greater Yellowstone Coalition (GYC), Community Association for Responsible Planning, Teton Valley/Regional Land Trust (TRLT), USFS	Teton County Economic Development Council							x									
Site-Specific Technology for Agriculture			1995	1995	Idaho National Engineering/and Environmental Laboratory (INEEL), NRCS, Ricks College	Hess Farms						x	x	x								
North Leigh Creek Amphibian Enhancement Project – Educate public about western boreal toad and spotted frog habitat	Teton River		1995	1995	Wildlife Forever	USFS								x								
Buffalo River Fish Passage Facilities	Upper Henry’s		1996	1996	IDFG, HFF, USFS, USFWS, Federal Energy Regulatory Commission (FERC)	Buffalo Hydro, Inc.						x										

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IEA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Warm River Fish Hatchery – Reopen hatchery to produce rainbow and Yellowstone cutthroat trout	Upper Henry's		1996	1996		Shoshone-Bannock Tribes					x											
Henry’s Lake Flat Water Development – Riparian exclusion fencing and development of alternative water source for livestock	Upper Henry's		1996	1996	Idaho Department of Parks and Recreation (IDPR), TNC, Farm Services Administration (FSA), NRCS, Howard Creek Ranch	Idaho Department of Lands (IDL)					x											
Targhee National Forest Revised Forest Plan – Comments submitted to the Supervisor of the Targhee National Forest			1996	1996		Council					x	x	x									
Davis Lake Allotment Well Construction – Develop a well water source for livestock to allow restoration of flow in Sheridan Creek	Upper Henry's		1996	1996	HFF, IDL, IDPR, Idaho Department of Water Resources (IDWR), NRCS, USFS, Davis Lake Allotment Permit Holders, ISCC	Clark Soil Conservation District (CSCD)					x											

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Teton Watershed Integrated Resource Analysis Project – Develop an information management system for the Teton subbasin	Teton River		1997	1997	IDFG, HFF, TRLT, IDEQ, Fremont-Madison Irrigation District (FMID)	INEEL							x									
Operation of Ashton Gage on Fall River for 1997	Upper Henry's		1997	1997	IdaWest/Marys ville Hydro, WD1, FMID, USGS	FMID					x											
Native Cutthroat Trout Conservation Project – Inventory of streams in upper Henrys subbasin	Upper Henry's		1997	1997	HFF, IDFG, Idaho State University (ISU), Gregory Aquatics	USFS					x											
Henry's Fork Weed Management Area Project – Noxious weed information and education			1997	1997	BLM; BoR; Fremont County, ID; Teton County, WY; Idaho Department of Agriculture (IDA); IDPR; Idaho Department of Transportation (IDT); IDL; IDFG; Rocky Mountain Elk Foundation; Fall River Rural Electric Cooperative (FRREC); Union Pacific Railroad	USFS, National Park Service (NPS)					x	x										

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Squirrel Meadows - Grand Targhee Resort Land Exchange	Lower Henry's		1997	1997		USFS						x										
Willow Creek Vegetation Management Project – Restore aspen-dominated plant community	Upper Henry's		1998	1998		USFS					x											
Ashton Visitor Center, Phase Two – Staffing and publication of brochures	Upper Henry's		1998	1998		Ashton Area Development Committee					x											
Henry’s Fork Springs Investigation – Research into the mechanisms of spring recharge in the upper Henry’s subbasin	Upper Henry's		1998	1998	USGS; FMID; INEEL; Utah State University (USU); University of Utah; University of Oregon	HFF					x											
Thurmon Creek Yellowstone Cutthroat Trout Restoration – Eliminate nonnative trout and reintroduce cutthroat trout	Upper Henry's		1998	1998	USFS, IDFG, IDPR, BoR	Native Trout Subcommittee					x											

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Upper Snake River Managed Groundwater Recharge – Augment flow at Thousand Springs by recharging aquifer in Henry’s Fork basin	Upper Henry's		1998	1998	Egin Bench Canals, Inc.; Fall River Irrigation Co.; Salem Union Canal Co.; Twin Groves Irrigation Co.; FMID; WD1; BLM; Private landowners	Idaho Water Resources Board (IWRB)					x											
Teton Dam Reservoir – Future Management Study, Phase I – Collect and analyze data to determine future management of area inundated by the reservoir upstream of the Teton Dam	Teton River		1998	1998	IDFG, USGS, BLM	BoR							x									
Assessment of Nutrient Concentrations in Groundwater, Lower Henrys Fork and Lower Teton River Basins – Measurement of nitrate concentrations in ground and drinking water	Lower Henry's Fork and Teton		1999	1999	IDEQ, IDWR, District Seven Health Department, IDA, Lockheed-Martin Idaho	USGS						x	x									

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
The Henry’s Fork Ag Corridors Conservation Project – Perform education and outreach to preserve farmland and open space	Lower Henry's Fork		1999	1999	Private landowners, NRCS, IDFG, Land Trust Alliance, Fremont County Commissioners , HFF	TRLT						x										
1999 Henry’s Fork Weed Management Area Cooperative Early Detection/Eradica tion Project			1999	1999	TNC, Fremont County (ID) Weed Control, Teton County (WY) Weed and Pest, IDA, IDPR, IDT, IDL, IDFG, USFS, BLM, NPS, NRCS, BoR, National Fish and Wildlife Foundation (NFWF)	Henry’s Fork Weed Management Area Working Group					x	x										
Publication of Aquatic Resources of the Henry’s Fork Watershed, Idaho, a Special Issue of the Intermountain Journal of Sciences			1999	1999	American Fisheries Society, FRREC, Federation of Fly Fishers, HFF, IDFG, Montana Cooperative Fisheries Research Unit at Montana State University, Trout Unlimited (TU), USFS	Intermountai n Journal of Sciences					x	x										

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IEA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Greater Yellowstone Trumpeter Swan Initiative – Coordinate private and agency efforts to restore a regional population of swans	Upper Henry's		1999	1999	USFS, HFF, IDFG, FMID, IDPR	The Trumpeter Swan Society					x											
Ashton Reservoir Water Quality Protection – Proposal for Clean Water Act § 319 funding	Upper Henry's		2000	2000	Private landowners	TRLT					x											
2000 Henry’s Fork Weed Management Area Cooperative Early Detection/Eradica tion Project – Mapping noxious weeds			2000	2000	TNC, Fremont County (ID) Weed Control, Teton County (WY) Weed and Pest, IDA, IDPR, IDT, IDL, IDFG, USFS, BLM, NPS, NRCS, BoR, National Fish and Wildlife Foundation (NFWF)	Henry’s Fork Weed Management Area Working Group					x	x										

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage													
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR		
Teton River Hydrologic Monitoring and Spring Creek Study – Install stream gages and monitor discharge, monitor water quality	Teton River		2001	2001	Private landowners, Teton Valley Trout Unlimited (TVTU), IDFG, IDEQ, Idaho Association of Soil Conservation Districts (IASCD), USGS, Intermountain Aquatics, Inc., TRLT	Friends of the Teton River																	
Ecology of Montane Wetlands in the Caribou-Targhee National Forest – Year 1 – Field research to better understand montane wetlands dynamics	Upper Henry's		2002	2003	University of Missouri- Columbia, IDFG, USFWS, BoR,	USFS																	
Habitat Assessment and Restoration – Research and implementation to improve habitat for Yellowstone cutthroat trout	Upper Henry's		2002	2002	IDFG, TRLT, ISU, Intermountain Aquatics, Inc., TVTU, USFS	Friends of the Teton River																	

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Foster’s Slough Restoration Project	Teton River		2002	2002	Private landowners, NRCS, TSCD, IDFG, TVTU, Intermountain Aquatics, Inc., Ducks Unlimited, SAIC, NFWF	TRLT							x									
Marysville Pipeline Project – Conduct a feasibility study to replace Marysville Canal with a pipeline to improve water quality in Fall River and the Henry’s Fork River	Upper Henry's		2002	2002	NRCS	Marysville Canal Company					x											
Sawtell Creeks Yellowstone Cutthroat Trout Restoration Project – Restore stream connectivity to allow fish passage	Upper Henry's		2003	2003	Private landowners, IDFG, NRCS	USFS on behalf of the Native Trout Subcommitt ee					x											
Watershed Perspectives on Hydrologic Alteration in the Henry’s Fork Basin – Research and data analysis			2003	2003	USGS, HFF, TNC, TU, GYC, FMID, ISU Undergraduate Research Committee	ISU					x	x										

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Henry’s Fork Greenway – Construction of signs	Lower Henry’s Fork		2003	2003	Henry’s Fork Greenway Committee, City of St. Anthony Parks and Recreation Committee, Fremont County, BLM, TRLT, HFF, IDEQ, IDT, U.S. Army Corps of Engineers	City of St. Anthony						x										
Gray's Lake/Willow Creek Basin Review	Willow Creek Subbasin and Gray's Lake Area	Ongoing	2004	2005	Greater Yellowstone Coalition	Greater Yellowstone Coalition		GYC is currently conducting a review of conservation opportunities in the Willow Creek Subbasin and Gray's Lake area. A review of historical information is underway and talks with landowners, agencies and other NGO's have begun as well. Depending upon the outcome of our review and assessment, GYC will begin a collaborative process to protect and restore the lands, water and wildlife in these locations. Our main concerns are private land development; water and land issues related to the Gray's Lake NWR, and Yellowstone Cutthroat Trout populations in the Willow Creek Subbasin.	Special use permits to access across USDA Administered lands must be acquired													

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Kirk Wetland,	Teton				Ducks Unlimited, Partners for Fish and Wildlife Project;	USFWS			Teton Valley Wetlands Restoration				x									
Flat Ranch Wetland restoration	Upper Henry's				The Nature Conservancy, Partners for Fish and Wildlife Project;	USFWS					x											
Flying R Ranch Riparian habitat restoration	Upper Henry's				The Nature Conservancy, Partners for Fish and Wildlife Project;	USFWS					x											
Diamond D Ranch Habitat protection and restoration	Upper Henry's				The Nature Conservancy, Partners for Fish and Wildlife Project;	USFWS					x											
Foster/Fox Creek Wetland protection	Teton				Teton Valley Land Trust, Partners for Fish and Wildlife Project	USFWS							x									
Hill Project Wetland protection and fish passage restoration	Teton				Teton Valley Land Trust, Partners for Fish and Wildlife Project	USFWS							x									

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Fox Creek and Teton River restoration	Teton				Teton Valley Land Trust, Partners for Fish and Wildlife Project	USFWS							x									
Woods Creek Fen	Lower Henry's				Teton Valley Land Trust, Partners for Fish and Wildlife Project	USFWS		Peatland restoration in Henry's Fork watershed				x										
Six S Ranch	Cassia County				Six S Ranch, Partners for Fish and Wildlife Project	USFWS		Habitat development and management										x				
Si Ellen Dairy	Jerome County				Si Ellen Dairy, Partners for Fish and Wildlife Project	USFWS		Wetland and upland restoration												x		
Salisbury Habitat development and management	Fremont County				Salisbury, Partners for Fish and Wildlife Project	USFWS						x										
Reid Ranch	Bingham County				North Bingham Soil and Water Conservation District, Reid Ranch	USFWS		Riparian protection and management on the Blackfoot River							x							
Sellars Creek	Bingham County				Idaho Department of Fish and Game	USFWS		Riparian development, restoration, and management							x							
Davis-Bond WRP	Madison County				Bond, Davis- Bond WRP, Partners for Fish and Wildlife Project	USFWS		Slough restoration on the Henry's Fork					x									

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementing/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage												
										IFA	UHF	LHF	TET	WIL	AMF	BFT	PTF	LWT	RFT	GSE	USR	
Bradley/Blackfoot River	Bingham County				Central Bingham Soil and Water Conservation District, Bradley, Partners for Fish and Wildlife Project	USFWS		Riparian restoration and development								x						
Klausmann Marsh	Teton				Idaho Department of Fish and Game, Partners for Fish and Wildlife Project	USFWS		Wetland development and management					x									

Table 3. Closed Basin subbasin project inventory list, Upper Snake province.

