Snake Hells Canyon Subbasin Assessment

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Prepared for the Northwest Power and Conservation Council

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0 Introduction to Snake Hells Canyon Subbasin Assessment

This assessment is volume one of the *Snake Hells Canyon Subbasin Plan.* Volumes two and three—the inventory and management plan—are provided under separate cover. This assessment was produced as part of the Northwest Power and Conservation Council's (NPCC) subbasin planning process. The assessment, inventory and plan will help direct Bonneville Power Administration's (BPA) funding of projects that mitigate for damage to fish and wildlife caused by the development and operations of the Columbia River basin's hydropower system.

An adopted subbasin plan is intended to be a living document that increases analytical, predictive, and prescriptive ability to restore fish and wildlife. The *Hells Canyon Subbasin Plan* will be updated every three years to include new information to be integrated in a revision of the biological objectives, strategies, and implementation plan. The NPCC views plan development as an ongoing process of evaluation and refinement of the region's efforts through adaptive management, research, and evaluation. More information about subbasin planning can be found at www.nwcouncil.org.

The *Hells Canyon Subbasin Plan* includes three interrelated volumes that describe the characteristics, management, and vision for the future of the Hells Canyon subbasin:

Assessment (Volume 1)—The assessment is a technical analysis that examines the biological potential of the Hells Canyon subbasin to support key habitats and species, as well as factors limiting this potential. These limiting factors provide opportunity for restoration. The assessment describes existing and historic resources and conditions within the subbasin, focal species and habitats, environmental conditions, impacts outside the subbasin, ecological relationships, limiting factors, and a final synthesis and interpretation. A **technical team** was formed to guide development of the assessment and technical portions of the management plan. The technical team was comprised of scientific experts with the biological, physical, and management expertise to refine, validate, and analyze data used to inform the planning process.

Inventory (Volume 2)—The inventory summarizes fish and wildlife protection, restoration, and artificial production activities and programs within the Hells Canyon subbasin that have occurred over the last five years or are about to be implemented. The information includes programs and projects, as well as locally developed regulations and ordinances that protect fish, wildlife, and habitat.

Management plan (Volume 3)—This management plan defines a vision for the future of the subbasin, including biological goals and strategies for the next 10 to 15 years. The management plan includes a research, monitoring, and evaluation plan to ensure that implemented strategies succeed in addressing limiting factors and to reduce uncertainties and data gaps. The management plan also includes information about the relationship between proposed activities and the Endangered Species Act (ESA) and Clean Water Act (CWA).

Multiple agencies and entities are involved in managing and protecting fish and wildlife populations and their habitats in the Hells Canyon subbasin. Federal, state, and local regulations, plans, policies, initiatives, and guidelines are part of this effort. The Nez Perce Tribe, Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife

(WDFW), and IDFG share management authority over the fisheries resource. Federal involvement in this arena stems from ESA responsibilities and from management responsibilities for federal lands, most notably the Hells Canyon National Recreation Area. Numerous federal, state, and local land managers are responsible for multipurpose land and water use management, including the protection and restoration of fish and wildlife habitat. Major management entities involved in developing the *Hells Canyon Subbasin Plan* are outlined below.

Nez Perce Tribe

The Nez Perce Tribe served as lead entity for subbasin planning for the Hells Canyon subbasin. The tribe contracted with the NPCC to deliver the Hells Canyon Subbasin Plan while providing opportunities for participation in the process by fish and wildlife managers, local interests, and other key stakeholders, including tribal and local governments.

The Nez Perce Tribe is responsible for managing, protecting, and enhancing treaty fish and wildlife resources and habitats for present and future generations. Tribal government headquarters are located in the Clearwater River subbasin in Lapwai, Idaho, with offices in Kamiah and Orofino, Idaho. The NPT has treaty-reserved fishing, hunting, and gathering rights pursuant to the 1855 Treaty with the United States. Fish and wildlife activities relate to all aspects of management, including recovery, restoration, mitigation, enforcement, and resident fish programs.

Northwest Power and Conservation Council

The NPCC has the responsibility to develop and periodically revise the Fish and Wildlife Program for the Columbia Basin (NPCC 2000). In the 2000 revision, the NPCC proposed that 62 locally developed subbasin plans, as well as plans for the mainstem Columbia and Snake rivers, be adopted into its Fish and Wildlife Program. The NPCC will administer subbasin planning contracts pursuant to requirements in its Master Contract with BPA (NPCC 2003). The NPCC will be responsible for reviewing and adopting each subbasin plan, ensuring that it is consistent with the vision, biological objectives, and strategies adopted at the Columbia Basin and province levels.

Bonneville Power Administration

The BPA is a federal agency established to market power produced by the federal dams in the Columbia River basin. As a result of the Northwest Power Act of 1980, BPA is required to allocate a portion of power revenues to mitigate the damages caused to fish and wildlife populations and habitat from federal hydropower construction and operation. These funds are provided and administered through the Lower Snake River Compensation Plan (LSRCP). BPA provided the funds for subbasin planning contracts administered by the NPCC.

The Nez Perce Tribe subcontracted with Ecovista to facilitate the planning process and write plan documents. The Nez Perce Tribe subcontracted with the Idaho Council on Industry and the Environment (ICIE) to organize the public involvement and public relations tasks for the Hells Canyon subbasin. Staff at the NPT, Ecovista and ICIE comprised the **Project Team**. The Project Team coordinated the formation of the **Hells Canyon Planning Team** and **Technical Team**. The Planning Team was composed of representatives from government agencies with jurisdictional authority in the subbasin, fish and wildlife managers, county, industry, and user group representatives, and private landowners. The Planning Team guided the public involvement process, developed the vision statement, helped develop and review the biological objectives, and participated in prioritizing subbasin strategies. The technical team included scientific experts who guided the development of the subbasin assessment and plan. The technical team guided and participated in developing the biological objectives, strategies and research, and monitoring and evaluation sections of the plan, and the team reviewed all project documents. For more information about the Project Team, Planning Team and Technical Teams, including lists of participants, please see the introduction to Volume Three, *Snake Hells Canyon Subbasin Management Plan*.

For more information on subbasin planning and on subbasin planning in the Snake Hells Canyon Subbasin, please see the introduction to Volume Three, *Snake Hells Canyon Subbasin Management Plan*. This volume also contains information on public involvement and the review process.

1 Subbasin Overview

1.1 Subbasin Size and Location

The Snake Hells Canyon subbasin includes the mainstem of the Snake River and the small tributaries that flow into it as the Snake River flows from Hells Canyon Dam to the mouth of the Clearwater River at Lewiston, a length of 109 miles (river mile [RM] 247 to RM 138; Figure 1). The Snake River forms the border between Oregon and Idaho for the upper 71 miles of the subbasin and the border between Washington and Idaho for the lower 38 miles. The subbasin contains 862 square miles, or 551,792 acres. About 62% of this area falls in Idaho, 31% is in Oregon and the remaining 7% is in Washington. The subbasin contains part of five counties: Adams, Idaho, and Nez Perce in Idaho; Asotin in Washington; and Wallowa in Oregon. The lower portion of the subbasin contains the town of Asotin and portions of Clarkston and Lewiston. The remainder of the subbasin is either rural or undeveloped. The Salmon, Imnaha, Grande Ronde, and Clearwater rivers, as well as Asotin Creek, are major tributaries that join the Snake River in the Snake Hells Canyon subbasin. These rivers drain a combined area of 19,280 square miles (12,339,200 acres) and dramatically influence the water quality and hydrologic conditions in the Snake River.

Archaeological evidence suggests that the Snake Hells Canyon subbasin has been inhabited by Native Americans for the last 7,100 to 10,000 years. The subbasin's relatively mild winters, lush forage, and plentiful wildlife made it a particularly attractive home. It was consistently inhabited by the Nez Perce and frequently visited by the Shoshone-Bannock, Northern Paiute, and Cayuse Indians. The canyon's rock walls were an ideal canvas for ancient pictographs, and the inaccessibility of the subbasin has aided in their preservation. The unique geology and inaccessibility of the subbasin have made it a place of extreme cultural significance (USFS 1999). The entire subbasin is within the lands ceded by the Nez Perce Tribe to the federal government under the Treaty of 1855, and the tribe maintains treaty rights to fish, roots and berries, hunting, and pasture for horses and livestock in this area (Figure 1).

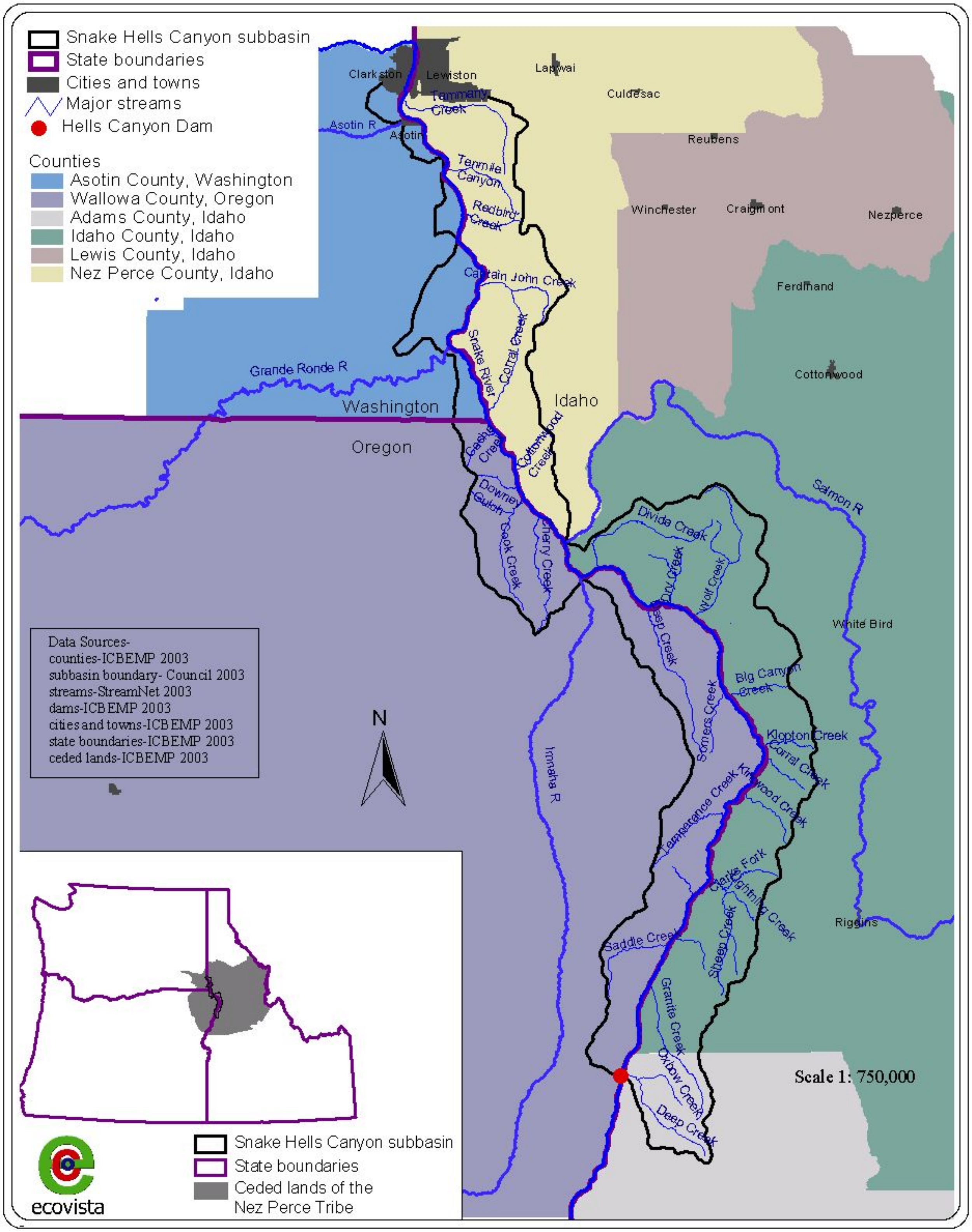

Figure 1. Location and major features of the Snake Hells Canyon subbasin.

1.2 Topography, Geology, and Soils

Elevations in the Snake Hells Canyon subbasin are highly variable, ranging from a low of 218 meters (715 feet) at its confluence with the Clearwater River (RM 139.3) to more than 2,860 meters (9,384 feet) in the peaks of the Seven Devils Mountains (Figure 2). He Devil Mountain, the tallest of the Seven Devils, towers almost 8,000 feet above the river below, creating the deepest gorge in the United States. The canyon averages 10 miles across. The upper part of the subbasin is characterized by an elevated mountainous mass cut by the deep canyons of the Snake and Salmon rivers; to the north is a gently undulating plateau 3,000 to 5000 feet in elevation (WDFW et al. 1990).

The most important events to shape Hells Canyon began about 13 million years ago when lava flows to the south dammed the Snake River, forming paleo-Lake Idaho, which was 150 miles long and 50 miles wide (Orr and Orr 1996). During this time, the Snake River was a tributary to the Salmon River north of Oxbow Dam. The mountain building of the Northern Rockies, which began sometime in the past 6 million years and still continues, uplifted the mountains to their current elevations, causing rivers and streams to rapidly incise the landscape and form the many canyons and gorges throughout the region (Orr and Orr 1996). Headward erosion of the Snake River in the southward direction cut through the lava dam, emptying Lake Idaho about 2 million years ago. The enormous amount of water spilling into the Snake River greatly increased the downcutting of the Hells Canyon, undercutting the Salmon River and making it a tributary to the Snake River at the same time (Vallier 1998).

The over-steepened side slopes of Hells Canyon caused many landslides to occur, forming many colluvial and alluvial fans near the base of the canyon. Wind-blown loess and volcanic ash have been deposited in the area and now mantle the ridges and summits on both sides of the canyon (USFS 1981a). During the late Pleistocene epoch (14,500 years ago), the Bonneville flood swept down through the Snake River, further steepening canyon slopes, creating terraces, and depositing gravels (Vallier 1998).