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										BCM	MDL	BCK	LLR	BLR
Summit Creek Exclosure and Instream Habitat Improvement	Snake, Upper Closed	Ongoing	1968	1998	Idaho Department of Fish and Game Conservation Data Center	IDFG	Unpaved roads in the area receive considerabl e amount of traffic and may be a source of sediment to the stream and wetlands						x	
GRASSLAND KIPUKA	Snake, Upper	Unknown	1979	1988	Idaho Department of Fish and Game Conservation Data Center	IDFG			7-28-96: U.S. Route 20-26-93, which bisects the RNA, was widened within the last month and is currently being paved. During construction, the two road cuts were enlarged considerably, destroying part of the west slope once covered by excellent stands of low sagebrush. Observation by Bob Moseley, Idaho CDC.					x
GAME CREEK	Snake, Upper	Unknown	1996	1997	Idaho Department of Fish and Game Conservation Data Center	IDFG		Game Creek is within Upper Snake River Districts BLM, Medicine Lodge RA. It is managed as a Research Natural Area.			X			
Mesa Marsh Noxious Weed Control		Complete d	2003	2003	Fremont	RAC Title II				x				
Webber Creek Trailhead Toilet Replacement		Approved	2003	2003	Clark	RAC Title II					x			
Restriction and Information Signing		Complete d	2002	2002	Clark	RAC Title II					x			

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										BCM	MDL	BCK	LLR	BLR
Travel Management and Information Signing		Approved	2002	2002	Clark	RAC Title II					x			
Crooked Creek Ranch	Crooked Creek Ranch	Ongoing	2001	2004	The Nature Conservancy, North American Grouse, Partnership, native Seed Network	private, BLM		Model for sage steppe grassland management			x			
DEQ 319 projects		Ongoing	2003	2004	DEQ	DEQ				x	x	x	x	x
Amphibian monitoring		Ongoing	2003	2013	IDFG	IDFG		Basic amphibian surveys and monitoring across the region. Survey three sites each year focusing on high mountain lakes and wildlife management areas.		x	x	x	x	x
Lost Rivers National Learning Site in Holistic Management	Big Lost & Little Lost	Ongoing	2002	2007	USDA FS & Allan Savory Center for Holistic Management	USDA FS		To assist our communities in building this kind of approach, members of the community have used a variety of models in a few projects, including Holistic Management decision-making (see www.holisticmanagement.org). This planning and decision making process has a track record of helping rural producers and diverse community groups create more productive land (including wildlife habitat) and increased wealth.					x	x
Thousand Springs, Chilly Slough	Big Lost	Complete	2003	2003	RMEF, USFWS, IDFG	RMEF								x

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										BCM	MDL	BCK	LLR	BLR
Medicine Lodge (Irving Creek)	Medicine Lodge		2002	2003	Clark County Conservation District	319 Program, Additional funding sources include Continuous CRP (Conservatio n Reserve Program) for fencing and willows, EQUIP for AFOs, Idaho Soil Conservation Commission	Water Quality	Willow Clumps, Willow pole plantings, Toe rock rip rap, Vertical bundles of willows, V-Notch weirs used for drop structures, Grass, Fencing			x			
Medicine Lodge (Warm Creek)	Medicine Lodge		2003	2004	Clark County Conservation District	319 Program, Additional funding sources include Continuous CRP (Conservatio n Reserve Program) for fencing and willows, EQUIP for AFOs, Idaho Soil Conservation Commission	Water Quality				x			
Romrell WRP Habitat development and management	Clark County				Romrell WRP, Partners for Fish and Wildlife Project	USFWS					x			

Project Name (BPA contract #)	Subbasin/ Location	Status	Begin Year	End Year	Implementin g/ Principal Agency	Funding/ Sponsor	Cause of Limiting Factors	Project Description	Comments/ Results/ Monitoring	Geographic area of coverage				
										BCM	MDL	BCK	LLR	BLR
Beller Farm	Butte County				Butte Soil and Water Conservation District, Beller Farm, Partners for Fish and Wildlife Project	USFWS		Riparian habitat restoration						x
Freeman	Custer County				Butte Soil and Water Conservation District, Freeman, Partners for Fish and Wildlife Project	USFWS		Riparian and wetland habitat protection						x

APPENDIX 4-2—LOSS ASSESSMENT

1 Introduction

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Public Law 96-501) established a process for protecting, mitigating, and enhancing fish and wildlife affected by the construction and operation of hydropower projects in the Columbia River Basin. The act formed the Northwest Power Planning Council (NPPC). The council's purpose was to ensure the region a reliable supply of inexpensive power and balance that goal with the needs of fish and wildlife. In 1982, the council introduced a fish and wildlife program. The council's program takes an adaptive approach to fish and wildlife mitigation and has been amended several times. In 1995, program amendments included a two-step process for resident fish mitigation (Section 10; NPPC 1995). The amendment requested that fish and wildlife managers complete assessments of resident fish losses related to the construction and operation of hydropower facilities. Secondly, the amendment called for the development of biological objectives for mitigation (e.g., escapement, harvest, and production goals).

The purpose of this document is to quantify lotic habitat lost from construction of Minidoka Dam and Palisades Dam. Preliminary estimates of the number of native salmonids (Yellowstone cutthroat trout (YCT) *Oncorhynchus clarki* and mountain whitefish *Prosopium williamsoni*) that likely would have inhabited the lotic habitat lost following dam and reservoir construction are presented here. Losses dealt with here are primarily associated with inundation. A thorough evaluation of fish losses associated with the operational and construction impacts of these projects were beyond the resources and time frames available for the subbasin assessment.

Some would argue that reservoirs created behind dams create a net benefit to fish populations. They would argue that post-reservoir fish populations expand and increased fishermen benefits result. That may be true, but benefits do not accrue to native fish populations and benefits are highly dependent on water levels that are subject to fluctuation due to availability and demand. In addition, fish management costs increase post-reservoir construction, as most reservoir fisheries require substantial supplemental stocking with hatchery fish or new species introduction to support fisheries in the altered habitat.

In August 1998 YCT were petitioned for listing as threatened under the Endangered Species Act, 1973 as amended. While listing was found unwarranted, creation of migration barriers and reservoir construction were included as threats to species persistence in the petition.

Background and Description of Study Area

Minidoka Dam and Walcott Reservoir

Minidoka Dam was completed in 1906 and a power plant was added in 1909. The hydroelectric power plant was one of the first built by the federal government in the northwest (Martin and Meuleman 1989). Minidoka Dam is located 16 km northeast of the Rupert, Idaho (Figure 9). The Dam is a rock-fill structure with a concrete core and stands 26 m high (Figure 10). The dam's crest length is 1,364 m. Elevation at full pool is 1,294 m, which is the optimal elevation for diverting water during the irrigation season. Water storage capacity is $259 \times 10^6 \text{ m}^3$ (BOR 1997). Average annual inflow to the reservoir is $5,778 \times 10^6 \text{ m}^3/\text{yr}$.

The climate in the area of Minidoka Dam is considered semi-arid. Annual precipitation is 32 cm. Summers are hot and dry and winters are cold with a mean annual temperature of 9.4°C. Sagebrush/ wheat grass steppe is the dominant vegetation with the occasional stand of junipers. Riparian vegetation includes sedges and forbs with mixed willow, alders, and cottonwoods (Lay 1999).

Palisades Dam and Reservoir

Palisades Dam was completed in 1957 with the first reservoir spill in 1959. Palisades provides water for irrigation, flood control, recreation, and electrical power generation. The dam was initially equipped with four power-generating units, which provided a total generating capacity of 118 megawatts. These were later upgraded (in the 1990's) to provide a continuous power output of 168 megawatts (Simonds 1995).

Palisades Dam is located 11.3 km southeast of Irwin, in Bonneville County, Idaho near river km 1,450 on the South Fork Snake River (BOR 1996; Figure 11). The concrete gravity-type structure stands 82 m high with a crest length of 640 m (Figure 12). At maximum pool, the reservoir is 1,716 m above sea level. The dam impounds $1,481 \times 10^6 \text{ m}^3$ of water at full pool. The South Fork Snake River drainage area above Palisades Dam is $13,468 \text{ km}^2$ (BOR 1996). Average annual inflow to the reservoir is $5,923 \times 10^6 \text{ m}^3/\text{yr}$.

Fish Species

Historically, YCT populations exhibited resident and migratory life history strategies. Resident populations generally spend their entire lives in tributary and headwater streams. Migratory forms rear in tributary streams for several years and migrate to more productive downstream habitat in larger rivers (fluvial) or lakes (adfluvial). Migratory trout

link resident populations to the species' gene pool. Barriers to migration isolate resident populations, which cause isolated populations to become vulnerable to catastrophic loss through habitat degradation, continued loss of genetic diversity, and potentially local extirpation (USFWS 1999).

Minidoka

Yellowstone cutthroat trout and mountain whitefish are the dominant native salmonids. Utah sucker *C. ardens*, Utah chub *Gila atraria*, and mottled sculpin *Cottus bairdi* are other fishes commonly found above Shoshone Falls (Simpson and Wallace 1982). The construction of Minidoka dam inundated approximately 51.5 km of the Snake River and 4.5 km of tributary streams. Rock Creek and the Raft River are the two largest tributaries entering the Snake River within the boundaries of Walcott Reservoir.

Palisades

Prior to the completion of Palisades Dam, the native sport fish community was dominated by YCT and mountain whitefish. Other native fish found in the South Fork Snake River included sculpin *Cottus sp.*, suckers *Catostomus sp.*, and dace *Rhinichthys sp.* We did not differentiate among the phenotypic variations of YCT.

Prior to the construction of Palisades Dam, The South Fork Snake River supported a good quality cutthroat trout fishery. Catch rates were estimated at 0.68 fish/h in the river above the dam site, similar to the river downstream (Miller and Roby 1957). Fishing in the river was reported as highly seasonal due to the heavy spring flows and fluctuations from Jackson Lake (USFWS 1947). Historically the South Fork Snake River was known for its large cutthroat trout and it was not uncommon to harvest up to 2.3 kg trout (Moore et al. 1981). Local anglers reported these large fish became scarce within three to

five years following the completion of Palisades Dam (Miller and Roby 1957).