The formation of Hells Canyon is one of the most interesting geologic stories in North America. Major events begin in the Pennsylvanian period, about 300 million years ago when a volcanic island arc was accreted to the North American continent (Vallier 1998). The resulting formations containing volcanic, sedimentary, and metamorphic rocks are part of the Seven Devils Group (Orr and Orr 1996). The lithology of the Seven Devils Group includes argillite/slate, sandstone, mud/siltstone, interlayered meta-sedimentary, mafic meta-volcanic, and granitic gneiss. This group of rocks forms much of the bedrock through which the river currently cuts at the bottom of Hells Canyon and is an important influence on channel morphology and habitat (Hubbard 1956).

Jurassic and Cretaceous (160–120 million years ago) calc-alkaline intrusive granite associated with the Idaho batholith forms the high peaks of the Seven Devils Mountains and outcrops in various locations around Sheep Creek and the Triangle, Cactus, and Craig mountains (Vallier and Brooks 1986). The granite tends to weather into coarse granular sediment forming grussic, noncohesive soils prone to slope failure and mass wasting at higher elevations (McClelland et al. 1997).

The most dominate rock type in the Hells Canyon is the mafic volcanic flows from the early Miocene epoch (17.5–15 million years ago) Columbia River Basalt Group (Hooper and Swanson 1990). Many layers of lava form bench topography with cliff-faced rock outcrops intermixed with soils on the steep mid to upper slopes of the canyon (Figure 3). Basalt is prone to rockslides, forms many colluvium and alluvium deposits throughout the canyon, and is a major contributor of gravel and cobbles into the Snake River.

Soils within Hells Canyon influence erosion and sedimentation into the Snake River and its tributaries, affecting water quality and habitat. The primary factor governing soil development is the deep canyon itself, with steep continuous slopes that often continue well over a mile from the river to the crest of the mountain ridges on either side, ascending through several soil climatic regimes. Vegetation and soil development within the canyon are heavily influenced by the east/west-facing canyon sides that receive different precipitation and the north/south-slope aspects caused by many ephemeral streams receiving sunlight differently.

Soils in the canyon commonly contain varying amounts of coarse angular gravels, cobbles, silt, and ash (USFS 1981a). Many rock outcrops interrupt the soil landscape on the midslopes of the west-facing Idaho side and along the upper slopes of the east-facing Oregon side of the canyon. The intermittent outcrops and coarse material can inhibit erosion from surface runoff and reduce sediment transport.

Grassland soils called Mollisols are the dominant soil type in Hells Canyon (Figure 4). Many variations of this soil occur because it forms over the wide variety of conditions that exist throughout the canyon. The most common subtype forms in a semiarid environment and contains a clay-rich subsurface horizon. Near Lewiston, Idaho, the grassland soils at lower elevations with less precipitation are noted for having lime hardpans with some soils having natric or sodic horizons. In the higher elevations along the ridges of the Craig Mountains on the Idaho side of the canyon, clay-rich grassland soils grade into Alfisols. These soils often have an organic litter layer that protects them from surface erosion when left undisturbed.

In the area of the Seven Devils Mountains above 7,000 feet elevation, cold temperatures and recently exposed bedrock have severely restricted soil development and submature, coarse-grained, grussic soils called Inceptisols formed from granite and on the glacial till found in the area (USFS 1981b). These soils are noncohesive and prone to slope failure. Volcanic ash deposited over the whole region accumulated deep enough in the upper elevations on the Oregon side to form ashy soils called Andisols. These soils have a wide variety of properties, and erodibility is difficult to assess.

Few studies of soils and soil erosion have taken place in Hells Canyon, so information on the erosion characteristics and processes of soils is limited. Soils identified in the canyon are highly erodible (high K-factors) because of high silt/fine sand texture along with high concentrations of volcanic ash. However, surface erosion processes, such as rill and sheet erosion, are not as common in the canyon as in other nearby watersheds due to the undisturbed protective cover of grassland and shrub-steppe vegetation as well as forest canopies on many north-facing side slopes (Art Kreger, soil scientist, U.S. Forest Service [USFS], personal communication, May 2, 2001). Within the side slopes of the many draws on the Oregon side of the canyon in the bench topography, evidently some soil creep has taken place because deep current soils overlie horizons of rich, dark organic topsoil from past grassland soils (Art Kreger, soil scientist, USFS, personal communication, May 2, 2001).

Unlike soil erosion, the many hazards associated with geology in the Hells Canyon National Recreation Area (HCNRA) have long been studied (Vallier 1994, 1998). Erosion processes taking place in the canyon consist mainly of various forms of mass wasting, with rock and debris flows being the most prevalent. Sustained rainfalls and shaking from the many earthquakes that take place in and around Hells Canyon increase the likelihood of landslides occurring (Vallier 1994).

Because of the continuous steep slopes on either side of the canyon, landslides and debris flows can travel great distances downslope, often reaching the bottom. The colluvium at the bottom of many steep slopes, which is often unstable and subject to movement at any time, is also a source for sedimentation into streams. Undercutting by stream erosion or road construction has increased instability and movement on these deposits (Vallier 1994).

Rockslides in Hells Canyon and large falling rocks are an imminent danger to travelers in the HCNRA. Rock falls occur without warning on almost a daily basis. Rocks falling onto powerline roads have been known to leave indentations in these roads (Vallier 1994).

Although the many gravel bars, alluvial fans, river terraces, and landslides have occupied the Hells Canyon area for many thousands of years, sedimentation from fine material from more recent modern influences is still a large concern.

1.3 Climate and Weather

Climatic conditions in the Snake Hells Canyon subbasin are driven by summertime marine air moving up the Columbia River from the Pacific Ocean and Arctic air masses that spill over the Rockies during the winter. The 300-mile distance from the coast and the barrier provided by the Cascade Mountains moderates Pacific air masses and introduces many continental characteristics (Moseley and Bernatas 1991), such as hot summer temperatures (mean temperatures of 80–90 °F, with maximums often exceeding l00 °F) that are mediated by short and intense thunderstorms derived from thick, moist layers (Chapman 2001). In lower-elevation areas, occasional thunderstorms occurring from late spring through summer may result in flash floods that produce annual peak flows in localized areas. However, thunderstorms are generally brief and limited in size, resulting in highly localized impacts where they occur.

Arctic air masses may dominate the area during winter months, although Pacific air normally flushes these systems out, producing relatively mild winters (mean temperatures > 30 °F). At mid-elevations and on the upper plateau, temperatures are cooler with moderately severe winters and warm summers (Cassirer 1995). Precipitation comes in the form of short intense summer storms and longer, milder winter storms (IDEQ and ODEQ 2001). Timing, duration, and volume of peak flows are driven by snowmelt and/or seasonal rainstorms at lower elevations (< 5,000 feet) in the Snake Hells Canyon subbasin. Therefore, interannual variability in both the timing and volume of peak flows can be expected to be much greater than that at higher elevations. Rainstorms having the greatest impacts to hydrology at lower elevations are those occurring during winter or spring, with precipitation falling on frozen or snow-covered ground. Such rain-on-snow events can occur from November through March (Thomas et al. 1963) and may result in hydrograph peaks throughout this period.

Between 1961 and 1990, the average annual precipitation measured near Lewiston was 12.4 inches. The maximum annual precipitation recorded at this location during the same time period was 15.4 inches. Precipitation patterns do not change dramatically upstream: measurements taken at Weiser, a small town 225 miles upstream of Lewiston and 109 miles upstream of Hells Canyon Dam, indicate little change in precipitation patterns from those measured at Lewiston. Between 1961 and 1990, the average annual precipitation measured at Weiser was 11.3 inches. The maximum annual precipitation recorded at Weiser during this period was 16.3 inches (IDEQ and ODEQ 2001). Precipitation patterns do change dramatically with elevational increases in the subbasin. Data generated by the PRISM project indicate that the highest average annual precipitation of 51 inches per year occurs in the Seven Devils Mountains, the highest elevational area of the subbasin (Figure 5; Daly et al. 1997). Above 5,000 feet, more than 70% of the annual precipitation is in the form of snow (IDEQ 1998).

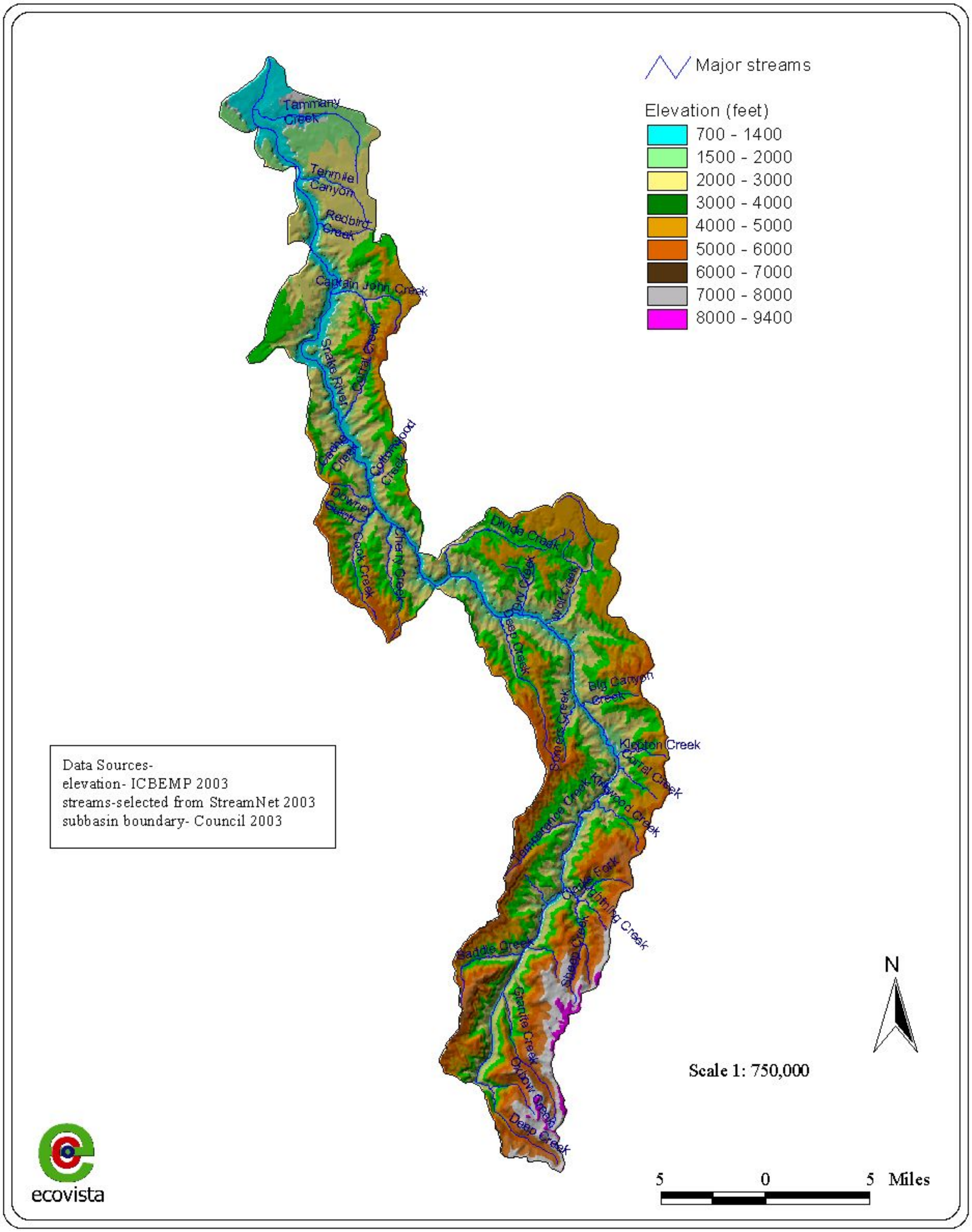

Figure 2. Topography and elevation in the Snake Hells Canyon subbasin.

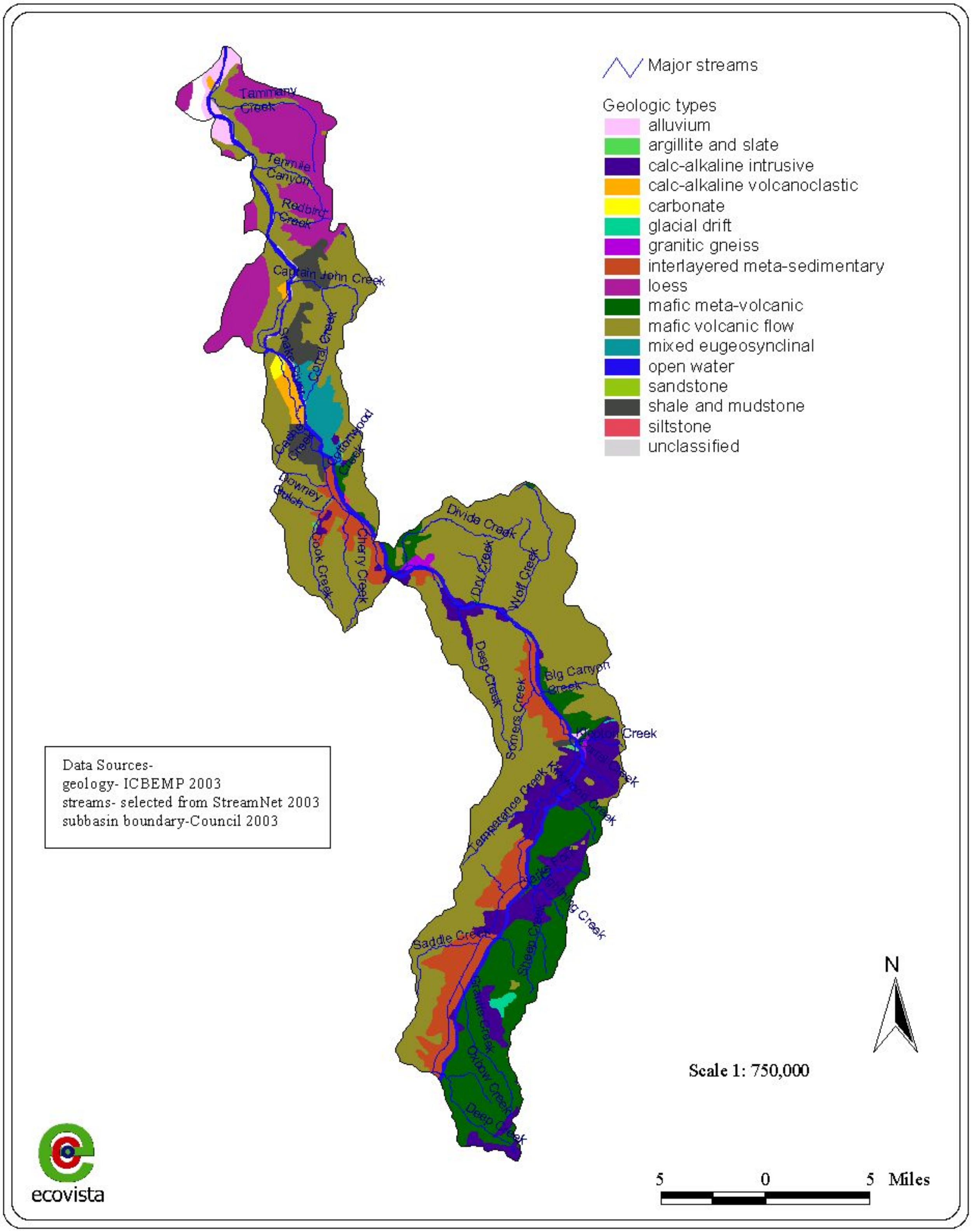

Figure 3. Geology of the Snake Hells Canyon subbasin.