Palisades Dam is an impassible barrier to migrating cutthroat trout. The completion of Palisades ended upstream spawning runs of cutthroat trout beyond that point. Large numbers of trout were reported in the afterbay of the dam in 1957. These fish were thought to be remnants of fish that spawned in tributaries above the dam (Miller and Roby 1957).

Methods

Estimating native sport fish losses is exceptionally difficult, especially when pre-impoundment data are nonexistent or qualitative in nature. However, attempts have been made using post-impoundment fisheries information (Zubic and Fraley 1987; Marotz et al. 1998; Fraley et al. 2003). In both studies, the authors estimated native fish losses by averaging population data (e.g., fish / 100 m²) from tributary and river reaches in the same geographical area; and then applied those values to the amount of inundated habitat. We used a similar approach to estimate the losses of YCT and mountain whitefish resulting from the construction of Minidoka, and Palisades dams and reservoirs.

An extensive literature search provided information on pre- and post-reservoir conditions including fish assemblages, available/lost habitat, environmental impacts, and fish densities. When information from the study area was not available or limited in scope, data was pooled from adjacent or similar systems

River kilometers (km) and tributary length lost to inundation were measured using All Topo Maps (ATM), a computerized map viewing software package (Gage 1999). Lengths of inundated tributaries and river channels were measured on USGS 1:250,000

scale topo maps with the ATM software. Maps were enlarged to 150%, and length distances measured using the tracing tool. As a check of the accuracy of ATM, distances measured by the described protocol were compared to distances measured using the odometer in a vehicle. An arbitrary distance on a road (approximately 2.5 km) was measured using ATM and compared to the odometer reading.

Tributary width was determined from IDFG stream survey records, and/or the ATM tracing tool. Mean width of inundated tributaries was estimated by stream order using mean stream width from the same stream above inundated reaches or from similar order streams near the inundated stream reach. Inundated area was calculated by multiplying mean width by inundated length.

Stream order was determined using ATM to view a reservoir tributary from its mouth to the headwaters. Stream order was designated using a hierarchical classification. Intermittent streams, those flowing for only a portion of the year, were recorded separately from perennial streams. Intermittent streams were designated on the maps by a series of dots followed by a straight line. The smallest perennial stream was named a first order and when two streams of the same order (n) joined they became a new order (n + 1), (Allan 1995).

Fish abundance information from streams near inundated reaches was used to approximate pre-inundation fish abundance. Fish loss post-inundation was estimated by multiplying average fish density by inundated area. Fish loss estimates were stratified by stream order. Pre-impoundment fish populations were estimated for each tributary by multiplying the area inundated by the average fish density for that stream order.

Minidoka Dam and Walcott Reservoir

Density estimates data were provided by Lukens (1988). Lukens (1988) sampled fish from the Snake River near Shelley, which is about 120 km upstream from Walcott Reservoir (Figure 1). Fish abundance was estimated using a Schnabel mark recapture method. Fish densities (fish / 100 m²) found in the upriver reach were used to estimate fish loss in the inundated area of the Snake River.

Palisades Dam and Reservoir

Width of inundated stream tributaries was estimated using USFS and IDFG streams survey data. The average width of the South Fork Snake River and Salt River were estimated using the mapping software because there were insufficient data on fifth order streams to provide an average width.

Density estimates from the South Fork Snake River Drainage were used to estimate pre-dam fish densities in the flooded tributaries and the Snake River mainstem. Fish abundance data were provided by the United States Forest Service (USFS) and Idaho Department of Fish and Game (IDFG). Past data from the South Fork Snake River below the dam were used to estimate losses in the main river (Moore and Schill 1984; Elle and Corsi 1994; Gamblin et al. 1998; Dillon et al. 1999). Tributary densities were estimated from population data in tributaries within the impacted reach of the South Fork Snake River (USFS, unpublished data). Average fish densities are shown.

Similar to tributary estimates, existing population data were pooled to estimate pre-impoundment abundance for the South Fork Snake River. Some of the tributary surveys were single pass electrofishing estimates. Single pass data were expanded to total fish abundance using the equation: $y = \text{first pass abundance} \times 1.6236$; $r^2 = 0.75$, $p < 0.01$. The

regression equation was derived by plotting total fish abundance estimates (three pass depletion) from 20 (3 removed as outliers) stream reaches as a function of first pass abundance.

ResultsMinidoka Dam and Lake Walcott

Lake Walcott inundated 51.5 km of the Snake River. No fish bearing tributaries were inundated by Lake Walcott. Mean width of the Snake River was 269.1 m. Total area inundated of the Snake River was 1,385.84 ha.

Yellowstone cutthroat trout occupy the upper reaches and feeder streams of tributaries but are absent lower in the drainages (Lay 1999; DEQ 1994-97, unpublished data). Mountain whitefish are also absent from the lower reaches of the tributaries near the reservoir. Most of the water that reaches the reservoir is degraded irrigation return water (Lay 1999). Because the diversions are not related to the construction of Minidoka Dam, fisheries losses within 4.5 km of inundated tributaries are insignificant.

Lukens (1988) estimated YCT and whitefish density in the Snake River 120 km upstream from Lake Walcott was .004 and 7.180 fish per 100 m², respectively.

Habitat for 554 YCT and 995,051 whitefish was inundated by lake Walcott and annual loss caused by inundation of the Snake River by Lake Walcott was 554 YCT and 995,051 whitefish beginning in 1906.

Palisades Dam and Reservoir

Palisades Reservoir inundated 27.4 km of the South Fork Snake River and 27.1 km of tributary streams. Mean width of 1st to 5th order streams was 1.2, 2.2, 4.9, 8.0, 9.1, and 35 m, respectively. Mean width of the South Fork Snake River was 117.9 m. Estimated

area inundated of 1st to 5th order streams, and the South Fork Snake River was 346.826 ha. Area inundated by stream order (1st to 5th, and the South Fork Snake River), was .089, 2.124, 3.007, 6.203, 12.383, and 323.020 ha, respectively.

Average YCT and whitefish density was estimated from 2, 10, 17, and 3, for 1st through 4th order streams (except McCoy Creek), respectively. Yellowstone cutthroat trout and whitefish density in McCoy Creek were 6.0 and 1.0. Yellowstone cutthroat trout and whitefish density in the South Fork Snake River were 1.82 and 5.99, respectively. Fish density in the South Fork Snake River was used to estimate Salt River fish density. Yellowstone cutthroat trout and whitefish density ranged between 1.82 and 15.38, and .00 and 5.99 fish per 100 m², respectively.

Habitat for 9,413 YCT and 291 whitefish was lost in tributaries inundated by Palisades Reservoir. An additional 2,253 and 58,790 YCT were lost in the Salt and South Fork Snake Rivers, respectively. Also, an additional 13,495 and 193,489 whitefish were lost to inundation of the Salt and South Fork Snake Rivers, respectively. Annual loss from inundation each year since 1957 includes 70,456 YCT and 207,275 whitefish.

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APPENDIX 4-3— RESEARCH, MONITORING AND EVALUATION ACTIVITIES.

Information for the Research, Monitoring and Evaluation sections were originally taken from the respective Subbasin Summary documents (NWPPC 2002a, NWPPC 2002b, NWPPC 2002c, NWPPC 2002d, NWPPC 2002e) edits and additions to the information contained in the original documents were made by technical team members to update information where necessary.

Upper Snake Subbasin- Henrys Fork Watershed

Research, Monitoring, and Evaluation Activities

Fisheries

BPA funded – Subbasin level

The Snake River Native Salmonid Assessment (Project No. 980002) is an ongoing IDFG research project initiated in August 1998 to: 1) assess the current status of native salmonids in the middle and upper Snake River provinces in Idaho, 2) identify factors limiting populations of native salmonids, and 3) develop and implement recovery strategies and plans. The inventory phase is being used to assess presence/absence and abundance of native salmonids in all major watersheds of the middle and upper Snake River provinces, and concurrent habitat measurements are being used to preliminarily examine factors that influence this presence/absence and abundance. Genetic samples are also being collected to assess the purity of populations and the degree of genetic variability among and within populations of native salmonids. Based on these findings, major limiting factors will be investigated during the second phase of the project. In the third phase, recovery strategies for individual or groups of subbasins will be developed to address the factors most important in limiting the patterns of distribution and abundance of native salmonids.

In the first three years of the project, fish and habitat surveys have been made at a total of 757 sites on private and public lands across southern Idaho in nearly all major watersheds, including the Teton in the Henrys Fork subbasin. Genetic samples of redband trout and Yellowstone cutthroat trout have

been collected at a total of 155 sites, and results are available for 15 sites. Water temperature has been measured and/or obtained from other agencies at 97 stream sites across the middle and upper Snake River provinces. A comprehensive database has been developed that includes data on native salmonid abundance and distribution, genetic samples, habitat summaries, and herpetofauna observations. This project is also evaluating the effectiveness of electrofishing to remove non-native brook trout as a means of reducing threats to native salmonids; after three years of removal in test streams, the brook trout population has not been reduced (Meyer 2000; Meyer and Lamansky in review). Other removal techniques (e.g., Young 2001) may be evaluated in subsequent years in an attempt to find a more viable method of removing non-native salmonids where the long-term persistence of native salmonids is being threatened by the presence of exotic species.

Because the inventory phase is still underway and not yet completed for any one species (Yellowstone cutthroat trout will be completed in 2002), analysis to date for the most part has been preliminary and cursory (Meyer 2000; Meyer and Lamansky in review). However, in a study of Yellowstone cutthroat trout in southeast Idaho, cutthroat trout densities have remained unchanged and size structure has improved over the last 20 years, suggesting that at least at some locations in the middle and upper Snake River provinces, native salmonid populations may currently be relatively stable (Meyer et al. in review).

Non-BPA funded - Subbasin level

Research efforts that involve aquatic resources in the Henrys Fork subbasin are extensive and have been compiled in a bibliography by Van Kirk (2000). Recent

research, monitoring, and habitat improvement projects have been included in this section.

From 1996 to 1999 the Henry's Fork Foundation conducted a recognizance level fish and fish habitat assessment of all the fish-bearing streams in the upper and lower Henrys Fork hydrologic units (Gregory 1997a, 1998a, 2000a, and Gregory and Van Kirk 1998). This study, when combined with work conducted by the USFS (as reported in Jaeger et al. 2000) and IDEQ on Teton hydrologic unit streams (Hill 2001) provides a subbasin-wide assessment of trout distributions (Appendix A) and a nearly complete subbasin view of fish habitat.