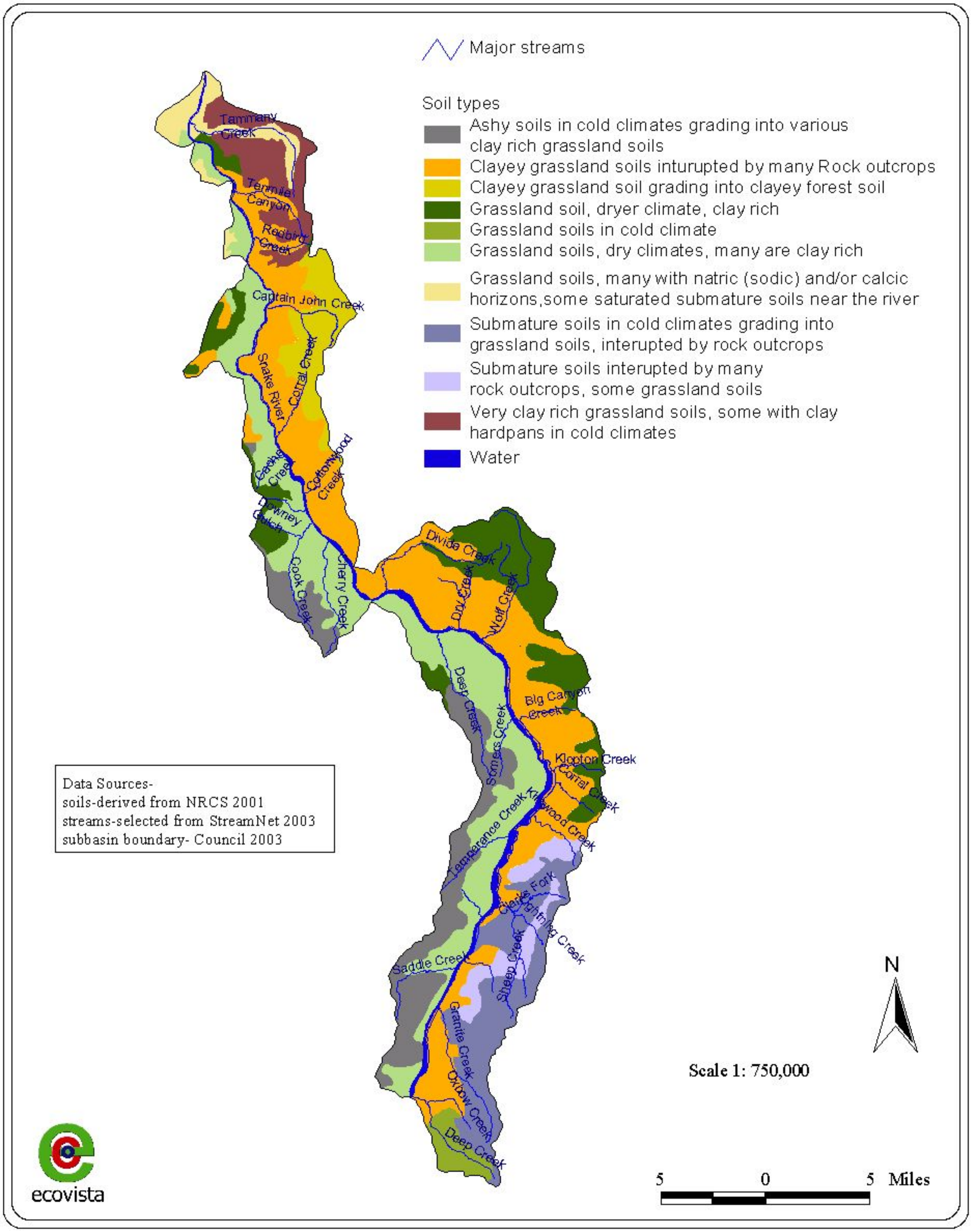

Figure 4. Soils of the Snake Hells Canyon subbasin.

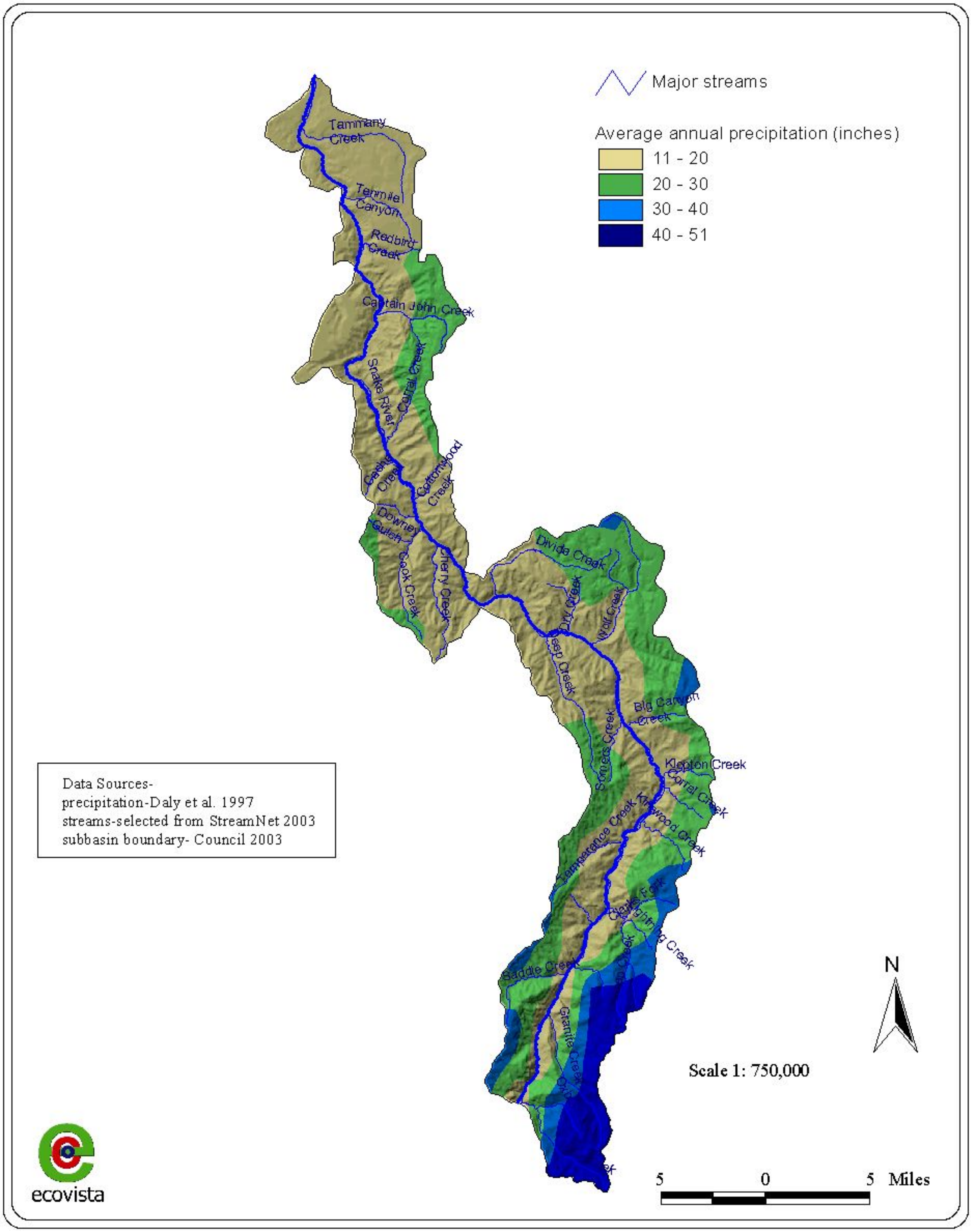

Figure 5. Precipitation patterns in the Snake Hells Canyon subbasin.

1.4 Land Cover and Wildlife Habitat Types

The flora of the Snake Hells Canyon subbasin is exceptionally diverse. This diversity reflects the complex topography, varied soil conditions, and dispersal corridors provided by the Snake and Salmon rivers. The area is home to many rare and endemic species of plants (Mancuso and Moseley 1994). This rich flora is known to include at least 650 vascular plant species, of which approximately 77% are native. Asteraceae (aster family) is the largest contributor to the flora, with a documented 98 species, followed by Poaceae (grass family) with 70 species (BLM 2002).

Wildlife habitat types (WHTs) are groupings of vegetative cover types, based on similarity of wildlife use, that have been delineated across the Columbia Basin by the Northwest Habitat Institute (2003). Descriptions in this assessment of the subbasin's vegetation were organized according to these WHTs to facilitate the assessment of wildlife conditions at the scale of the subbasin and allow for interpretation of this subbasin-scale assessment in the context of the Blue Mountain province and Columbia Basin as a whole.

Johnson and O'Neil define a wildlife habitat as "an area with the combination of the necessary resources (e.g., food, cover, water) and environmental conditions (temperature, precipitation, presence or absence of predators and competitors) that promotes occupancy by individuals of a given species (or population) and allows those individuals to survive and reproduce" (2001). Wildlife habitats are viewed as hierarchical in nature with vegetative type being the coarsest element selected for by a species, vegetative structure the next, and unique habitat elements (e.g., snags) the finest (Johnson and O'Neil 2001).

The current distributions and abundance of WHTs in the subbasin are shown in Figure 6, listed in Table 1, and described below. The Northwest Habitat Institute has also developed estimates of the historical distribution of WHTs in the Columbia Basin. Comparisons of these data with current WHT distributions are presented in section 3.5.10 and Appendix A. Areas designated as shrub-steppe in the original WHT classifications made by the Northwest Habitat Institute for the subbasin were reclassified as interior grasslands for this assessment. Local knowledge and subbasin-specific literature (BLM 2002, USFS 2003a) indicate that areas with either of these WHT designations in the subbasin have very similar characteristics, and both are dominated by similar canyon grassland communities. Therefore, they are more appropriately designated as interior grasslands.

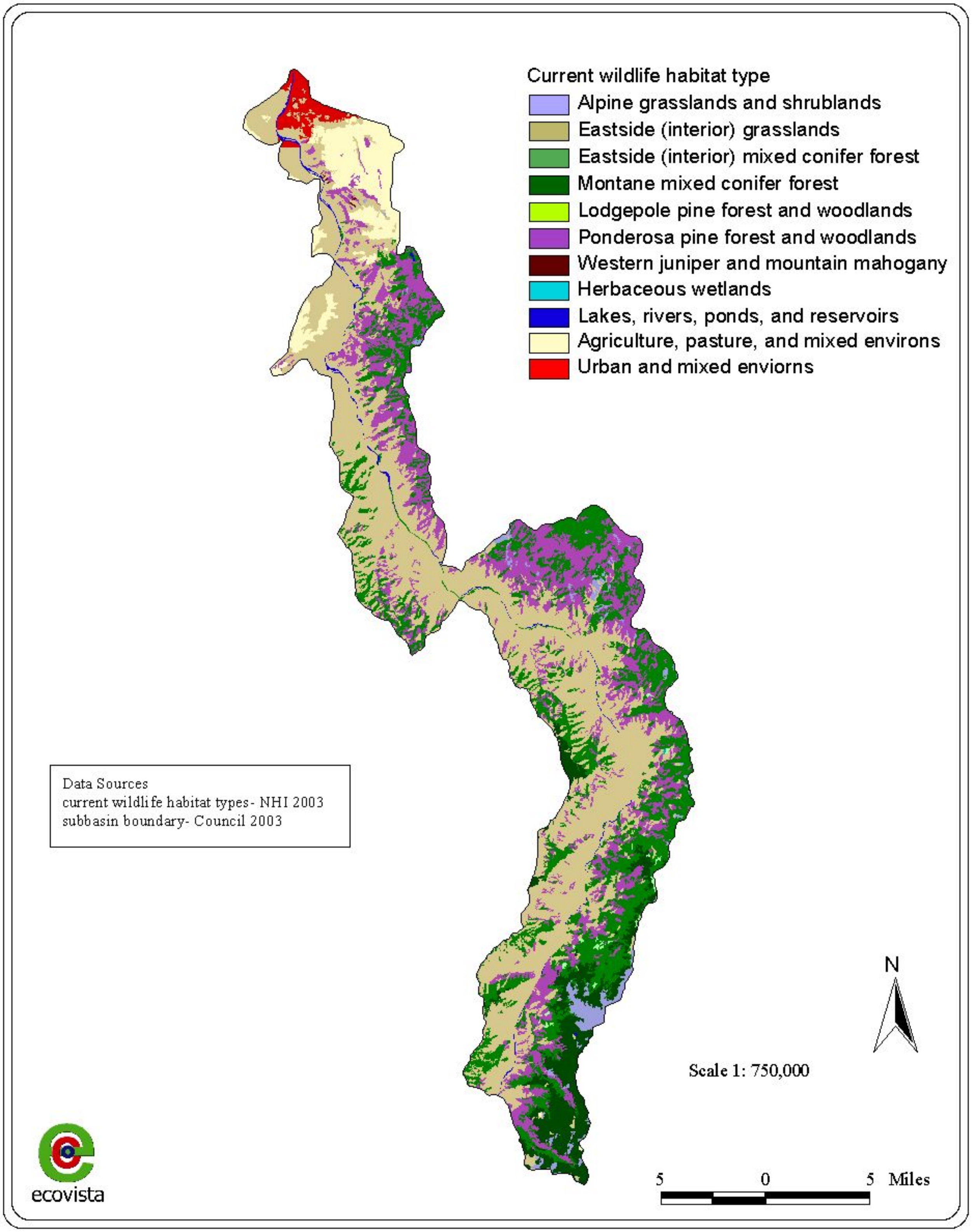

Figure 6. Current wildlife habitat types in the Snake Hells Canyon subbasin.

Table 1. Current acreages covered by the wildlife habitat types of the Snake Hells Canyon subbasin.

Habitat Type	Current Acreage
Interior grasslands (includes shrub-steppe designation)	239,834
Interior mixed conifer forest	115,175
Ponderosa pine and woodlands	110,806
Montane mixed conifer forest	33,483
Agriculture, pasture, and mixed environs	29,956
Alpine grasslands and shrublands	10,309
Urban and mixed environs	7,743
Lakes, rivers, ponds, and reservoirs	3,468
Lodgepole pine forest and woodlands	1,154
Western juniper and mountain mahogany woodlands	270
Herbaceous wetlands	58

1.4.1 Alpine Grassland and Shrublands

Alpine grasslands and shrublands occur in high mountains throughout the Pacific Northwest, including the Cascades, Olympic Mountains, Okanogan Highlands, Wallowa Mountains, and Blue Mountains, as well as on the Steens Mountain in southeastern Oregon. It is most extensive in the Cascades from Mount Rainier north and in the Wallowa Mountains. In the Snake Hells Canyon subbasin, it occupies 10,309 acres and occurs mainly in the Seven Devils area (Figure 6).

The climate is the coldest of any habitat in the region. Winters are characterized by moderate to deep snow accumulations, very cold temperatures, and high winds. Summers are relatively cool. Growing seasons are short because of persistent snowpack or frost. Elevation ranges from a minimum of 5,000 feet to 10,000 feet and always occurs above upper treeline in the mountains or a short distance below it. Small areas of open water, herbaceous wetlands, and subalpine parkland habitats sometimes occur within a matrix of this habitat. Cliffs, talus, and other barren areas are common features within or adjacent to this habitat (Johnson and O’Neil 2001).

This habitat type is dominated by grassland, dwarf-shrubland, or forbs and is extremely variable. Patches of krummholz are a common component of this habitat, especially just above upper treeline. In subalpine grasslands, which are considered part of this habitat, widely scattered coniferous trees sometimes occur. Five major structural types can be distinguished: subalpine and alpine bunchgrass grasslands, alpine sedge turf, alpine heath or dwarf-shrubland, fellfield and boulderfield, and snowbed forb community. Most subalpine or alpine bunchgrass grasslands are dominated by Idaho fescue (*Festuca ovina* var. *ingrata*), alpine fescue (*F. brachyphylla*), green fescue (*F. viridula*), Rocky Mountain fescue (*F. saximontana*), or timber oatgrass (*Danthonia intermedia*) and, to a lesser degree, by purple reedgrass (*Calamagrostis purpurascens*), downy oat-grass (*Trisetum spicatum*), or muttongrass (*Poa fendleriana*). Forbs are diverse and sometimes abundant in the grasslands. Alpine sedge turfs may be moist or dry and are dominated by showy sedge (*Carex spectabilis*), black alpine sedge (*C. nigricans*), Brewer's sedge (*C. breweri*), capitate sedge (*C. capitata*), nard sedge (*C. nardina*), dunhead sedge (*C. phaeocephala*), or western single-spike sedge (*C. pseudoscirpoidea*) (Johnson and O'Neil 2001).

One or more of the following species dominates alpine heaths: pink mountain-heather (*Phyllodoce empetriformis*), green mountain-heather (*P. glanduliflora*), white mountain-heather (*Cassiope mertensiana*), or black crowberry (*Empetrum nigrum*). Other less extensive dwarf-shrublands may be dominated by the evergreen coniferous common juniper (*Juniperus communis*), the evergreen broadleaf kinnikinnick (*Arctostaphylos uva-ursi*), the deciduous shrubby cinquefoil (*Pentaphylloides floribunda*), or willows (*Salix cascadensis* and *S. reticulata* ssp. *nivalis*). Tree species occurring as shrubby krummholz in the alpine are subalpine fir (*Abies lasiocarpa*), whitebark pine (*Pinus albicaulis*), and Engelmann spruce (*Picea engelmannii*) (Johnson and O'Neil 2001).

Most natural disturbances seem to be very infrequent and small scale in their effects. Herbivory and associated trampling disturbance by elk, mountain goats, and occasionally bighorn sheep seem to be important disturbances in some areas, creating patches of open ground. Small mammals can also have significant effects on vegetation. Frost heaving is a climatically related small-scale disturbance that is extremely important in structuring the vegetation. Extreme variation from the norm in snowpack depth and duration can act as a disturbance, exposing plants to winter desiccation, shortening the growing season, or facilitating summer drought. Slow recovery from disturbances is critically important in the maintenance of alpine grassland communities. Where fires have cleared sites previously inhabited by alpine forests, grasslands will form. It may take as much as 500 years for these forests to recover from fire and regenerate (Johnson and O'Neil 2001).

Because of the high elevation and moisture content in this environment, fire usually is not a significant factor in any successional processes. Most of the native grasses in this habitat type can establish themselves eventually on burned sites by wind-dispersed seeds. After low-severity fires, most can also sprout from on-site surviving rhizomes. Whitebark pine (*Pinus albicaulis*) and mixed conifer communities with a whitebark component experience fire frequently, although fire is usually unable to spread due to openings in the canopies and lack of fuel from any understory (Johnson and O'Neil 2001).

Vegetation changes in these communities are relatively slow. Tree invasion rates into subalpine grasslands are minimal compared with those for other subalpine communities. Seedling establishment for many plant species in the alpine zone is poor. Heath communities take about 200 years to mature after initial establishment and may occupy the same site for thousands of years. Most of this habitat is still in good condition and dominated by native species (Johnson and O'Neil 2001).

1.4.2 Interior Grasslands

Interior grasslands are found primarily in the Columbia Basin of Idaho, Oregon, and Washington, at mid- to low elevations and on plateaus in the Blue Mountains, usually within the ponderosa pine zone. In the Snake Hells Canyon subbasin, there is an estimated 239,834 acres of interior grasslands (Figure 6). The grasslands of the subbasin are particularly distinctive. Canyon grasslands are rare within the Columbia Basin, and despite years of disturbance, the Hells Canyon grasslands are among the most intact in terms of the native grassland species component (USFS 1999).

Perennial bunchgrasses dominate the interior canyon grasslands (Mancuso and Moseley 1994). Bluebunch wheatgrass (*Pseudoroegneria spicata*) and Idaho fescue (*Festuca ovina* var. *ingrata*) are the characteristic native bunchgrasses of this habitat and alternate dominance. Idaho fescue is common in moister, higher elevation areas, and bluebunch wheatgrass is more abundant in drier sites. Sand dropseed (*Sporobolus cryptandrus*) or threeawn (*Aristida longiseta*) are native dominant grasses on hot dry sites in deep canyons. Sandberg bluegrass (*Poa sandbergii*) is usually present and occasionally codominant in drier areas. Annual grasses are usually present on more disturbed sites. Medusahead (*Taeniatherum caput-medusae*), Kentucky bluegrass (*Poa pratensis*), and several brome grasses (*Bromus* spp.) can be widespread and codominant (Mancuso and Moseley 1994).

A dense and diverse forb layer can be present or entirely absent. More than 40 species of native forbs can grow in this habitat, including balsamroots (*Balsamorhiza* spp.), desert parsleys (*Lomatium* spp.), buckwheat (*Eriogonum* spp.), fleabane (*Erigeron* spp.), lupines (*Lupinus* spp.), and milkvetches (*Astragalus* spp.). Weedy invasive forbs that can grow in this habitat are knapweeds (*Centaurea solstitialis*, *C. diffusa*, *C. maculosa*), tall tumblemustard (*Sisymbrium altissimum*), hoary cress (*Cardaria draba*), and Russian thistle (*Salsola kali*) (Johnson and O'Neil 2001).

Smooth sumac (*Rhus glabra*) is a deciduous shrub locally found in combination with these grassland species. Rabbitbrushes (*Chrysothamnus nauseosus*, *C. viscidiflorus*) can occur in this habitat in small amounts, especially where grazed by livestock. In moist Palouse regions, common snowberry (*Symphoricarpos albus*) or Nootka rose (*Rosa nutkana*) may be present, but they are shorter than the bunchgrasses. Dry sites contain low succulent pricklypear (*Opuntia polyacantha*). Big sagebrush (*Artemisia tridentata*) is occasional and may be increasing in grasslands on former shrub-steppe sites. Black hawthorn (*Crataegus douglasii*) and other tall shrubs can form dense thickets near Idaho fescue grasslands. Ponderosa pine (*Pinus ponderosa*) may occur within the interior grasslands but mainly on northern aspects (Mancuso and Moseley 1994). Western juniper (*Juniperus occidentalis*) rarely occurs but in isolated patches (Johnson and O'Neil 2001).

A number of factors may be responsible for the loss of native grassland habitat. Disturbances resulting from overgrazing practices and fire have severely degraded bunchgrass community composition (Tisdale 1986). These disturbances favor annuals over perennials because annuals are better competitors overall for soil moisture (Barbour and Billings 2000). Overgrazing by livestock has introduced nonnative, invasive species such as starthistle and knapweed *(Centaurea* spp.), which may dominate most grassland habitats. Many species of invasive annual grasses—including cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), and medusahead (*Taeniatherum caput-medusae*)—increase in dominance after fire and establish grass/fire cycles (Barbour and Billings 2000). Only in steeper, more remote areas where livestock grazing was limited are there healthy, native grassland communities (Mancuso and Mosely 1994).

Fire effects vary with ecological conditions, season, and severity of fire. Intense fires that occur in summer can cause considerable damage to native perennial grasses, resulting in the emergence of annual forbs. Bunchgrasses can usually survive light-severity fires and may reestablish from seed after fire if temperatures are low enough to allow for survival of seed (Wright and Bailey 1982).

Fire suppression can alter the composition of interior grasslands and, subsequently, their natural fire regimes. The result is often a heavy cover of shrubs or woody species. Without fire, black hawthorn patches expand on slopes, along with common snowberry and rose. Fires covering large areas can eliminate shrubs and their seed sources and create interior grassland habitat (Johnson and O'Neil 2001).

When lightning is the fire source, the severity of the fire is determined on whether it is a dry or wet storm (USFS 2003a). The Maloney Creek fire started during a dry lightning storm near the confluence of Maloney Creek and the Salmon River inside the Snake Hells Canyon subbasin; it covered over 74,000 acres. The majority of the burn was on the Idaho Department of Fish and Game's Craig Mountain Wildlife Management Area. The burn was mostly in the steep grasslands and exposed basalt rock cliffs that characterize this area. The Maloney Creek fire burned in an area that has a very active fire history, with natural fire intervals between 10 to 15 years. Since grass is the primary fuel for fires in this habitat, regeneration is rapid, and visible effects from a fire are masked in as short as one year (USFS 2003a).

1.4.3 Interior Mixed Conifer Forest

The interior mixed conifer forest habitat appears primarily in the Blue Mountains, East Cascades, and Okanogan Highland ecoregions of Oregon, Washington, adjacent Idaho, and western Montana. This habitat is located between the subalpine portions of the montane mixed conifer forest habitat and lower treeline ponderosa pine (*Pinus ponderosa*) forests. This habitat type inside the Snake Hells Canyon subbasin consists of an estimated 115,175 acres (Figure 6), with an elevation range between 3,000 and 5,500 feet. These forests consist of Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine forests at the lower, more xeric elevations, and grand fir–Douglas-fir forests and western larch (*Larix occidentalis*) forests at the upper, more mesic elevations (Johnson and O'Neil 2001).

This habitat contains a wide array of tree species and stand dominance patterns. Stand canopy structure is generally diverse, although single-layer forest canopies are currently more common than multilayered forests with snags and large woody debris. The tree layer varies from closed forests to more open-canopy forests or woodlands. This habitat may include very open stands. Undergrowth such as shrubs and forbs may dominate stands (Johnson and O'Neil 2001).

Douglas-fir is the most common tree species in this habitat. Lower elevations or drier sites may have ponderosa pine as a codominant with Douglas-fir in the overstory and often have other shade-tolerant tree species growing in the undergrowth. On moist sites, grand fir (*Abies grandis*), western redcedar (*Thuja plicata*), and/or western hemlock (*Tsuga heterophylla*) are dominant or codominant with Douglas-fir. Other conifers include western larch and western white pine (*Pinus monticola*) on mesic sites, Engelmann spruce (*Picea engelmannii*), lodgepole pine (*Pinus contorta*), and subalpine fir (*Abies lasiocarpa*) on colder sites (Johnson and O'Neil 2001).