The IDEQ has completed a water quality assessment for the Upper Henrys hydrologic unit (Hill and Mebane 1998) and a draft assessment and TMDL for the Teton hydrologic unit (Hill 2001). The Lower Henrys hydrologic unit, which is essentially the main river from Ashton Dam to the mouth and the Fall River drainage, contains no Water Quality Limited (Clean Water Act §303(d)) streams. Therefore, neither a water quality assessment nor a TMDL is required for the Lower Henrys hydrologic unit. The IDEQ's TMDL program is a three-step process that includes 1) preparation of a water quality assessment, 2) development of a TMDL or Watershed Management Plan, and 3) development of an Implementation Plan (Hill 2001). The purpose of the assessment is to:

- describe the physical, biological, and cultural attributes of the hydrologic unit, particularly in relation to surface water resources,
- summarize existing water quality information available for the hydrologic unit,
- describe applicable water quality standards,
- identify and evaluate pollution sources and disturbance activities that contribute to impairment of water quality,
- summarize past and present pollution control efforts, and
- outline water quality management needs including identification of those water bodies that a) require development of a TMDL, b) may be removed from the § 303(d) list because they are not impaired, c) are not subject to TMDL development because the pollutant responsible for impairment is habitat modification or flow alteration, or d) are candidates for § 303(d) listing.

If the water quality assessment demonstrates that a water body identified on Idaho's § 303(d) list is not water quality-impaired and does not require development of a TMDL, IDEQ will develop a revised § 303(d) list that excludes that water body. If EPA approves the revised list, a TMDL will not be developed for the excluded water body. Conversely, if the subbasin assessment demonstrates that a water body is water quality-impaired, the water body will be included on the next § 303(d) list prepared for submission to EPA. Development of a TMDL or management and control plan for newly listed water bodies will be delayed until at least 2006, following completion of the current TMDL schedule. During this time, it is possible that the water body will be restored to a condition that meets water quality standards, making development of a TMDL unnecessary. Currently, 14 stream segments in the subbasin are listed on the §303(d) list.

A whirling disease risk assessment has been conducted for the Henrys Fork subbasin (Gustafson 1998). This assessment is based on occurrence of *Tubifex tubifex*, the only

known secondary host for the parasite *Myxobolus cerebralis*, which is the causative agent of whirling disease. Risk was considered high when *Tubifex* was present in the stream or when invertebrate biodiversity was low. Eight areas were identified as “high risk” areas based on these criteria. These areas were streams from Henrys Lake Flat downstream to Island Park Reservoir, the lower watershed of Sheridan Creek, Island Park Dam tail water, Osborne Springs, Lower Warm River, Porcupine Creek, Lower Fall River and the entire lower elevation area of the Teton River drainage. All of the large springs of the Henrys Fork headwaters and most of the mountain forest streams were listed at low risk. Risk may be reduced in some areas by high summer temperatures and large numbers of non-host worm species.

IDFG Project Level

Henrys Lake

IDFG uses gill nets annually to monitor trends in cutthroat, hybrid, and brook trout populations. Gill nets are also used to monitor abundance and trends in the population of non-native Utah chubs. A creel survey is conducted on an alternate year basis to assess catch rates, total harvest, and angler effort. Gill net and creel data are used to evaluate stocking numbers and stocking strategies as well as evaluate growth and survival of sterile hybrid trout and brook trout. Otoliths are collected annually to assess length-at-age and assess cohort strength in an attempt to understand factors (biotic and abiotic) that affect survival and abundance. Stomach content samples are also collected annually to identify food habits of salmonids and Utah chubs.

Hatchery released fish are marked annually to assess contribution of hatchery fish to the population and evaluate and refine the production of sterilized triploid hybrid and

brook trout. Outmigrating juvenile trout are trapped in tributaries on alternate years to estimate production of naturally produce cutthroat trout. Several irrigation diversions have been screened on Henrys Lake tributaries, and several miles of riparian fence are maintained by IDFG.

Henrys Fork

Populations of trout and mountain whitefish are annually or semi-annually assessed by electrofishing in representative reaches throughout the mainstem Henrys Fork. Otoliths are collected from a sub-sample of fish to enable assessment of cohort strength and evaluate the relationship between flows and year-class strength. Electrofishing surveys and angler catch are being used to evaluate the success of a Yellowstone cutthroat supplementation program in the reach of the river above Island Park Reservoir.

Teton River

Populations of trout are assessed on alternate years in representative reaches in the Teton Valley by electrofishing. Juvenile trout production in tributaries to the Teton River is being evaluated in an effort to better understand factors limiting the Yellowstone cutthroat trout population in the mainstem Teton River. The infection rate of juvenile trout to whirling disease is being evaluated by the use of sentinel cutthroat trout in tributaries and in the mainstem.

BPA funded – Project level

None

Wildlife***BPA funded – Subbasin level***

None

Non-BPA funded - Subbasin level

None

BPA funded – Project level

Non

**Upper Snake Subbasin- Remainder
of Upper Snake Watershed****Research, Monitoring and
Evaluation Activities****Fisheries****BPA-funded Research, Monitoring and
Evaluation Activities****Snake River Native Salmonid Assessment
(Project No. 980002)**

The Snake River Salmonid Assessment is an ongoing research project initiated in August 1998 to assess the current status of native salmonids in the Middle and Upper Snake River Provinces in Idaho (Phase I), identify factors limiting populations of native salmonids (Phase II), and develop and implement recovery strategies and plans (Phase III). The inventory phase is being used to assess presence/absence and abundance of native salmonids in all major watersheds of the Middle and Upper Snake River Provinces, and concurrent habitat measurements are being used to examine factors that influence this presence/absence and abundance. Genetic samples are also being collected to assess the purity of populations and the degree of genetic variability among and within populations of native salmonids. Based on

these findings, major limiting factors will be investigated during the second phase of the project. Recovery strategies for individual or groups of subbasins will be developed to address the factors most important in limiting the patterns of distribution and abundance of native salmonids.

Results

In the first 3+ years of the project, fish and habitat surveys have been made at a total of 757 sites on private and public lands across southern Idaho in nearly all major watersheds, including the Goose, Raft, Rock, Bannock, Portneuf, Blackfoot. Genetic samples of redband trout and Yellowstone cutthroat trout have been collected at a total of 155 sites, and results are available for 15 sites. Water temperature has been measured and/or obtained from other agencies at 97 stream sites across the middle and upper Snake River provinces. A comprehensive database has been developed that includes data on native salmonid abundance and distribution, genetic samples, habitat summaries, and herpetofauna observations. This project is also evaluating the effectiveness of electrofishing to remove non-native brook trout as a means of reducing threats to native salmonids; after three years of removal, the brook trout population has not been reduced (Meyer 2000; Meyer and Lamansky 2001, in progress). Other removal techniques (e.g., Young 2001) may be evaluated in subsequent years in an attempt to find a more viable method of removing non-native salmonids where the long-term persistence of native salmonids is being threatened by the presence of exotic species.

Because the inventorying phase is ongoing and not completed for any one species (Yellowstone cutthroat trout will be completed in 2002), analysis to date for the most part has been preliminary and cursory (Meyer 2000; Meyer and Lamansky 2001). However, in a study of Yellowstone cutthroat

trout densities across southeast Idaho, densities remained unchanged and fish size structure improved over the last 20 years, suggesting that at least at some locations in the middle and upper Snake River provinces, native salmonid populations may be relatively stable (Meyer *et al.* in review). Maturity of Yellowstone cutthroat trout has been determined for a number of locations across southeast Idaho to assess effective population size for extinction risk analysis in Idaho.

Non BPA funded Research, Monitoring and Evaluation Activities
None reported.

Wildlife

BPA-funded Research, Monitoring and Evaluation Activities
None reported.

Non BPA-funded Research, Monitoring and Evaluation Activities
None reported.

Snake Headwaters Subbasin

Research, Monitoring and Evaluation Activities

BPA-funded

Snake River Native Salmonid Assessment Research (Project No. 980002)

This project is conducted by the Idaho Department of Fish and Game. The overall goal of this research is to protect and rebuild populations of native salmonids in the middle and upper Snake River provinces to self-sustaining, harvestable levels. Associated with this goal are three specific objectives, which are being implemented in phases:

Objective 1. Assess current stock status and population trends of

native salmonids and their habitat.

Strategy 1: Coordinate with other ongoing projects and entities to avoid data duplication and to prioritize sampling efforts.

Strategy 2: Use electrofishing and snorkeling to estimate presence/absence and abundance of salmonids throughout the middle and upper Snake River provinces.

Strategy 3: Identify, describe, and measure stream habitat and landscape-level characteristics at the fish sampling sites.

Strategy 4: Collect genetic samples (fin clips) from native salmonids to determine (using microsatellite DNA markers) the purity of populations and the degree of genetic variability among and within populations.

Strategy 5: Develop models that explain the occurrence and abundance of native salmonids based on measurable characteristics of stream habitat and landscape features. Results will identify populations at risk and in need of recovery strategies, and will guide study design for Objective 2.

Objective 2: Based on results from Objective (or Phase) 1, initiate studies to identify major limiting factors and life history and habitat

needs for native salmonid populations throughout the middle and upper Snake River provinces, especially for populations most at risk of extirpation.

Objective 3: Develop and implement recovery and protection plans based on results from Objectives (or Phases) 1 and 2.

Project Description: This is an ongoing research project initiated in August 1998 to assess the current status of native salmonids in the middle and upper Snake River provinces in Idaho (Phase I), identify factors limiting populations of native salmonids (Phase II), and develop and implement recovery strategies and plans (Phase III). The inventorying phase is being used to assess presence/absence and abundance of native salmonids in all major watersheds of the middle and upper Snake River provinces, and concurrent habitat measurements are being used to preliminarily examine factors that influence this presence/absence and abundance. Genetic samples are also being collected to assess the purity of populations and the degree of genetic variability among and within populations of native salmonids. Based on these findings, major limiting factors will be investigated during the second phase of the project. Recovery strategies for individual or groups of subbasins will be developed to address the factors most important in limiting the patterns of distribution and abundance of native salmonids.

Results: In the first 3+ years of the project, fish and habitat surveys have been made at a total of 757 sites on private and public lands across southern Idaho in nearly all major watersheds, including the Weiser, Owyhee, Payette, Boise, Goose, Raft, Rock, Bannock, Portneuf, Blackfoot, Willow, South Fork Snake, and Teton. Genetic samples of

redband trout and Yellowstone cutthroat trout have been collected at a total of 155 sites, and results are available for 15 sites. Water temperature has been measured and/or obtained from other agencies at 97 stream sites across the middle and upper Snake River provinces. A comprehensive database has been developed that includes data on native salmonid abundance and distribution, genetic samples, habitat summaries, and herpetofauna observations. This project is also evaluating the effectiveness of electrofishing to remove non-native brook trout as a means of reducing threats to native salmonids; after three years of removal, the brook trout population has not been reduced (Meyer 2000; Meyer and Lamansky 2001, in progress). Other removal techniques (e.g., Young 2001) may be evaluated in subsequent years in an attempt to find a more viable method of removing non-native salmonids where the long-term persistence of native salmonids is being threatened by the presence of exotic species.

Because the inventorying phase is ongoing and not completed for any one species (Yellowstone cutthroat trout will be completed in 2002), analysis to date for the most part has been preliminary and cursory (Meyer 2000; Meyer and Lamansky 2001). However, in a study of Yellowstone cutthroat trout densities across southeast Idaho, densities remained unchanged and fish size structure improved over the last 20 years, suggesting that at least at some locations in the middle and upper Snake River provinces, native salmonid populations may be relatively stable (Meyer et al. in review). Maturity of Yellowstone cutthroat trout has been determined for a number of locations across southeast Idaho to assess effective population size for extinction risk analysis in Idaho.