Undergrowth vegetation varies from open to nearly closed shrub thickets with one to many layers. Throughout the interior conifer habitat, tall deciduous shrubs include Rocky Mountain maple (*Acer glabrum*), serviceberry (*Amelanchier alnifolia*), oceanspray (*Holodiscus discolor*), mallowleaf ninebark (*Physocarpus malvaceus*), and Scouler's willow (*Salix scouleriana*) at mid- to lower elevations. Medium-tall deciduous shrubs at higher elevations include fools huckleberry (*Menziesia ferruginea*), Cascade azalea (*Rhododendron albiflorum*), and big huckleberry (*Vaccinium membranaceum*). At generally drier sites, widely distributed mid-height to short deciduous shrubs include baldhip rose (*Rosa gymnocarpa*), shiny-leaf spirea (*Spiraea betulifolia*), and snowberry (*Symphoricarpos albus*, *S. mollis*, and *S. oreophilus*). Low shrubs of higher elevations include low huckleberries (*Vaccinium cespitosum* and *V. scoparium*) and five-leaved bramble (*Rubus pedatus*) (Johnson and O'Neil 2001).

Herbaceous broadleaf plants are important indicators of site productivity and disturbance. Species generally indicating productive sites include western oakfern (*Gymnocarpium dryopteris*), vanillaleaf (*Achlys triphylla*), wild sarsparilla (*Aralia nudicaulis*), wild ginger (*Asarum caudatum*), queen's cup (*Clintonia uniflora*), goldthread (*Coptis occidentalis*), false bugbane (*Trautvetteria caroliniensis*), windflower (*Anemone oregana*, *A. piperi*, *A. lyallii*), fairybells (*Disporum hookeri*), Sitka valerian (*Valeriana sitchensis*), and pioneer violet (*Viola glabella*). Other indicator forbs are dogbane (*Apocynum androsaemifolium*), false solomonseal (*Maianthemum stellata*), heartleaf arnica (*Arnica cordifolia*), several lupines (*Lupinus caudatus*, *L. latifolius, L. argenteus* ssp. *argenteus* var. *laxiflorus*), western meadowrue (*Thalictrum occidentale*), rattlesnake plantain (*Goodyera oblongifolia*), skunkleaf polemonium (*Polemonium pulcherrimum*), trailplant (*Adenocaulon bicolor*), twinflower (*Linnaea borealis*), western starflower (*Trientalis latifolia*), and several wintergreens (*Pyrola asarifolia*, *P. picta*, *Orthilia secunda*) (Johnson and O'Neil 2001).

Graminoids are common in this forest habitat. Columbia brome (*Bromus vulgaris*), oniongrass (*Melica bulbosa*), northwestern sedge (*Carex concinnoides*), and western fescue (*Festuca occidentalis*) are found mostly in mesic forests with shrubs or mixed with forb species. Bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca ovina* var. *ingrata*), and junegrass (*Koeleria macrantha*) are found in drier, more open forests or woodlands. Pinegrass (*Calamagrostis rubescens*) and Geyer's sedge (*C. geyeri*) can form a dense layer under Douglas-fir or grand fir trees (Johnson and O'Neil 2001).

Fires in interior mixed conifer forests were probably of moderate frequency, averaging 30 to 100 years before the twentieth century. Currently, fire intervals are averaging between 15 to 20 years. Shorter interval, less severe fires serve to maintain grassland and keep an open forest structure by removing seedlings and understory and enhancing tree regeneration, especially of ponderosa pine (Smith and Fischer 1997).

Most interior mixed forests have Douglas-fir as the most abundant species where fire has been suppressed. Where fire occurs in this habitat type, other tree species are better adapted and can dominate stands (Franklin and Dyrness 1973). Generally, wetter sites burn less frequently and stands are older with more western hemlock and western redcedar than drier sites. Many sites dominated by Douglas-fir and ponderosa pine, which were formerly maintained by wildfire, may now be dominated by grand fir, which is a fire-sensitive, shade-tolerant species (Johnson and O'Neil 2001).

1.4.4 Montane Mixed Conifer Forest

The geographic distribution of these forests is in mountains throughout Washington, Oregon, and Idaho. Within the Snake Hells Canyon subbasin, the habitat type occupies 33,483 acres (IBIS 2003). Montane mixed conifer stands are located in the Wallowa Mountains in Oregon, which are adjacent to the Grande Ronde subbasin, and in the Seven Devils Mountains in Idaho, next to the Salmon subbasin (Figure 6).

This habitat is typified by a moderate to deep winter snowpack that persists for three to nine months. Mean annual precipitation ranges from about 40 inches to greater than 200 inches. Elevation is mid- to upper montane, from as low as 2,000 feet (610 m) in northern Washington to as high as 7,500 feet (2,287 m) in southern Oregon and in the Seven Devils in Idaho. Soils are typically not well developed but varied in their parent material (IBIS 2003).

These forests vary from range to range in overstory, understory, and groundcover composition. They include a mixture of conifers such as Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), western hemlock (*Tsuga heterophylla*), western larch (*Larix occidentalis*), western redcedar (*Thuja plicata*), white fir (*Abies concolor*), and mountain hemlock (*Tsuga mertensiana*). Some shrubs that commonly dominate or codominate the understory are ninebark (*Physocarpus malvaceus*), Scouler's willow (*Salix scouleri*), snowberry species (*Symphoricarpos albus* and *S. mollis*), oval-leaf huckleberry (*Vaccinium ovalifolium*), big huckleberry (*V. membranaceum*), grouseberry (*V. scoparium*), dwarf huckleberry (*V. cespitosum*), fools huckleberry (*Menziesia ferruginea*), devil's-club (*Oplopanax horridum*), and currants (*Ribes* spp.). Important evergreen shrubs include bearberry (*Arctostaphylos uva-ursi*), and Oregon boxwood (*Pachistima myrsinites*). A very diverse selection of graminoids and forbs exists throughout the subbasin (IBIS 2003).

Large areas of this habitat within the Snake Hells Canyon subbasin, specifically the Seven Devils wilderness area, are relatively undisturbed by human impacts and include significant old-growth stands. Fire is the major natural disturbance in this habitat. Other montane mixed conifer sites on private lands within the subbasin have been affected by logging and grazing practices. Windstorms are a common small-scale disturbance and occasionally result in stand replacement. Insects and fungi are often important small-scale disturbances, although they sometimes affect larger areas also (Johnson and O'Neil 2001).

Mean fire-return intervals vary greatly, from around 70 years for lower elevation forests to 400 years for higher elevation forests (FEIS 2004). Long periods of fire suppression may result in crowded to open mixed conifer stands with dense understories, resulting in severe stand-replacing burns. Fire is an important factor in providing wildlife habitat. A fire may thin dense stands of mixed conifer by clearing overstory, reduce competition by removing understory, and rejuvenate sprouting plants, thereby increasing the availability of browse and forage (Crane and Fischer 1986). Some post-fire invaders in this habitat type are lodgepole pine and quaking aspen. Trees of both species mature rapidly following fire and can form extensive even-aged stands (Barbour and Billings 2000).

1.4.5 Lodgepole Pine Forest and Woodlands

This habitat type is found along the interior of the Cascade Rang, as well as in the Blue Mountains and Okanogan Highlands. It ranges north into British Columbia and south to Colorado and California and is located mostly at mid- to higher elevations (3,000–9,000 feet). These environments can be cold and relatively dry, usually with a persistent winter snowpack. In the Snake Hells Canyon subbasin, it intermixes in small populations with montane mixed conifer forests on the east side of the Snake River and also appears occasionally in the Blue Mountains with ponderosa pine habitats (Figure 6). Lodgepole communities occupy only 1,154 acres of the subbasin area.

Rocky Mountain lodgepole pine grows with nearly all of the other mountain conifers in its range and often forms dense, nearly pure even-aged stands (Anderson et al. 1995). Mixed stands of Rocky Mountain lodgepole pine and other species are also common, especially stands of Rocky Mountain lodgepole pine, Engelmann spruce (*Picea engelmannii*), and subalpine fir (*Abies lasiocarpa*) at higher elevations and stands of Rocky Mountain lodgepole pine and Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) at lower elevations (Achuff 1989). Reproduction of other more shade-tolerant conifers can be abundant in the undergrowth.

Dominant lodgepole pine forests are usually associated with other montane conifers such as Grand fir (*Abies grandis*), western larch (*Larix occidentalis*), white pine (*Pinus monticola*), ponderosa pine (*P. ponderosa*), Douglas-fir, subalpine fir, mountain hemlock (*Tsuga mertensiana*), Engelmann spruce, and whitebark pine (*Pinus albicaulis*). Quaking aspen (*Populus tremuloides*) sometimes occur in small numbers.

Several distinct undergrowth types develop under the tree layer, such as evergreen or deciduous medium-tall shrubs, evergreen low shrub, or graminoids with few shrubs.. Tall deciduous shrubs include Rocky Mountain maple (*Acer glabrum*), serviceberry (*Amelanchier alnifolia*), oceanspray (*Holodiscus discolor*), or Scouler’s willow (*Salix scouleriana*). These tall shrubs often occur over a layer of mid-height deciduous shrubs such as baldhip rose (*Rosa gymnocarpa*), russet buffaloberry (*Shepherdia canadensis*), shiny-leaf spirea (*Spiraea betulifolia*), and snowberry (*Symphoricarpos albus* and/or *S. mollis*). At higher elevations, big huckleberry (*Vaccinium membranaceum*) can be locally important, particularly following fire. Mid-tall evergreen shrubs can be abundant in some stands. These include creeping Oregon grape (*Mahonia repens*), tobacco brush (*Ceanothus velutinus*), and Oregon boxwood (*Paxistima myrsinites*). Colder and drier sites support low-growing evergreen shrubs, such as kinnikinnick (*Arctostaphylos uva-ursi*) or pinemat manzanita (*A. nevadensis*). Grouseberry (*V. scoparium*) are consistent evergreen low-shrub dominants in the subalpine part of this habitat.

Some undergrowth is dominated by graminoids with few shrubs. Pinegrass (*Calamagrostis rubescens*) and/or Geyer’s sedge (*Carex geyeri*) can appear with grouseberry in the subalpine zone. Pumice soils support a grassy undergrowth of long-stolon sedge (*C. inops*), Idaho fescue (*Festuca ovina* var. *ingrata*), or western needlegrass (*Stipa occidentalis*). Other graminoids frequently encountered in this habitat are California oatgrass (*Danthonia californica*), blue wildrye (*Elymus glaucus*), Columbia brome (*Bromus vulgaris*), and oniongrass (*Melica bulbosa*). Kentucky bluegrass (*Poa pratensis*) and bottlebrush squirreltail (*Elymus elymoides*) can be locally abundant where livestock grazing has persisted.

The forb component of this habitat is diverse and varies with environmental conditions. A partial forb list includes goldthread (*Coptis occidentalis*), false solomonseal (*Maianthemum stellata*), heartleaf arnica (*Arnica cordifolia*), several lupines (*Lupinus caudatus*, *L. latifolius*, *L. argenteus* ssp. *argenteus* var. *laxiflorus*), meadowrue (*Thalictrum occidentale*), queen's cup (*Clintonia uniflora*), rattlesnake plantain (*Goodyera oblongifolia*), skunkleaf polemonium (*Polemonium pulcherrimum*), trailplant (*Adenocaulon bicolor*), twinflower (*Linnaea borealis*), Sitka valerian (*Valeriana sitchensis*), western starflower (*Trientalis latifolia*), beargrass (*Xerophyllum tenax*), and several wintergreens (*Pyrola asarifolia, P. picta, Orthilia secunda)*.

The successional status of lodgepole pine forests depends on environmental conditions, disturbance history, and competition from associated species. Fire, insects, pathogens, and certain wildlife have an important role in perpetuating or renewing lodgepole pine stands. Where lodgepole pine is seral, shade-tolerant trees will replace lodgepole without fire or other disturbance because of its shade intolerance and mineral seedbed preference. Absence of stand disturbance favors regeneration and eventual dominance of shade-tolerant species. Generally, the effect of fire in mature lodgepole stands is essentially the same as in immature stands. Severe fires recycle the stand by clearing competition and releasing seeds. Less severe burns thin the stand and prepare a seedbed for lodgepole regeneration (Crane and Fischer 1986).

Most stands of lodgepole pine forests have multiple age classes. This condition may be caused by disturbance patterns such as fire, insect infestation, fungal pathogens and parasitic plants (Agee 1993). These forests thrive under the influence of fire, and on many sites, fire is essential to lodgepole pine dominance (Achuff 1989). High-severity crown fires are likely in young stands, when the tree crowns are near deadwood on the ground. After the stand opens up, shade-tolerant trees increase in number. Lodgepole pine forests have a mean fire interval between 68 and 80 years. Summer drought areas generally have low- to medium-intensity ground fires occurring at intervals of 25 to 50 years, whereas areas with more moisture have sparse undergrowth and slow fuel buildup that result in less frequent, more intense fire (Agee 1993). With time, lodgepole pine stands increase in fuel loads. Woody fuels accumulate on the forest floor from insect and disease outbreaks and residual wood from past fires, windthrow, and snow breakage (Crane and Fischer 1986).

Lodgepole pine may be a host for parasitic plants such as dwarf mistletoe, which can infect stands and increase flammability. This increases risks to severe wildfire and subsequent stand replacement (Crane and Fischer 1986). Dwarf mistletoes kill by slowly robbing the tree of food and water. Diseased trees decline and die from the top down as lower infected branches take more food and water. Mortality occurs slowly in most cases and depends on the severity of infection and the stature of the tree. Dwarf mistletoes have a relatively long life cycle between infection and seed production (six to eight years). Fire affects dwarf mistletoe distribution. Less severe fires can leave an open, infested overstory, creating an ideal situation for rapid infection of the regenerated stand. But large, complete burns can eliminate or greatly reduce the parasite. After a severe burn, dwarf mistletoe slowly invades the new stand from infected trees along the edges of the burn. When trees are heavily infested by mistletoe, they are commonly attacked by bark beetles that kill branches or whole trees (Crane and Fischer 1986).

Mountain pine beetles can seriously deplete mature stands of lodgepole forests. Infestations of beetles attack, in epidemic proportions, large low-productivity stands capable of sustaining brood populations (Agee 1993). After an infestation by the beetles, stands of lodgepole are succeeded by more shade-tolerant species such as Douglas-fir, subalpine fir, or Engelmann spruce, depending on elevation. Mountain pine beetle outbreaks thin stands that add fuel and create a drier environment for fire or open canopies and create gaps for other conifer regeneration (Crane and Fischer 1986).

1.4.6 Ponderosa Pine Forest and Woodlands

In the Pacific Northwest, ponderosa pine–Douglas-fir (*Pseudotsuga menziesii*) woodland habitats occur along the eastern slope of the Cascades, in the Okanogan Highlands, and in the Blue Mountains. This habitat generally occurs on the driest sites supporting conifers. It is widespread and variable, appearing on moderate to steep slopes in canyons and foothills and on plateaus or plains near mountains. It can be found at elevations of 100 feet (30 m) to over 6,000 feet (1,829 m) (IBIS 2003). The Snake Hells Canyon subbasin has ponderosa pine forests and woodlands throughout its range, occupying 110,806 acres (Figure 6).

Ponderosa pine and Douglas-fir are the most common evergreen trees in this habitat. The deciduous conifer, western larch (*Larix occidentalis*), can be a codominant with the evergreen conifers in the Blue Mountains of Oregon, but it is seldom a canopy dominant. Grand fir may be frequent in the undergrowth on more productive sites, giving stands a multilayer structure.

Undergrowth can include dense stands of shrubs or, more often, be dominated by grasses, sedges, and/or forbs. Some Douglas-fir and ponderosa pine stands have a tall to medium-tall deciduous shrub layer of mallowleaf ninebark (*Physocarpus malvaceus*) or common snowberry (*Symphoricarpos albus*) and/or a short shrub layer including kinnikinnick (*Arctostaphylos uva-ursi*) and *Vaccinium* species. Antelope bitterbrush (*Purshia tridentata*), big sagebrush (*Artemisia tridentata*), black sagebrush (*A. nova*), and green rabbitbrush (*Chrysothamnus viscidiflorus*) often grow with ponderosa pine–Douglas-fir habitats.

Undergrowth is generally dominated by herbaceous species, especially graminoids. Within a forest matrix, these woodland habitats have an open to closed sodgrass undergrowth dominated by pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*C. rossii*), long-stolon sedge (*C. inops*), or blue wildrye (*Elymus glaucus*). Drier savanna and woodland undergrowth typically contains bunchgrass steppe species such as Idaho fescue (*Festuca ovina* var. *ingrata*), rough fescue (*F. campestris*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Indian ricegrass (*Oryzopsis hymenoides*), or needlegrasses (*Stipa comata, S. occidentalis*). Common exotic grasses that may appear in abundance are cheatgrass (*Bromus tectorum*) and bulbous bluegrass (*Poa bulbosa*). Forbs, which are common associates in this habitat, are too numerous to be listed.

Windfall, insect infestations, and fire together have a role in the natural succession of a ponderosa pine forest (Wright 1978). Historically, natural fires burned ponderosa pine stands between 8 to 18 years on the average (USDAFS 1978). Most were ground fires consuming downed trees and branches from windfall and insect attacks, some understory components, and young tree seedlings (Franklin and Dyrness 1973). This process allowed seeds to become established on the bare mineral soil surface (Wright 1978). Ponderosa pine seeds will germinate rapidly when a fire has cleared the grass and the forest floor of litter, leaving only mineral-rich soil. (Fischer and Bradley 1987). Although some seedlings may be killed, pole-sized and mature ponderosa pine are resistant to fire because of thick bark and high canopy structure. No other conifer within its range is better adapted to survive surface fires. Ponderosa pine is more vulnerable to fire at more mesic sites where other conifers such as Douglas-fir and grand fir form dense understories that can carry fire upward to the canopy (Franklin and Dyrness 1973).

Wildlife, several diseases, rusts, and insects play important roles at various stages in the ponderosa pine's life cycle. Rabbits and hares injure or kill many seedlings, and in areas where pocket gopher populations are high, all seedlings and many saplings may be destroyed. Squirrels and porcupines attack sapling and pole-sized trees, deforming stems and trunks. Squirrels, chipmunks, and birds eat many seeds from cones, but in some reported cases, as much as 15% of ponderosa pine seedlings develop from unrecovered caches from squirrels. In years of low cone production, the potential seed crop may be severely reduced (Franklin and Dyrness 1973).

In eastern Washington, Idaho, and western Montana, over 50 species of insects have been identified as causing damage to or mortality of ponderosa pine. The most damaging of the tree-killing insects are the beetle species of *Dendroctonus* and *Ips*. The western pine beetle (*D. brevicomis*) and the mountain pine beetle (*D. ponderosae*) are major contributors to mortality in overmature, decadent trees. Trees die from the combined effects of a blue stain fungus transmitted by the beetle and extensive larval consumption of the phloem (Oliver and Ryker 1990).

Dwarf mistletoe *(Arceuthobium campylopodium*) is ponderosa pine's most widespread disease. On trees not killed, the parasite is responsible for a significant loss in growth, primarily in height, and is reported to reduce seed viability as much as 20%. In the Northwest, dwarf mistletoe has little effect on vigorous, young trees because height growth will usually exceed its upward spread, relegating the parasite to the lower crown branches (Oliver and Ryker 1990).

1.4.7 Western Juniper and Mountain Mahogany Woodlands

Western juniper and mountain mahogany (*Cercocarpus ledifolius*) woodlands are distributed from the Pacific Northwest south into southern California and east to western Montana and Utah, where it often occurs with pinyon–juniper habitat. In Oregon and Washington, this dry woodland habitat appears primarily in the Owyhee Uplands, High Lava Plains, and northern Basin and Range ecoregions. Secondarily, it develops in the foothills of the Blue Mountain and East Cascade ecoregions and seems to be expanding into the southern Columbia Basin, where it was naturally found in outlying stands. Isolated mountain mahogany communities occur throughout canyons and mountains of eastern Oregon. In the Snake Hells Canyon subbasin, small populations of juniper–mountain mahogany communities may be found on benches and foothills of the Blue Mountains and Craig Mountain and occupy around 270 acres.

Western juniper and/or mountain mahogany woodlands are often found on shallow soils on flats at mid- 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 feet, mostly between 4,000 and 6,000 feet.

This habitat reflects a transition between ponderosa pine forests and shrub-steppe. 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.

Western juniper and/or mountain mahogany dominate these woodlands either with bunchgrass or shrub-steppe undergrowth. Western juniper is the most common dominant tree in these woodlands. Part of this habitat will have curl-leaf mountain mahogany as the only dominant tall shrub or small tree. Mahogany may be codominant with western juniper. Ponderosa pine 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,* ssp. *wyomingensis*, and ssp. *vaseyana*) and/or bitterbrush (*Purshia tridentata*). They usually provide significant cover in juniper stands. Low or stiff sagebrush (*Artemisia arbuscula* or *A. rigida*) are dominant dwarf shrubs 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 serviceberry (*Amelanchier alnifolia*). Shorter shrubs such as mountain snowberry (*Symphoricarpos oreophilus*) or creeping Oregon grape (*Mahonia repens*) can be dominant in the undergrowth. Rabbitbrush (*Chrysothamnus nauseosus* and *C. viscidiflorus*) will 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—Idaho fescue (*Festuca ovina* var. *ingrata*), 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' sedge (*Carex geyeri, C. rossii*), pinegrass (*Calamagrostis rubescens*), and blue wildrye (*E. glaucus*) appear on mountain foothills. Sandy sites typically have needle-and-thread (*Stipa comata*) and Indian ricegrass (*Oryzopsis hymenoides*). Cheatgrass (*Bromus tectorum*) or bulbous bluegrass (*Poa bulbosa*) often dominate overgrazed or disturbed sites. In good condition, this habitat may have mosses growing under the trees.

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. It is an increaser in many earlier seral communities in these zones and invades without fires. Most trees over 13 feet (4 m) tall can survive low-intensity fires. The historical fire regime of mountain mahogany communities varied 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, after which time it has increased. 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 (Johnson and O'Neil 2001).

Juniper invades shrub-steppe and steppe 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 (Johnson and O'Neil 2001).

Over the past 150 years, with fire suppression, overgrazing, and changing climatic factors, western juniper has increased its range into adjacent shrub-steppe, grasslands, and savannas. 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 of annual grasses. Diverse mosses and lichens occur on the ground in this type if it has not been too disturbed by grazing. Excessive grazing will decrease bunchgrasses and increase exotic annual grasses plus various native and exotic forbs. Animals seeking shade under trees decrease or eliminate bunchgrasses and contribute to increasing cheatgrass cover (Johnson and O'Neil 2001).

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 woodlands, and mountain mahogany cover types are now significantly greater in extent than they were before 1900. Although it covers more area, this habitat is generally in degraded condition 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 (Johnson and O'Neil 2001).

1.4.8 Herbaceous Wetlands

Herbaceous wetlands are found throughout the Pacific Northwest, usually in isolated sites, and represented in Oregon and Washington wherever local hydrologic conditions promote their development. They are more widespread in valley bottoms and high rainfall areas. but they are present in montane and arid climates as well. Hardstem bulrush–cattail–burreed marshes occur in wet areas throughout Oregon and Washington. Sedge meadows and montane meadows are common in the Blue and Ochoco mountains of central and northeastern Oregon. In the Snake Hells Canyon subbasin, herbaceous wetlands are scarce because of the steep terrain escalating up both sides of the Snake River. This habitat type may be found in the Seven Devils range and occupies only around 55 acres.

Seasonally to semipermanently flooded wetlands are found where standing fresh water is present through part of the growing season and the soils stay saturated throughout the season. Some sites are temporarily to seasonally flooded meadows, which generally occur on clay, pluvial, or alluvial deposits within montane meadows or along stream channels in shrubland or woodland riparian vegetation. In general, this habitat is flat, usually with stream or river channels or open water present. Elevation varies between sea level to 10,000 feet, although this habitat is infrequently above 6,000 feet (1,830 m).

Various grasses or grass-like plants dominate or codominate these habitats. Cattails (*Typha latifolia*) occur widely, sometimes adjacent to open water with aquatic bed plants. Several bulrush species (*Scirpus acutus, S. tabernaemontani, S. maritimus, S. americanus, S. nevadensis*) occur in nearly pure stands or in mosaics with cattails or sedges (*Carex* spp.). Burreeds (*Sparganium angustifolium, S. eurycarpum*) are the most important graminoids in areas with up to 3.3 feet (1 m) of deep standing water. A variety of sedges characterize this habitat. Some sedges (*Carex aquatilis, C. lasiocarpa, C. scopulorum, C. simulata, C. utriculata, C. vesicaria*) tend to occur in cold to cool environments. Other sedges (*C. aquatilis* var. *dives, C. angustata, C. interior, C. microptera, C. nebrascensis*) tend to be at lower elevations in milder or warmer environments. Slough sedge (*C. obnupta*) and several rush species (*Juncus falcatus, J. effusus, J. balticus*) are characteristic of coastal dune wetlands that are included in this habitat. Several spikerush species (*Eleocharis* spp.*)* and rush species can be important. Common grasses that can be local dominants and indicators of this habitat are American sloughgrass (*Beckmannia syzigachne*), bluejoint reedgrass (*Calamagrostis canadensis*), mannagrass (*Glyceria* spp.), and tufeeted hairgrass (*Deschampsia caespitosa*). Important introduced grasses that increase and can dominate with disturbance in this wetland habitat include reed canarygrass *(Phalaris arundinacea*), tall fescue (*Festuca arundinacea*), and Kentucky bluegrass (*Poa pratensis*).

Montane meadows are occasionally forb dominated with plants such as arrowleaf groundsel (*Senecio triangularis*) or ladyfern (*Athyrium filix-femina*). Climbing nightshade (*Solanum dulcamara)*, purple loosestrife (*Lythrum salicaria*), and poison hemlock (*Conium maculatum*) are common nonnative forbs in wetland habitats.

Shrubs or trees are not a common part of this herbaceous habitat although willow (*Salix* spp.) or other woody plants occasionally occur along margins, in patches, or along streams running through these meadows.

This habitat type is maintained through a variety of hydrologic regimes that limit or exclude invasion by large woody plants. Habitats are permanently flooded, semipermanently flooded, or flooded seasonally and may remain saturated through most of the growing season. Most wetlands are resistant to fire and those that are dry enough to burn usually burn in the fall. Most plants are sprouting species and recover quickly. Beavers play an important role in creating ponds and other impoundments in this habitat. Trampling and grazing by large native mammals is a natural process that creates habitat patches and influences tree invasion and success.

Herbaceous wetlands are often in a mosaic with shrub- or tree-dominated wetland habitats. Woody species can successfully invade emergent wetlands when this herbaceous habitat dries. Emergent wetland plants invade open water habitat as soil substrate is exposed. As habitats flood, woody species decrease to patches on higher substrate (soil, organic matter, large woody debris), and emergent plants increase unless the flooding is permanent. Fire suppression can lead to invasion of woody species in drier herbaceous wetland habitats (Johnson and O’Neil 2001).

Nationally, herbaceous wetlands have declined. These wetlands receive regulatory protection at the national, state, and county level. Montane wetland habitats are less altered than lowland habitats have been, even though they have undergone modification as well. A keystone species, the beaver, has been trapped to near extirpation in parts of the Pacific Northwest, while its population has been regulated in others. Herbaceous wetlands have decreased along with the diminished influence of beavers on the landscape (Johnson and O'Neil 2001).

1.4.9 Lakes, Rivers, Streams, Ponds, and Reservoirs

Lakes, streams, and rivers in Oregon and Washington occur statewide and are found from near sea level to about 10,200 feet, forming a continuous network connecting high mountain areas to lowlands and the Pacific coast. In the Snake Hells Canyon subbasin, open water habitats occupy around 3,468 acres, the bulk of the acreage coming from the Snake River, which dissects the subbasin for its entire length (Figure 6).