Southern Idaho Wildlife Mitigation (Project 1995-057-01)

This project is conducted by IDFG and the Shoshone-Bannock Tribes to implement projects to achieve full mitigation for construction and inundation losses in southern Idaho from development of the federal hydropower system. Monitoring and evaluation actions take place on all acquisitions and easements administered by project managers. The Habitat Evaluation Procedure (HEP) is used to estimate habitat value for protection and/or enhancement credit to BPA. Photopoints and transects are used to monitor changes in vegetation and habitat. Neotropical birds are monitored using established protocols.

Non BPA funded

National Park Service, Grand Teton National Park

Sensitive, threatened and endangered species inventory and monitoring. -- The requirement for the National Park Service to conserve rare species is specifically stated in *NPS Management Policies*: “Consistent with the purposes of the Endangered Species Act, the National Park Service will identify and promote the conservation of all federally listed threatened, endangered, or candidate species within park boundaries and their critical habitats...Active management programs will be conducted as necessary to perpetuate the natural distribution and abundance of threatened or endangered species...The National Park Service also will identify all state and locally listed threatened, endangered, rare, declining, sensitive, or candidate species that are native to and present in the parks, and their critical habitats...(p. 4:11).

Furthermore, *NPS-77 Natural Resources Management Guideline*, states as

the first major program objective: “Inventory and monitor sensitive, candidate, and listed species. This includes mapping species’ distribution in the park, identifying critical habitats (if any), and determining numbers of individuals, threats to the species, and population trends” (p. 270).

Currently, the Park contains small breeding populations of one endangered (peregrine falcon) and two threatened species (grizzly bear and bald eagle). One species listed as experimental (gray wolf) uses the Park on occasion, but is not a resident at this time. Two additional resident species, the lynx and northern goshawk, are under review for listing by the U.S. Fish and Wildlife Service. The Park lists 33 avian species and 9 mammals as “Species of Special Concern”. The Wyoming Natural Diversity Database lists 66 “Plant Species of Concern” as occurring in the Park.

Threatened and Endangered (T & E) Species

As a rare species, the bald eagle has the longest history of monitoring within Grand Teton National Park, with efforts beginning in 1968 (detailed histories of all species addressed can be found in the *Resources Management Plan*). Studies were conducted on the population by various researchers until 1989. Since that time, Park biologists have maintained a monitoring and banding program in coordination with the U.S. Fish and Wildlife Service and the Wyoming Game and Fish Department (WGFD). Bald eagle territories increased from 3-4 in the Park in 1968 to 10 in 1997.

The Park was active in a peregrine falcon reintroduction program from 1980 to 1986, with 52 birds released during a hacking program. The first documented nesting attempt was observed in 1987. That territory has been active every year since that time. In

1990 and 1991, extensive surveys for peregrines were performed, funded by a regional NRPP initiative. No additional eyries were found. A new territory was located in the Park in 1995, and a third in 1996.

Grizzly bear research and monitoring within the Park has been conducted primarily by WGFD through the Interagency Grizzly Bear Committee (IGBC). In 1994, the first grizzly bear mauling in the Park occurred, when a runner was attacked injured in the Two Ocean Lake area. In 1995, grizzly bears were responsible for several domestic cattle depredations within Park boundaries in the Elk Ranch grazing allotment. The following year (1996), depredations continued, and the offending grizzly bear was caught and killed by WGF in accordance with IGBC guidelines. Three additional grizzly bears were caught by Park biologists, one for human habituation, and two for habituation to human attractants. In 1997, grizzly bears again preyed upon domestic cattle in the Elk Ranch allotment, however losses were acceptable and no action was taken. During this situation, WGFD personnel verbally stated that they were relinquishing all responsibility for grizzly bear management within Park boundaries due to staffing constraints. A second grizzly bear mauling occurred in the fall of 1997 in the Parkway during the moose archery season.

Gray wolves have been documented within the Park prior to the 1994 reintroduction effort in Yellowstone National Park, however they did not become established. In 1996, a pair reintroduced in Yellowstone began using areas immediately adjacent to the Park in Buffalo Valley, but finally settled down north of Dubois. In 1997, an entire pack from the Heart Lake area traveled south and began using areas within Park boundaries in the Two Ocean Lake area. They have since returned to Yellowstone, but are expected to use Park lands on a more frequent basis now that they are familiar with

the area. Wolf biologists expect pack establishment within Park boundaries in the unspecified future.

Sensitive Species

Monitoring of a variety of sensitive species has occurred in the Park since the early 1960's when the monitoring of trumpeter swan nests began. Surveys of great blue heron rookeries began in 1968, and the monitoring of osprey nests began in 1972, and both continue on an annual basis. A monitoring program for amphibians was begun in 1991 by an outside researcher, but has since been maintained by Park biologists. Annual harlequin duck surveys began in 1984 but ceased in 1995 due to staffing constraints. Annual sage grouse counts have occurred since the late 1980's. A radiotelemetry research project on bighorn sheep was initiated in 1994 and is maintained by Park biologists, along with helicopter and ground surveys.

Sensitive Species Processes

Aside from formal surveys, additional information on sensitive species is collected through the Park Natural History Field Observation reporting process whereby visitors and staff report observations of sensitive species. Significant observations are followed up with verbal or written interviews and/or site visits to better assess to accuracy and importance of the report.

The current Inventory and Monitoring (I & M) program is the primary responsibility of the Project Biologist, with direction from the Senior Wildlife Biologist. Since 1995, a Resource Management Biologist has not been available to the park. These duties (both I & M related and otherwise) have been reapportioned upon existing staff, reducing the effectiveness of the current I & M program.

Further Park status changes include an increase in:

- a) the number of T & E species (the addition of the gray wolf, possible additional listing of the lynx and the northern goshawk)
- b) the population of all resident T & E species (grizzly bear, bald eagle, peregrine falcon)
- c) the complexity of management of T & E species (grizzly bear depredations, maulings, human habituation)
- d) the complexity of non-T & E wildlife related issues (brucellosis, bison management, black bear management)

Due to decreased staffing and funding levels, some I & M projects had to be eliminated, while the information gained in other projects was severely reduced, resulting in inadequate information in some instances. For example, following the periodic changes in nest trees, the locations of two of the ten bald eagle nests in the Park are currently unknown due to insufficient resources to locate the nests. Although peregrine falcons are expanding in the Park, thorough surveys to search for new sites have not been instituted since 1991.

Idaho Department of Environmental Quality

Programs to assess water quality -- Monitoring activities in Idaho have focused on beneficial uses and ambient water quality trends. Data from Idaho DEQ's monitoring are used to document the existence of uses, the degree of use support, and reference conditions. This monitoring is made up of primarily the collection of biological and physical data. The ambient trend-monitoring network is designed to document water

quality trends at the river basin and watershed scales through the collection of mainly water column constituent data. Biological parameters are being added to this network as well. Fifty-six monitoring stations are currently sampled on a rotating basis to provide data for water quality trend assessment.

The Idaho Department of Environmental Quality is engaged in ongoing research to obtain the most recent and site specific scientific knowledge available for the purposes of refining water quality criteria. DEQ also monitors chemical, physical and biological components of the aquatic environment through the Beneficial Use Reconnaissance Project. DEQ continues to refine the water body assessment guidance for evaluating BURP data. The primary assessments are designed to determine the support status of the two main aquatic life beneficial uses, Cold Water Biota and Salmonid Spawning.

Jackson Fish Hatchery

Currently, evaluations for individual stocking programs are underfunded and are accomplished only if incorporated into a larger, overall study of the habitat or watershed. This information would determine if the wild trout program has benefits over and above the annual production costs or, if the extra costs of this program exceed the benefits derived.

Safari Club International

Mule Deer Recruitment in Southern Idaho --
The SE Idaho Chapter of Safari Club International partnered with the Idaho Department of Fish and Game (IDFG) for this project. The study area is in Game Management Units 54, 55, 56, 57, 70, and 73A located in the Upper Snake subbasin, with additional studies in Game Management

Unit 67 in the Upper Snake Headwaters subbasin and Game Management Units 59 and 59A in the Upper Snake Closed basin. The study period is from 1998 through 2003. The Idaho Chapter of Safari Club International, to date, has donated \$10,000.00 and has supplied hundreds of man-hours trapping deer for the study. \$125,000.00 has been leveraged towards this study through the U.S. Forest Service, the Bureau of Land Management, National Shooting Sports Foundation, National Fish and Wildlife Foundation and Safari Club International. This research has 2 major emphases that will identify factors that influence deer populations in Southern Idaho. The first will determine the effect of predation on mule deer population characteristics such as population growth, recruitment, and mortality. This will include an evaluation of the effectiveness of coyote control as a means to increase deer populations. The second emphasis will identify habitat factors influencing population levels of mule deer in southern Idaho. Without a thorough understanding of how deer and predator populations interact on a large scale, management of deer populations on the typical big game unit level is difficult.

Sharp-tailed Grouse Lek Inventory --

This project is a partnership between the SE Idaho Chapter of Safari Club International and the Idaho Department of Fish and Game (IDFG), and the Southeast Idaho, Jefferson County and Upper Snake River Chapters of Pheasants Forever. The study area is in portions of Bingham, Bonneville, Fremont, Jefferson, Madison and Teton counties located in the Upper Snake Headwaters subbasin and the Upper Snake Closed Basin. The study period is scheduled for March and May 2002. The Idaho Chapter of Safari Club International with matching grants and private contributions has donated \$6,500.00 towards this study. The study partners have pledged an additional \$6,250.00. Biological aides will be hired by the IDFG to systematically

ground search suitable habitat in the identified study area. Additional survey personnel will include Idaho Chapter volunteers. Columbian sharp-tail grouse (*Tympanuchus phasianellus columbianus*) leks will be located and mapped, and the number of birds occupying will be recorded. This project will provide scientifically collected information on distribution and relative abundance of sharp-tailed grouse in a portion of eastern Idaho where only limited data currently exists. This data will be used to develop population management recommendations and prioritize habitat conservation areas.

United States Geological Survey

Interior Columbia Basin Ecosystem --The USGS provides earth science information to the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) project staff, which is completing a scientific assessment of all land in a seven-State region of the Columbia River Basin east of the Cascade Mountains. Goals of the scientific assessment are to understand the development and current state of land, water, plants, animals, and society within the basin and to model future conditions that could result from different management alternatives and disturbances. In coordination with the scientific assessment, the USFS and BLM staff also is developing regional management strategies for Federal lands in the Basin. Goals of the management strategies are to maintain and improve ecological integrity by promoting the natural processes that operate in healthy aquatic, terrestrial, and landscape ecosystems and to provide sustainable flows of resources from Federal lands. Mineral-resource potential of the Interior Columbia Basin is a partial indicator of the potential for economic development, land use, and environmental hazards. USGS scientists have provided detailed digital geologic, hydrologic, and mineral-resource information to USFS and BLM staff biologists, botanists, forest

ecologists, sociologists, and economists; participated in systems modeling; provided data to be used by the agencies in the development of management alternatives; and contributed to several reports.

Hydrologic and Water-Quality Data-- Idaho has seven major river basins--the Kootenai, the Pend Oreille, the Spokane, the Clearwater, the Salmon, the Snake, and the Bear. Rivers in these basins supply surface water for agriculture, industry, hydroelectric-power generation, recreation, fish and wildlife habitat, and other uses within Idaho and in adjacent States. Aquifers supply ground water for these same uses in many parts of the State. Water from geothermal aquifers also is used for space heating. Hydrologic and water-quality data are critical for the day-to-day administration and management of water resources; for determining the extent and severity of droughts; for characterizing and predicting conditions during floods; and for monitoring the effects of people's activities on streamflow, ground-water supply, and water quality. The data also are essential to plan development activities and to carry out interpretive studies that provide information for making decisions about water issues that affect millions of people.

The USGS, in cooperation with the Idaho Department of Water Resources, the Bureau of Reclamation, and more than 20 other local, State, and Federal agencies, collects surface- and ground-water and water-quality data at numerous sites throughout the State. For example, streamflow discharge was measured at 279 gaging stations; water-quality data were collected at 124 of those stations in 1996.

South Fork Snake River

IDFG (with funding from the Bureau of Reclamation) annually monitors populations of cutthroat, rainbow, and brown trout in 2 representative reaches of the South Fork. These data were used in a cooperative project with Idaho State University to assess the relationship between discharge (hydrologic regime) and recruitment of the different species of trout. The relationships are being used to modify the flow regime with the intent of enhancing recruitment of cutthroat trout and inhibit production of rainbow trout. The effects of the flows on recruitment will be monitored by annual electrofishing surveys. The effects on rainbow trout redd success will be evaluated using radio tags buried in rainbow trout redds.

IDFG is currently using fish traps to monitor spawning runs of cutthroat trout and control rainbow trout invasion into tributaries. Various weir and trap designs are being tested in an effort to identify an effective, but low maintenance system.

IDFG conducts creel surveys on the South Fork periodically to monitor angler catch, catch rates, harvest, and effort. Creel surveys will be particularly important to gauge the success of the efforts to educate anglers and encourage rainbow trout harvest in the South Fork.

IDFG is working with a biometrician in a project funded by Trout Unlimited to construct a model to help predict the trends in rainbow and cutthroat trout abundance under a range of management scenarios. The intent is to assess the likelihood of management actions to successfully suppress rainbow trout over a long period of time.

Selected Ongoing or Recently Completed Research Projects

An investigation of coyote (*Canis latrans*) habitat use-movement patterns, and mortality in developed and undeveloped land in Jackson Hole, Wyoming -- A study of coyote (*Canis latrans*) habitat use-movement patterns, and mortality in Grand Teton National Park and the suburban-agricultural areas surrounding Jackson, WY was conducted between 15 August 1999 and 15 August 2000. This research focused on the influence of human development, habitat type, topography, and simulated wolf presence on fine scale coyote habitat use and movement (travel paths). This project also investigated the causes of mortality for marked coyotes, and compares the spatial habitat use, gender, social status, and activity cycles of coyotes that died vs. coyotes that survived. Eight coyotes were captured and fitted with radio collars equipped with activity and mortality sensors to add to the twenty-one surviving coyotes collared by Nate McClennen and Rachel Wigglesworth in 1998. There were a total of fifteen collared coyotes in the suburban-agricultural area and fourteen collared coyotes in Grand Teton National Park and adjacent areas of Bridger Teton National Forest. Marked coyotes were located twice a week by radio telemetry to determine habitat use patterns, response to wolf urine scent grids, and mortalities. Marked coyote movements were tracked weekly using short interval (5-15 minute) relocations to determine patterns of travel paths. During the winter track transects were skied weekly and coyote trails were backtracked and mapped using hand held GPS units to determine travel path patterns. Data analyses on coyote travel paths suggest that coyotes use travel paths mainly in sagebrush-grasslands or forest shrub-grass edge areas. Coyotes frequently used trails and roads, south facing slopes, and ridges when moving long distances. We also

observed frequent use of riparian corridors to move between open meadows mainly in the suburban-agricultural area. There is some evidence that suggests coyotes selectively travel fences and irrigation ditches for long distances in agricultural areas. The data on coyote locations suggests some avoidance of wolf urine scent grids in the National Park area, but not in the suburban agricultural area. We have recorded 9 mortalities (31%) of 29 marked animals. Human caused mortalities made up 88% of the overall mortalities. The influence of spatial habitat use, gender, social status, and activity on mortality is currently being assessed. Radio telemetry locations and travel paths, as well as snow tracking will continue at least through spring of 2001. The goal of this project is to provide information on the baseline parameters of the coyote population in Jackson Hole that can be used in the future to determine what if any impacts wolves, and human developments may have on coyotes in Jackson Hole.

An investigation of wild ungulate impacts on landbirds and their upland aspen habitat in Jackson Hole, Wyoming. --The purpose of this study is to compare the consequences of varying densities of elk (*Cervus elaphus*) and other wild ungulates on:

- 1) landbirds (i.e., smaller, upland-nesting, nongame species) in upland aspen communities and

- 2) habitat parameters within these aspen communities across Jackson Hole, WY.

Recent studies indicate

- 1) wild ungulate browse-induced impacts on landbirds in this and other regions and

- 2) a decline in the condition of woody vegetation on the USFWS National Elk Refuge (NER). Fieldwork

seasons include the summers of 2000 and 2001.

We selected 34 upland aspen stands satisfying a suite of biotic and abiotic criteria, and their location across a broad spatial scale should permit inference into the consequences of browsing over a range of ungulate densities and management jurisdictions. The unique challenge of this study lies in establishing a link between ungulates and birds that may or may not share spatial scale, yet generally do not share temporal scale. To this end, in addition to comparisons of avian and habitat parameters among all stands (e.g. habitat use analyses) and among categories defined by management jurisdictions, comparisons will be made at multiple spatial scales and among categories of aspen stands defined by differential proximate evidence of ungulate use (e.g. twig-browsing and bark-stripping). Analyses underway include comparisons among these categories of, for instance, avian diversity and abundance by nesting guild, understory vegetation parameters, and rates of aspen regeneration and recruitment to overstory. We designed methodologies to provide insight into the cause of hypothesized aspen stand area decay and its incremental consequences on landbird species. Landscape-scale analyses will consider the role of aspen stand size, adjacent landscape composition and stand proximity to feed sites in structuring avian communities. Findings of this study will contribute to an EIS documenting the broader effects of the NER supplemental feeding program, as well as to the NER Comprehensive Conservation Plan required by the USFWS National Wildlife Refuge Improvement Act of 1997. The longevity, mobility and diversity of responses to environmental change characteristic of bird species provide motivation for the study of bird communities as early indicators of habitat decline impacting entire faunas.

Diet and habitat use of coyotes in developed and undeveloped areas of Jackson Hole, Wyoming. -- Coyotes (*Canis latrans*) are ubiquitous. They adapt extremely well to most environments, including areas dominated by people. Coyotes have been moving into urban and suburban areas in increasing numbers as human development encroaches upon open space. The purpose of this study was to examine the differences in diet and habitat use in coyotes that live in suburban and agricultural areas of Jackson Hole, Wyoming with coyotes that live in undisturbed areas of Grand Teton National Park. Coyote scat was collected and washed and will be dissected to determine prey use. Additionally, small mammal live traps were used to determine if prey availability was different between the two areas. Habitat use was measured by using radio telemetry to determine which habitat types coyotes were located in most frequently. Blood was drawn from the coyotes that were captured. Serological tests found that coyotes had been exposed to tularemia, leptospirosis, plague, canine distemper, and brucellosis. The data collected during this study may also be used as baseline data from which to compare how coyote populations might change as wolves (*Canis lupis*) continue to move into Jackson Hole.

Effects of suburban development on the home range and activity of the coyote (*Canis latrans*) in Jackson Hole, Wyoming. -- Despite substantial research on coyotes, few studies have compared coyote ecology in protected areas such as national parks with adjacent areas of suburban and agricultural development. Research in this area could potentially aid in the understanding and management of wildlife found at the interface between developed and undeveloped areas. Twenty-seven coyotes were captured and radio-collared in Jackson Hole, Wyoming during the spring and fall of 1998. Eleven coyotes resided in the suburban/agricultural

areas in the south end of the valley and 17 coyotes were located in Grand Teton National Park. Home ranges were calculated from 1,966 relocations collected from July 1998 through August 1999. Resident coyote home ranges were significantly smaller in the developed areas as compared to the national park during pair formation/gestation and pup rearing seasons. Predictive models indicated that core home range size decreased as suburban development increased and transient coyotes tolerated or were relegated to more developed areas during all biological seasons. Activity of coyotes in the suburban/agricultural areas was significantly lower during the diurnal hours as compared to the coyotes in undeveloped areas. As development continues in Jackson, open space will be reduced, forcing coyotes and other adaptable species closer to human activity. This data suggested that coyotes in suburban/agricultural lands of Jackson Hole adapted to increased human presence by reducing core area size, relegating transient coyotes to higher density developments, and reducing diurnal activity.

The Jackson Hole pronghorn and Sublette mule deer studies -- Western Wyoming is home to the largest, most diverse ungulate populations in the western states. Maintenance of these populations and protection of their habitats is a primary concern among public and private sectors. The objective of this cooperative research effort is to gather baseline movement and distribution data to assist agencies with management decisions and minimize potential negative effects of natural gas development on big game winter ranges and migration corridors. The pronghorn study focuses on a small (~300) herd that summers in the Jackson Hole area and annually migrates ~150 miles to winter in the Green River Basin. We captured and radio-collared 35 pronghorn in Grand Teton National Park and the Gros Ventre River drainage. Telemetry

work identified the unusually long migration route and seasonal ranges this unique pronghorn population depends upon. The mule deer project centers on the Mesa and other winter ranges near Pinedale, where 160+ radio-collars were distributed. Subsequent monitoring has documented extremely long (>85 miles) north by northwest movements into 5 different mountain ranges.

Sage grouse seasonal habitat use in Grand Teton National Park -- The Jackson Hole sage grouse population has experienced a 63% decline since 1995, based on maximum rooster counts on known leks. The current population is 400% below its peak in 1950, and is estimated at less than 175 individuals. The current population needs to increase by 133% to reach viable population levels. It is imperative that potential causative factors be investigated before this population is extirpated. A 3-year project funded by the Wyoming Game and Fish Department and the National Park Service examining seasonal habitat selection and survival of sage grouse in Grand Teton National Park was initiated in 1999. The project is concerned with identifying seasonal habitat inadequacies, important seasonal ranges, and seasonal survival throughout the park. PI: Stanley Anderson RS(s): Matt Holloran, Alison Lyon MFA(s): WY Game & Fish Dept., National Park Service

Determination of factors affecting natural recruitment of Snake River cutthroat trout in spring streams tributary to the Salt River. Four spring streams were studied to provide information on the value of spring streams and habitat improvements on reproduction of the Snake River cutthroat trout in the Salt River Valley, Wyoming. Two of the streams (Christensen and Perk) have had a number of habitat improvements and the other two (Andersen and Bee) have had minimal habitat improvements. Christensen and Andersen creeks were

studied intensively and Perk and Big creeks were studied in less detail to determine if similar trends were occurring among streams.