Lakes were historically formed through various natural and anthropogenic processes. Glaciers melted and left depressions where water accumulated. Craters created by extinct volcanoes also formed lakes. Human-built dams impound water, creating lakes behind them, and many lakes have formed in depressions and rocky coulees through the process of seepage from irrigation waters. Beavers have also created many ponds and marshes in Oregon and Washington.

Rivers and streams are fed from melting snowpacks during the spring and winter and by annual rainfall. Ponds, lakes, and reservoirs are typically adjacent to riparian and herbaceous wetlands.

Removal of gravel substrates result in reduction of spawning areas for anadromous fish. Overgrazing and loss of vegetation caused by logging produces increased water temperatures and excessive siltation, harming invertebrate communities. Incorrectly installed culverts may act as barriers to migrating fish and contribute to erosion and siltation downstream. Construction of dams is associated with changes in water quality, loss of fish passage, competition among species, loss of spawning areas because of flooding, and declines in native fish populations. Agricultural, industrial, and sewage runoff—salts, sediments, fertilizers, pesticides, and bacteria—harms aquatic species. Unregulated aerial spraying of pesticides over agricultural areas also poses a threat to aquatic and terrestrial life. Because clearcutting creates excessive intermittent runoff conditions, increases erosion and siltation of streams, and diminishes shade, it causes higher water temperatures, fewer terrestrial and aquatic food organisms, and increased predation. Landslides, which contributed to the widening of the channel, were a direct result of clearcutting. Clearcut logging can alter snow accumulation and increase the size of peak flows during times of snowmelt. Building of roads, especially those of poor quality, can be a major contributor to sedimentation in the streams (Johnson and O'Neil 2001).

1.4.10 Agriculture, Pasture, and Mixed Environs

Agricultural habitat, which is widely distributed at low to mid-elevations, is most abundant in broad river valleys throughout the basin and on gentle rolling terrain east of the Cascade Mountains. In the Snake Hells Canyon subbasin, it covers more than 29,956 acres, primarily in the northern extent of the subbasin (Figure 6).

Habitats of agricultural use and pasture occur within a matrix of other habitat types including interior grasslands, shrub-steppe, and various low to mid-elevation forest and woodland habitats. This habitat often dominates the landscape in flat or gently rolling terrain on well-developed soils. Unlike other habitat types, agricultural habitat is often characterized by regular landscape patterns and straight borders because of ownership boundaries and multiple crops within a region. This habitat type is structurally diverse because it includes several cover types ranging from low-stature annual grasses and row crops to mature orchards. Depending on management intensity or cultivation method, agricultural habitat may vary substantially in structure year to year. Cultivated cropland and modified grasslands are typified by periods of bare soil and harvest whereas pastures are mowed, hayed, or grazed once or more during the growing season (Johnson and O'Neil 2001). Within the Snake Hells Canyon subbasin, agricultural crops are primarily dryland wheat with some legumes such as lentils or peas.

Perennial herbaceous plants such as alfalfa, several species of fescue (*Festuca* spp.), bluegrass (*Poa* spp.), orchardgrass (*Dactylis glomerata*), and timothy (*Phleum pratensis*) are commonly seeded in improved pastures. Grass seed fields are single-species stands, whereas pastures maintained for haying are typically composed of at least two species. The improved pasture cover type is one of the most common agricultural uses in both states; it is produced with or without irrigation (Johnson and O'Neil 2001).

Unimproved pastures are predominately grassland sites that are often abandoned fields with little or no active management such as irrigation, fertilization, or herbicide applications. These sites may or may not be grazed by livestock. Unimproved pastures include rangelands planted to exotic grasses that are found on private land, state wildlife areas, federal wildlife refuges, and U.S. Department of Agriculture Conservation Reserve Program (CRP) sites. Grasses commonly planted on CRP sites are crested wheatgrass (*Agropyron cristatum*), tall fescue (*F. arundinacea*), perennial bromes (*Bromus* spp.), and wheatgrasses (*Elytrigia* spp.). Intensively grazed rangelands that have been seeded to intermediate wheatgrass (*Elytrigia intermedia*) or crested wheatgrass or that are dominated by increaser exotics such as Kentucky wheatgrass (*Poa pratensis*) or tall oatgrass (*Arrhenatherum elatius*) are unimproved pastures. Other unimproved pastures have been cleared and intensively farmed in the past, but they have been allowed to convert to other vegetation. These sites may be composed of uncut hay, litter from previous seasons, standing dead grass and herbaceous material, invasive exotic plants (Himalaya blackberry [*Rubus discolor*] and yellow starthistle [*Centaurea soltstitalis*]) with patches of native black hawthorn (*Crataegus douglasii*), snowberry (*Symphoricarpos* spp.), spirea (*Spirea* spp.), poison oak (*Toxicodendron diversilobum*), and encroachment of various tree species, depending on seed source and environment (Johnson and O'Neil 2001).

Modified grasslands are generally overgrazed habitats that were formerly native grasslands or shrub-steppe but are now dominated by annual plants, with only remnant individual plants of the native vegetation. Cheatgrass (*Bromus tectorum*), other annual bromes, medusahead (*Taeniatherum caput-medusae*), bulbous bluegrass (*Poa bulbosa*), and knapweeds (*Centaurea* spp.) are common increasers that form modified grasslands. Fire, following heavy grazing or repeated early-season fires, can create modified grassland monocultures of cheatgrass (Johnson and O'Neil 2001).

Management practices disrupt natural succession and stand dynamics in most of the agricultural habitats. Abandoned agricultural habitats may convert to other habitats, mostly grassland and shrub habitats from the surrounding native habitats. Natural fires are almost totally suppressed in this habitat, except in unimproved pastures and modified grasslands where fire-return intervals can resemble those of native grassland habitats. Fires are generally less frequent today than in the past, primarily because of fire suppression, construction of roads, and conversion of grass and forests to cropland (Johnson and O'Neil 2001).

Controlled burning is an important economical tool for managing agricultural areas and rangeland. Fire may be used to control undesirable plant species, restore natural grassland communities, improve the quality and quantity of forage for livestock and wildlife, improve grass cover for the protection of soil from erosion, eliminate crop residue, and improve water yield from seeps and springs. Fire is also used for pest and weed control and lowers the need for supplemental herbicide and pesticide treatments. Fires can stimulate the growth of perennial grasses in savannas and provide nutritious regrowth for livestock. Alternately, fires may have a destructive effect on different vegetation communities and animal species. Fire can reduce the organic matter in the soil and result in a decrease of soil fertility in future years (Johnson and O'Neil 2001). The use of controlled burning for improving croplands is a topic of debate in Pacific Northwest states because the practice is considered responsible for increases in carbon dioxide levels to our atmosphere, as well as a direct health risk for people who reside in urban and rural areas around controlled burns (Agricultural Air Quality Task Force 1999).

1.4.11 Urban and Mixed Environs

Urban habitat occurs throughout the Pacific Northwest. Most urban development in the Snake Hells Canyon subbasin is located in the northern region and closely associated with the agriculture and pasture habitat types (Figure 6). There are around 7,743 acres of urban development and mixed environs in the subbasin, primarily along the northern edge near Lewiston, Idaho.

Urban development often occurs in areas with little or no slope and frequently includes wetland habitats. Many of these wetlands have been filled in and eliminated. Urban development may occur within or adjacent to nearly every habitat type in Oregon and Washington; it often replaces habitats that are valuable for wildlife. The highest urban densities normally occur in lower elevations along natural or human-made transportation corridors, such as rivers, railroad lines, coastlines, or interstate highways. These areas often contain good soils with little or no slope and lush vegetation. Once level areas become crowded, growth continues along rivers or shores of lakes or oceans and eventually up elevated sites with steep slopes or rocky outcrops. Because early settlers often modified the original landscape for agricultural purposes, many of our urban areas are surrounded by agricultural and grazing lands.

The original habitat is drastically altered in urban environments and replaced by buildings, impermeable surfaces, bridges, dams, and plantings of nonnative species. With the onset of urban development, total crown cover and tree density are reduced to make way for the construction of buildings and associated infrastructure. Understory vegetation may be completely absent, or if present, it is diminutive and single layered. Typically, three zones are characteristic of urban habitat. The high-density zone encompasses the heavy industrial and large commercial interests of the city, in addition to high-density housing areas. Vegetation is composed of a small amount of total tree canopy cover, low tree density, a high percentage of exotics, and a poor understory. The medium-density zone is composed of light industry mixed with high-density residential areas. Vegetation in this mid-zone is typically composed of nonnative plant species.

Characteristic vegetation in this zone consists of manicured lawns, trimmed hedges, and topped trees. The low-density zone is the outer zone of the urban–rural continuum. This zone normally contains only single-family homes. It has more natural groundcover than artificial surfaces. Vegetation is denser and more abundant than in the previous two zones and may include both native and nonnative plants.

1.5 Land Ownership and Protected Areas

1.5.1 Ownership

The majority of the Snake Hells Canyon subbasin is publicly owned, with more than half under USFS management (Table 2; Figure 7). The Wallowa-Whitman National Forest manages the majority of the USFS land, but portions on the Idaho side of the river are managed by the Payette and Nez Perce National Forests. Private land accounts for 32% of the subbasin. This private land is concentrated in the agricultural and urban areas of the lower subbasin and in the area surrounding Wolf and Dry creeks. The Craig Mountain area (Captain John, Corral, and Cottonwood Creeks) is cooperatively managed by the Bureau of Land Management (BLM), Idaho Department of Fish and Game (IDFG), Idaho Department of Lands, Nez Perce Tribe, and The Nature Conservancy.

Table 2. Land management agencies of the Snake Hells Canyon subbasin.

Land management agency	Acres	Percentage of Total Subbasin Area
Forest Service	287,006	52.4
Private	176,685	32.3
State of Idaho	45,006	8.2
Bureau of Land Management	31,369	5.7
State of Washington	3,068	0.6
Nez Perce Tribe	2,799	0.5
The Nature Conservancy	1,354	0.2
State of Oregon	112	> 0.1
Water	2,852	0.5

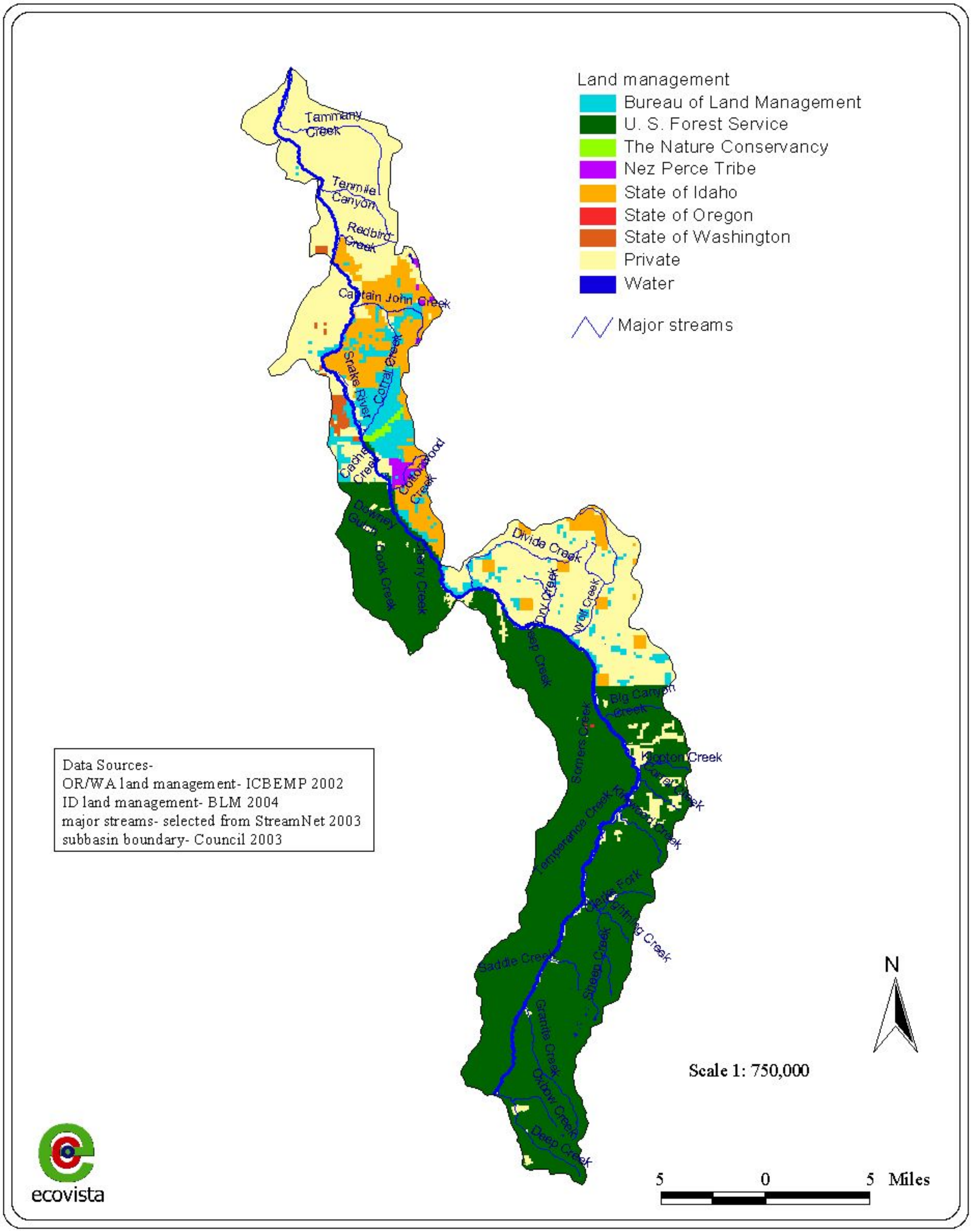

Figure 7. Land management in the Snake Hells Canyon subbasin.

1.5.2 Protected Areas

Much of the Snake Hells Canyon subbasin is protected and/or managed using a conservation-based strategy (Figure 8). The following areas in the Snake Hells Canyon subbasin are protected in this manner.