Project objectives were to:

(1) determine if spawning adults migrate from the mainstem of the Salt River into spring streams and the proportion of adults comprised of migrants;

(2) describe the habitat used for spawning;

(3) determine if rainbow trout are successfully spawning and if hybridization is occurring between Snake River cutthroat trout and rainbow trout;

(4) describe the habitat being used by age-0 fish; and

(5) determine the impact of whirling disease on survival of age-0 fish during the summer.

Preliminary results suggest that:

(1) a larger number of fish migrate into the streams with habitat improvements than into streams without improvements, but the migrants make up less than half the spawning population in both types of streams;

(2) more spawning occurs in the improved streams and there is more spawning habitat available in the improved streams;

(3) adult rainbow trout were observed in Perk Creek and may be hybridizing with Snake River cutthroat trout;

(4) abundance of age-0 fish in unimproved streams was too low to

make inferences about habitat use, but in the improved streams where the abundance was greater there seemed to be ontogenetic changes in habitat use by age-0 fish over the summer and fall;

(5) none of the age-0 fish captured in Perk Creek by electrofishing in 1999 showed clinical signs of whirling disease (blacktail and spinal deformities), but greater than 25% of the age-0 fish captured by electrofishing in Christensen Creek had clinical signs of whirling disease, and

(6) of 200 fish from Christensen Creek out for histological analysis, 80% were infected by *Myxobolus cerebralis* the causative agent of whirling disease.

(PI: Wayne Hubert G: Mike Joyce
(MS) MFA: WY Game & Fish Dept.)

Sport fish and habitat in the Salt River drainage -- There is a need for information on the status of fish and habitat because a variety of land and water uses are having cumulative effects. This is part of a larger study by the WGFD. The Unit's component is to determine the distribution patterns of fishes and habitat over the watershed; describe the features influencing sport fish; and suggest management activities that may enhance sport fisheries. The study encompasses the entire Salt River and 18 of its tributaries. Studies during 1996 and 1997 have shown that fragmentation of the stream system due to irrigation practices and variation in water temperature due to the geomorphology of the surrounding ranges are having substantial effects in fish distribution patterns.

The effects of landscape features on the distribution of *Myxobolus cerebralis* and occurrence of whirling disease among age-0

salmonids in the Salt River drainage, Wyoming-Idaho -- The purpose of this study is to evaluate possible relationships between spatial variation in channel slope, summer water temperatures, seasonal variation in stream flow, and fine sediment deposition among mainstem river reaches and tributaries to the Salt River and the spatial distribution patterns of age-0 trout and whitefish infected with *M. cerebralis* and exhibiting clinical and histological signs of whirling disease. The objectives of this study are to:

- (1) determine to what extent spatial variation in stream habitat features contribute to infection by *M. cerebralis* and signs of whirling disease,
- (2) develop a risk assessment tool that will determine where impacts from *M. cerebralis* may occur, and
- (3) identify possible management interventions that may circumvent outbreaks of whirling disease within the Salt River watershed.

Age-0 salmonids and associated habitat data were collected from 110 locations representing the variety of spatial characteristics within the watershed during summer 2000. Polymerase chain reaction (PCR) analysis is being conducted at the WGFD laboratory to determine *M. cerebralis* infection in individual fish. Histological analysis will be conducted on fish testing positive for *M. cerebralis* to determine the extent of whirling disease. Spatial analyses will be conducted using multivariate statistics and a GIS.

Breeding Ecology of Sandhill Cranes at Grays Lake National Wildlife Refuge -- Historically, Grays Lake supported the largest breeding concentration of greater Sandhill cranes (*Grus canadensis tabida*) in the Rocky Mountain Population. The purpose of this

study is to collect current information on population numbers and breeding success to compare with data collected in the 1950's and 1969-1971. The 4 main objectives of this project are to 1) determine the number of breeding and non-breeding Sandhill cranes; 2) determine nest success and evaluate the factors that affect nest success; 3) describe habitat use by breeding Sandhill cranes; and 4) determine how many pairs successfully raise chicks and how many migrating cranes use the Grays Lake valley. Data was collected during 1997-2000.

In 1997-2000, Sandhill crane nests throughout much of the Grays Lake basin were located by using a spotting scope and binoculars. Nests in tall vegetation or areas not easily viewed were located either on foot or by canoe. For each nest, information was collected on nest height and width, nest site vegetation, water depth, number of eggs, incubation stage, and nest fate (successful, destroyed, abandoned, or other). Data used in this study include those collected on cranes nesting in experimental units (12 Fish and Wildlife Service units where the Habitat Management is conducted), as well as on other public and private lands (non-experimental units) in the valley. A total of 129 nests were monitored in 1997 (60 on experimental units and 69 on non-experimental units); 131 in 1998 (66 and 65), 143 in 1999 (54 and 89), and 173 in 2000 (53 and 120). Apparent nest success rates of all nests averaged 43% in 1997, 66% in 1998, 55% in 1999, and 59% in 2000. Rates in experimental and non-experimental units differed by <7% in 1997 and 1998; larger differences in 1999 (44% vs. 61%) and 2000 (45% vs. 65%) were likely due to very high (>90%) nest success in areas searched only in those 2 years. Rate of renesting seems to vary among years with lower rates corresponding to years of higher nest success (4.6-9.2% of nests in 1997, 1.5-4.5% in 1998, and approximately 10% in 1999 and 2000).

Greater than 57% of monitored crane nests were located in Baltic rush/spikerush and wet meadow plant communities, in water depths averaging <10 cm. Nest success seems to be higher when the nests are more isolated by deep (>40 cm) water.

Spring population surveys were conducted from 17 April to 11 May, 1998-2000, to determine number and distribution of breeding and non-breeding Sandhill cranes in the Grays Lake basin. All cranes seen in the marsh and in adjoining pastures and uplands in the valley were counted during surveys. Mean population counts for 1998-2000 was 728 (n=14, range 613 to 831). Population counts were usually highest at the end of April then counts gradually declined as nesting began in early May and visibility began to deteriorate with rapid growth of vegetation. Each year the number of actual pairs was consistent among counts at 230-250.

Fall population counts were conducted from mid-August through the end of September, 1998-2000. Counts in mid-August include primarily resident Sandhill cranes and their young. Juvenile cranes are distinguished from adult cranes by plumage characteristics in order to determine the proportion of pairs at Grays Lake that successfully raised chicks. Counts during mid-August averaged 729 (n=5, range 628-847) for 1998-2000; 4.9% (1998), 4.4% (1999), and 2.0% (2000) of identifiable cranes were juveniles. Crane numbers started to increase after 20 August as cranes moved into the valley from other areas. Peak numbers (1,203-1,217 in 1998 and 1,485-1,574 in 1999) were counted during mid-September. In 2000, peak numbers (1,579-1,674) occurred in early September. Most cranes departed soon after 23 September, similar to records for earlier years.

Data is currently being analyzed; reports and final manuscripts will be

completed by early summer 2001. Proposals are currently being submitted for continued ecological and management related research of Sandhill cranes. (Austin, J., J. Ball, and A. Henry, September 2000, Breeding Ecology of Sandhill Cranes at Grays Lake National Wildlife Refuge, Idaho USGS, Northern Prairie Research Center, SE, Jamestown, ND [<http://www.npwrc.usgs.gov/grayslk/>])

Biologically Based System Management --

The declines of native plants and animals associated with, and dependant upon, the integrity of river/floodplain structure and function requires an examination of the management approaches that have been employed to either protect these resources and/or efforts for the restoration of rivers. This 3-phase Upper Snake River Biologically Based System Management Project is examining the river/floodplain structure and function to improve aquatic resource conditions between Palisades Dam and Heise. Phase 1 synthesized the significant scientific literature of the focal study. Phase 2 evaluated the hydrogeomorphic structure and function of the Snake River reaches in the focal area and will provide the detailed site-specific understanding of geomorphic and hydrologic processes and form the information platform for building Phase 3. Phase 3, will use hyperspectral imagery to extend the utility and application of on-site field work conducted in Phase 2, and will allow a landscape scale analysis of the entire focal study area resulting in restoration prescriptions this key river reach. One of the primary goals of this project is to accurately predict, and scientifically defend, flow rates requisite for conserving the fishery.

Closed Basin Subbasin

Research, Monitoring and Evaluation Activities

BPA-funded

The Snake River Native Salmonid Assessment (Project No. 980002) is an ongoing IDFG research project initiated in August 1998 to: 1) assess the current status of native salmonids in the middle and upper Snake River provinces in Idaho, 2) identify factors limiting populations of native salmonids, and 3) develop and implement recovery strategies and plans. The inventorying phase is being used to assess presence/absence and abundance of native salmonids in all major watersheds of the middle and upper Snake River provinces, and concurrent habitat measurements are being used to preliminarily examine factors that influence this presence/absence and abundance. Genetic samples are also being collected to assess the purity of populations and the degree of genetic variability among and within populations of native salmonids. Based on these findings, major limiting factors will be investigated during the second phase of the project. In the third phase, recovery strategies for individual or groups of subbasins will be developed to address the factors most important in limiting the patterns of distribution and abundance of native salmonids.

In the first 3+ years of the project, fish and habitat surveys have been made at a total of 757 sites on private and public lands across southern Idaho in nearly all major watersheds, including the Weiser, Owyhee, Payette, Boise, Goose, Raft, Rock, Bannock, Portneuf, Blackfoot, Willow, South Fork Snake, and Teton. Genetic samples of redband trout and Yellowstone cutthroat trout have been collected at a total of 155 sites, and results are available for 15 sites. Water temperature has been measured and/or obtained from other agencies at 97 stream sites across the middle and upper Snake River provinces. A comprehensive database has been developed that includes data on native salmonid

abundance and distribution, genetic samples, habitat summaries, and herpetofauna observations. This project is also evaluating the effectiveness of electrofishing to remove non-native brook trout as a means of reducing threats to native salmonids; after three years of removal, the brook trout population has not been reduced (Meyer 2000; Meyer and Lamansky 2001, In progress). Other removal techniques (e.g., Young 2001) may be evaluated in subsequent years in an attempt to find a more viable method of removing nonnative salmonids where the long-term persistence of native salmonids is being threatened by the presence of exotic species.

Because the inventorying phase is ongoing and not completed for any one species (Yellowstone cutthroat trout will be completed in 2002), analysis to date for the most part has been preliminary and cursory (Meyer 2000; Meyer and Lamansky 2001, In progress). However, in a study of Yellowstone cutthroat trout densities across southeast Idaho, densities remained unchanged and fish size structure improved over the last 20 years, suggesting that at least at some locations in the middle and upper Snake River provinces, native salmonid populations may currently be relatively stable (Meyer et al. in review). Maturity of Yellowstone cutthroat trout has been determined for a number of locations across southeast Idaho to assess effective population size for extinction risk analysis in Idaho

Non-BPA funded

USDS Forest Service

The Challis Ranger District of the USDA Forest Service is conducting or participating in the following research/assessment activities in the Little Lost River basin:

- A study assessing the relationship between summer stream

temperature and bull trout distribution and abundance.

- A study assessing the relationship between groundwater temperature and juvenile bull trout distribution in small stream basins.
- A study assessing the feasibility of electrofishing to remove exotic brook trout from small streams.
- A study assessing the relationship between water temperature and brook trout distribution to determine the influence of water temperature on brook trout invading bull trout streams.
- A study to identify which species of fish was native to the Sinks Drainages and the manner in which they were established.
- A study to determine the temporal nature of bull trout spawning.
- An assessment of fish entrainment through water diversions.
- An assessment of fish passage barriers (culverts and bridges) associated with roads and trails.
- A study to determine sculpin species occurrence and distribution.

The Forest Service monitors the following fish and fish habitat parameters in the Little Lost River:

- Fish populations
- Fish habitat
- Riparian vegetation

- Depth fines
- Stream temperatures

The Challis Ranger District of the USDA Forest Service is conducting or participating in the following research/assessment activities in the Big Lost River basin:

- A study assessing the relationship between water temperature and brook trout distribution to determine the influence of water temperature on brook trout invading bull trout streams.
- A study to identify which species of fish was native to the Sinks Drainages and the manner in which they were established.
- An assessment of fish entrainment through water diversions.
- A study to determine sculpin species occurrence and distribution.

The Forest Service monitors the following fish and fish habitat parameters in the

Big Lost River:

- Riparian vegetation
- Depth fines
- Stream temperatures

Idaho Department of Environmental Quality

The Idaho Department of Environmental Quality is engaged in ongoing research to obtain the most recent and site specific scientific knowledge available for the purposes of refining water quality criteria.

Monitoring activities in Idaho have focused on beneficial uses and ambient water quality trends. Data from DEQ's monitoring are used to document the existence of uses, the degree of use support, and reference conditions. This monitoring is made up of primarily the collection of biological and physical data. The ambient trend-monitoring network is designed to document water quality trends at the river basin and watershed scales through the collection of mainly water column constituent data.

Biological parameters are being added to this network as well. Fifty-six monitoring stations are currently sampled on a rotating basis to provide data for water quality trend assessment. DEQ also monitors chemical, physical and biological components of the aquatic environment through the Beneficial Use Reconnaissance Project. DEQ continues to refine the water body assessment guidance for evaluating BURP data. The primary assessments are designed to determine the support status of the two main aquatic life beneficial uses, Cold Water Biota and Salmonid Spawning.

United States Geological Survey

Interior Columbia Basin Ecosystem --The USGS provides earth science information to the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) project staff, which is completing a scientific assessment of all land in a seven-State region of the Columbia River Basin east of the Cascade Mountains. Goals of the scientific assessment are to understand the development and current state of land, water, plants, animals, and society within the basin and to model future conditions that could result from different management alternatives and disturbances. In coordination with the scientific assessment, the USFS and BLM staff also is developing regional management strategies for Federal lands in the Basin.

Goals of the management strategies are to maintain and improve ecological integrity by promoting the natural processes that operate in healthy aquatic, terrestrial, and landscape ecosystems and to provide sustainable flows of resources from Federal lands. Mineral-resource potential of the Interior Columbia Basin is a partial indicator of the potential for economic development, land use, and environmental hazards. USGS scientists have provided detailed digital geologic, hydrologic, and mineral-resource information to USFS and BLM staff biologists, botanists, forest ecologists, sociologists, and economists; participated in systems modeling; provided data to be used by the agencies in the development of management alternatives; and contributed to several reports.

Idaho National Engineering and Environmental Laboratory

The Idaho National Engineering and Environmental Laboratory (INEEL) which is operated by the U.S. Department of Energy, is located on the eastern Snake River Plain in southeastern Idaho. The USGS has monitored hydrologic conditions in the Snake River Plain aquifer at the INEEL since the early 1950's. A multiphase project began in 1987 to characterize the fate and transport of radioactive and chemical constituents in the aquifer. In the first phase of this project, stratigraphic, geochemical, and hydraulic studies are being incorporated to define the ground-water flow system at the INEEL. Complementary studies include the use of environmental tracers to provide information about the rate of ground-water flow and geochemical-reaction experiments to evaluate the chemical processes that affect the transport of waste constituents in the subsurface. In the second phase, numerical flow models are developed to simulate the occurrence and movement of water in the aquifer system. These models integrate data obtained from the first-phase studies and are

used to evaluate the conceptual model of the flow system. In the third phase, a solute-transport model is developed to test hypotheses about the movement of radiochemical constituents in the aquifer. In addition to the large-scale characterization study, the USGS began a flood-plain study in 1994 to delineate the possible extent, volume, and velocity of floods in relation to INEEL processing and storage facilities. Other USGS activities at the INEEL include regional and local surface geologic mapping and subsurface stratigraphic, isotopic, and paleomagnetic studies to help develop hazard assessments for potential threats from earthquakes and volcanic eruptions for the INEEL and for specific reactor and radioactive waste storage facilities. An extensive bibliography of USGS publications and reports relative to the INEEL is in Appendix F.

Hydrologic and Water-Quality Data --Idaho has seven major river basins—the Kootenai, the Pend Oreille, the Spokane, the Clearwater, the Salmon, the Snake, and the Bear. Rivers in these basins supply surface water for agriculture, industry, hydroelectric power generation, recreation, fish and wildlife habitat, and other uses within Idaho and in adjacent States. Aquifers supply ground water for these same uses in many parts of the State. Water from geothermal aquifers also is used for space heating. Hydrologic and water-quality data are critical for the day-to-day administration and management of water resources; for determining the extent and severity of droughts; for characterizing and predicting conditions during floods; and for monitoring the effects of people's activities on streamflow, ground-water supply, and water quality. The data also are essential to plan development activities and to carry out interpretive studies that provide information for making decisions about water issues that affect millions of people.

The USGS, in cooperation with the Idaho Department of Water Resources, the Bureau of Reclamation, and more than 20 other local, State, and Federal agencies, collects surface- and ground-water and water-quality data at numerous sites throughout the State. For example, streamflow discharge was measured at 279 gaging stations; water-quality data were collected at 124 of those stations in 1996.

U.S. Department of Energy, Idaho Operations Office

DOE-ID has had an air, soils, water and foodstuffs monitoring network in place throughout the Snake River Plain since the early 1950s, specifically to monitor radiation levels. Details of this effort can be found in Saffle et al. (2000). DOE-ID also sponsors five remote-area and eight near-facility annual Breeding Bird Surveys (Belthoff et al., 1995), winter and summer big-game counts, and an annual jackrabbit count (Luft and Warren, 2000). Moreover, DOE-ID historically supported a rigorous program of environmental and ecological research of the sagebrush-steppe ecosystem.

Safari Club International Mule Deer Recruitment in Southern Idaho -- The SE Idaho Chapter of Safari Club International partnered with the Idaho Department of Fish and Game (IDFG) for this project. The study area is in Game Management Units 54, 55, 56, 57, 70, and 73A located in the Upper Snake subbasin, with additional studies in Game Management Unit 67 in the Upper Snake Headwaters subbasin and Game Management Units 59 and 59A in the Upper Snake Closed basin. The study period is from 1998 through 2003. The Idaho Chapter of Safari Club International, to date, has donated \$10,000.00 and has supplied hundreds of man-hours trapping deer for the study. \$125,000.00 has been leveraged towards this study through the U.S. Forest Service, the Bureau of Land Management, National Shooting Sports Foundation, National Fish and Wildlife Foundation and Safari Club International. This research has 2 major emphases that will identify factors that influence deer populations in Southern Idaho. The first will determine the effect of predation on mule deer population characteristics such as population growth, recruitment, and mortality. This will include an evaluation of the effectiveness of coyote control as a means

to increase deer populations. The second emphasis will identify habitat factors influencing population levels of mule deer in southern Idaho. Without a thorough understanding of how deer and predator populations interact on a large scale, management of deer populations on the typical big game unit level is difficult.

Sharp-tailed Grouse Lek Inventory -- This project is a partnership between the SE Idaho Chapter of Safari Club International and the Idaho Department of Fish and Game (IDFG), and the Southeast Idaho, Jefferson County and Upper Snake River Chapters of Pheasants Forever. The study area is in portions of Bingham, Bonneville, Fremont, Jefferson, Madison and Teton counties located in the Upper Snake Headwaters subbasin and the Upper Snake Closed Basin. The study period is scheduled for March and May 2002. The Idaho Chapter of Safari Club International with matching grants and private contributions has donated \$6,500.00 towards this study. The study partners have pledged an additional \$6,250.00. Biological aides will be hired by the IDFG to systematically ground search suitable habitat in the identified study area. Additional survey personnel will include Idaho Chapter volunteers. Columbian sharp-tail grouse (*Tympanuchus phasianellus columbianus*) leks will be located and mapped, and the number of birds occupying will be recorded. This project will provide scientifically collected information on distribution and relative abundance of sharp-tailed grouse in a portion of eastern Idaho where only limited data currently exists. This data will be used to develop population management recommendations and prioritize habitat conservation areas

Idaho Department of Fish and Game

Big Lost River

IDFG assesses trout and mountain whitefish populations in 3 reaches below Mackay Dam every 2-3 years by electrofishing. Otoliths are collected from a sub-sample of fish to evaluate cohort strength and assess factors affecting year-class strength.

IDFG has subcontracted with Trout Unlimited to conduct an inventory of irrigation diversions in the Big Lost drainage to assess sites that constitute potential barriers to fish passage or are areas of entrainment.

IDFG is conducting periodic electrofishing surveys and angler interviews to evaluate the success of a Yellowstone cutthroat trout stocking program in the East Fork of the Big Lost River.

IDFG annually assesses fish populations in high mountain lakes to evaluate benefits of fish stocking. These surveys include catch rates, growth rates, presence and abundance of amphibians, and indices of anglers use. These surveys are used to refine stocking rates, or in some instances, discontinue stocking.

Little Lost River

IDFG is working with USFS to translocate bull trout from Sawmill Canyon to Bunting Canyon and Squaw Creeks. IDFG will monitor for establishment of self-sustaining populations.

Snake Headwaters Subbasin (Idaho)

Bald Eagle: Annual nest site monitoring is conducted at 1 nesting territory in the subbasin.

For discussion pertaining to the Wyoming portions of this subbasin, see section above addressing research monitoring and evaluation activities in Teton and Yellowstone National Parks.

Upper Snake Subbasin

Bald Eagle: Annual nest site monitoring is conducted at 70 nesting territories in the subbasin.

Peregrine Falcon: Annual nest site monitoring is conducted at 16 nesting territories in the subbasin.

Closed Basin Subbasin

No research monitoring or evaluation activity was submitted for the Closed Basins.