Hells Canyon National Recreation Area

Forty-six percent (298,270 acres) of the 652,488-acre HCNRA lies within the Snake Hells Canyon subbasin. The HCNRA was created by an act of Congress in 1975. Although the HCNRA includes portions of the Nez Perce, Payette, and Wallowa-Whitman National Forests, it is managed by the Wallowa-Whitman National Forest. The Hells Canyon Wilderness comprises nearly 215,000 acres within the HCNRA (USFS 2003a).
The act that created the HCNRA states that "to assure that the natural beauty, and historical and archaeological values of the Hells Canyon area and the seventy-one-mile segment of the Snake River between Hells Canyon Dam and the Oregon–Washington border, together with portions of certain of its tributaries and adjacent lands, are preserved for this and future generations, and that the recreational and ecologic values and public enjoyment of the area are thereby enhanced, there is hereby established the Hells Canyon Recreation Area" (USFS 2003a).

A comprehensive management plan was approved in 1982 and incorporated into the Wallowa-Whitman National Forest Land and Resource Management Plan (Forest Plan) in 1990. Adjustment of the existing (1982) comprehensive management plan was initiated in 1993, and the Draft Environmental Impact Statement was released in 1996. The Forest Supervisor re-initiated the process in 1998 with a revised draft environmental statement. The Record of Decision for the Hells Canyon National Recreation Area Comprehensive Management Plan was released July 22, 2003, and implemented August 29, 2003. The appeal period on the decision ended October 6, 2003. Six appeals were received and are currently under review by the Regional Forester. A decision on the appeals is anticipated some time in early spring 2004 (USFS 2003a). The Hells Canyon National Recreation Area Comprehensive Management Plan is a valuable reference on the area and contributed to the construction of this document.

Hells Canon National Wilderness Area

Almost 85% (182,370 acres) of the Hells Canyon Wilderness lies within the uppermost portion of the subbasin (Figure 8). The area is protected under the Wilderness Act of 1964.

Wild and Scenic Snake River

In 1975, approximately 67.5 miles of the Snake River in the HCNRA were designated as a component of the National Wild and Scenic Rivers System. In this reach, the river is managed to preserve its free-flowing character and unique environment while providing for continued public use (USFS 2001).

The 31.5-mile section of the river between Hells Canyon Dam and Upper Pittsburg Landing is designated as wild under the Wild and Scenic Rivers Act. This act defines wild as being "free of impoundments and generally accessible only by trail" and representing "vestiges of primitive America." The 36-mile section of river downstream of Upper Pittsburg Landing to RM 180.2 is designated as scenic, which is defined as “free of impoundments with shorelines and watershed still largely primitive, and shorelines largely undeveloped, but accessible in places by roads.” An additional 4.2 miles of the river from RM 180.2 north to the HCNRA boundary at the Oregon–Washington line is recommended for scenic designation (USFS 2001).

The Wild and Scenic Snake River corridor extends approximately one-quarter mile back from the high-water mark on each shore. The river corridor itself is not wilderness, so wilderness regulations do not apply (USFS 2001).

Craig Mountain

The majority of the Craig Mountain Cooperative Management Area lies within the subbasin. The area has multiple managers including the Nez Perce Tribe, BLM, Idaho Department of Lands, The Nature Conservancy, and private landowners. The Craig Mountain Cooperative Management Area contains the 60,000-acre Craig Mountain Wildlife Mitigation Area purchased by the Bonneville Power Administration (BPA) in 1992 as partial mitigation for wildlife habitat losses resulting from construction of Dworshak Dam on the Clearwater River. The Nez Perce Tribe, IDFG, and BPA agreed to provide for the protection and enhancement of wildlife habitat through management of the area (Cassirer 1995). The pileated woodpecker, yellow warbler, black-capped chickadee, river otter, elk, and white-tailed deer are species that have been identified as having been negatively affected by construction of Dworshak Dam in the Clearwater subbasin, so they are given special management attention on the Craig Mountain Wildlife Mitigation Area (Cassirer 1995).

Chief Joseph Wildlife Area

The Chief Joseph Wildlife Area is 2,065 acres in size and located in Asotin County, Washington. Elevations range from 825 to 4,913 feet at Mt. Wilson, the highest point in the vicinity. The area is made up primarily of bluebunch wheatgrass grasslands with riparian woodlands surrounding streams and springs. The area provides important elk, mule deer, bighorn sheep, game bird, and nongame habitat (WDFW 2001a).

Research Natural Areas

Research natural areas (RNAs) are natural ecosystems that provide benchmarks for comparison with areas influenced by humans. They facilitate research for ecological studies and help preserve gene pools for threatened and endangered plants and animals.

Two established RNAs occur in the subbasin—the Lightning Creek and Wapshilla Ridge RNAs—and cover 8,555. Seven areas are proposed for designation as RNAs in the Snake Hells Canyon subbasin. These areas were selected to represent particular plant associations, geological formations, or other needs outlined in state natural heritage plans. According to the Wallowa-Whitman Forest Plan, proposed RNAs will be protected from uses that would reduce their suitability for RNA designation. Since their designation, no logging has occurred in the proposed RNAs. Once officially established, an RNA management plan will be written and integrated into the Forest Plan (USFS 1999).

Areas of Critical Environmental Concern

The designation, Areas of Critical Environmental Concern (ACECs), is authorized in section 202(c)(3) of the Federal Land Policy and Management Act of 1976 (FLPMA, P.L. 94-579). ACECs include public lands where special management attention and direction is needed to protect human life and safety from natural hazards or to protect and prevent irreparable damage to important historic, cultural, and scenic values; fish or wildlife resources; or other natural systems or processes (BLM 2003a). The Wapshilla Ridge RNA/ACEC, Captain John Creek RNA/ACEC, Lower Salmon ACEC, and Craig Mountain ACEC cover 4,394 acres in the Craig Mountain area of the subbasin (Figure 8) (BLM 2002).

Garden Creek Preserve

The Garden Creek Preserve is part of the Craig Mountain Wildlife Management Area, supporting Rocky Mountain bighorn sheep, elk, mountain lion, wolverine, black bear, ruffed grouse, partridge, and quail. To date, nine rare plant species have been identified in the vicinity, including Spalding's silene (also called Spalding's catchfly), western ladies tress, and stalk-leaved monkey flower (TNC 2004). Managers for the Craig Mountain Cooperative Management Area also manage the Garden Creek Preserve, which covers 8,023 acres in the subbasin (Figure 8).

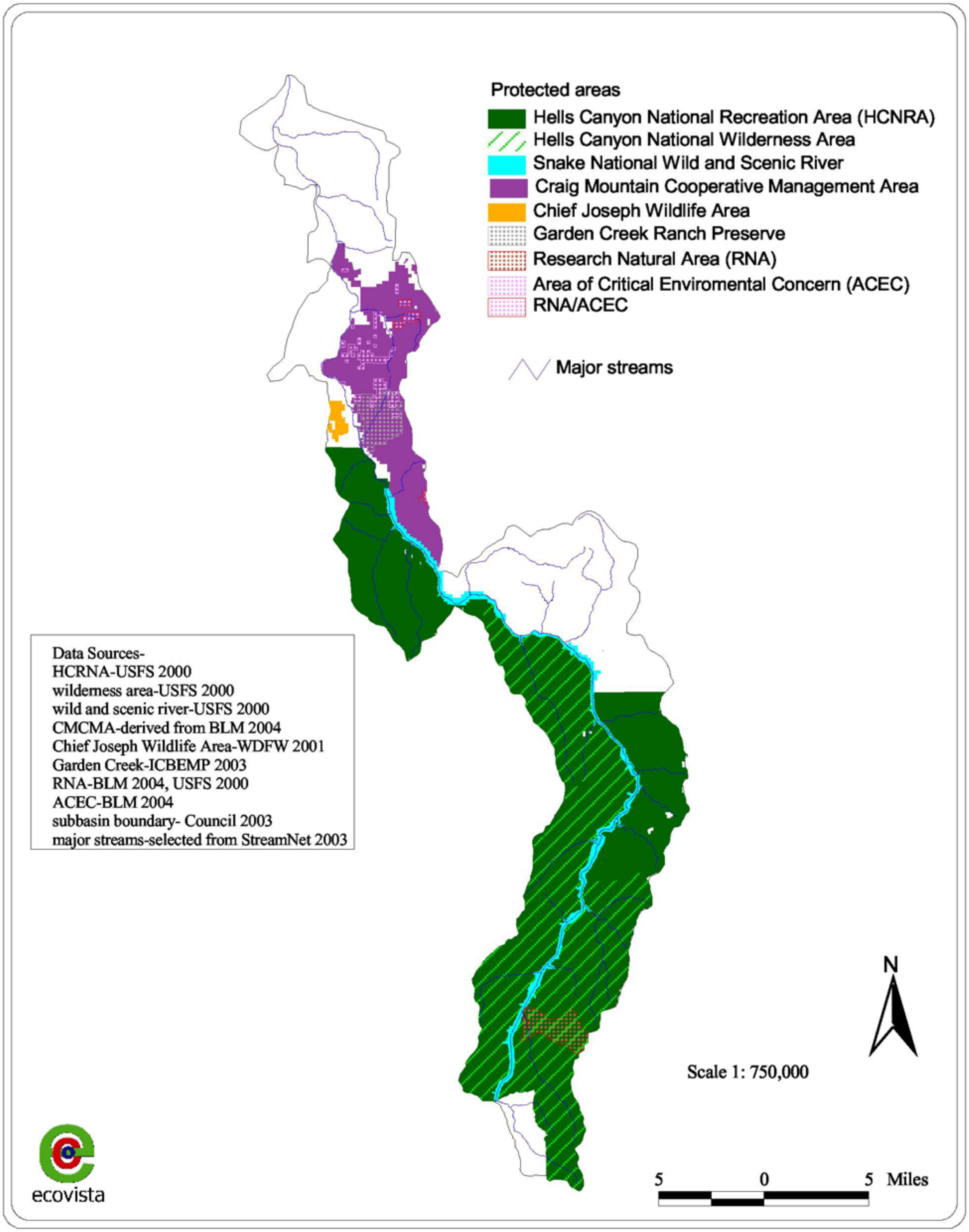

Figure 8. Areas in the Snake Hells Canyon subbasin that are managed and/or protected under a conservation-based strategy.

1.6 Socioeconomic Overview

1.6.1 Demographics and Economy

Comparison by State

Population—Idaho ranks 39th among the states in population and 11th in size. The projected population of Idaho in 2025 is approximately 1.7 million, compared with 4.2 million in Oregon and 7.8 million in Washington (Figure 9).

Income—For 1999, per capita income was below the U.S. average in both Idaho and Oregon and above the U.S. average in Washington (Figure 10).

Unemployment—On average, civilian labor-force unemployment declined from 1980 to 2000 in the United States, as well as in Idaho and Oregon (Figure 11) (U.S. Census 2002). In 1980, unemployment in Oregon, Washington, and Idaho was higher than the U.S. average, and the current unemployment rate in these three states remains higher than the U.S. average.

Poverty—The percentage of people below the poverty level in 1999 was higher in counties within the United States (12.4%) than in Idaho, Oregon, or Washington (Figure 12).

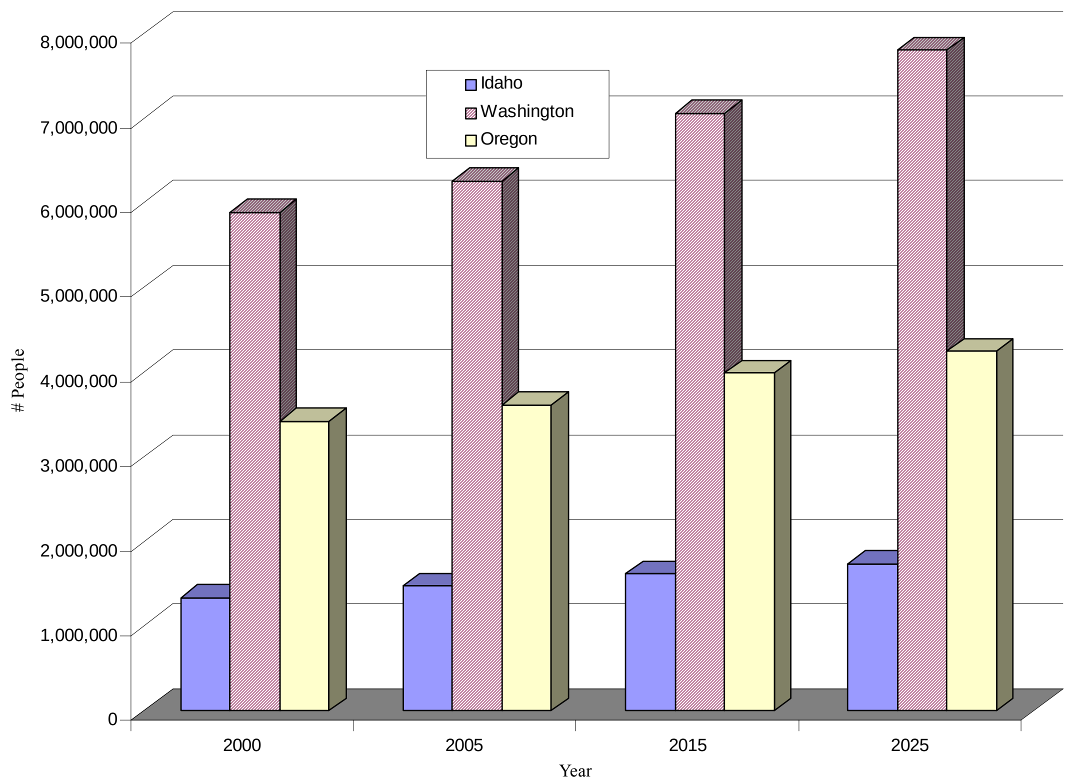

Figure 9. Projected populations of Idaho, Oregon, and Washington (U.S. Census Bureau 2000a).

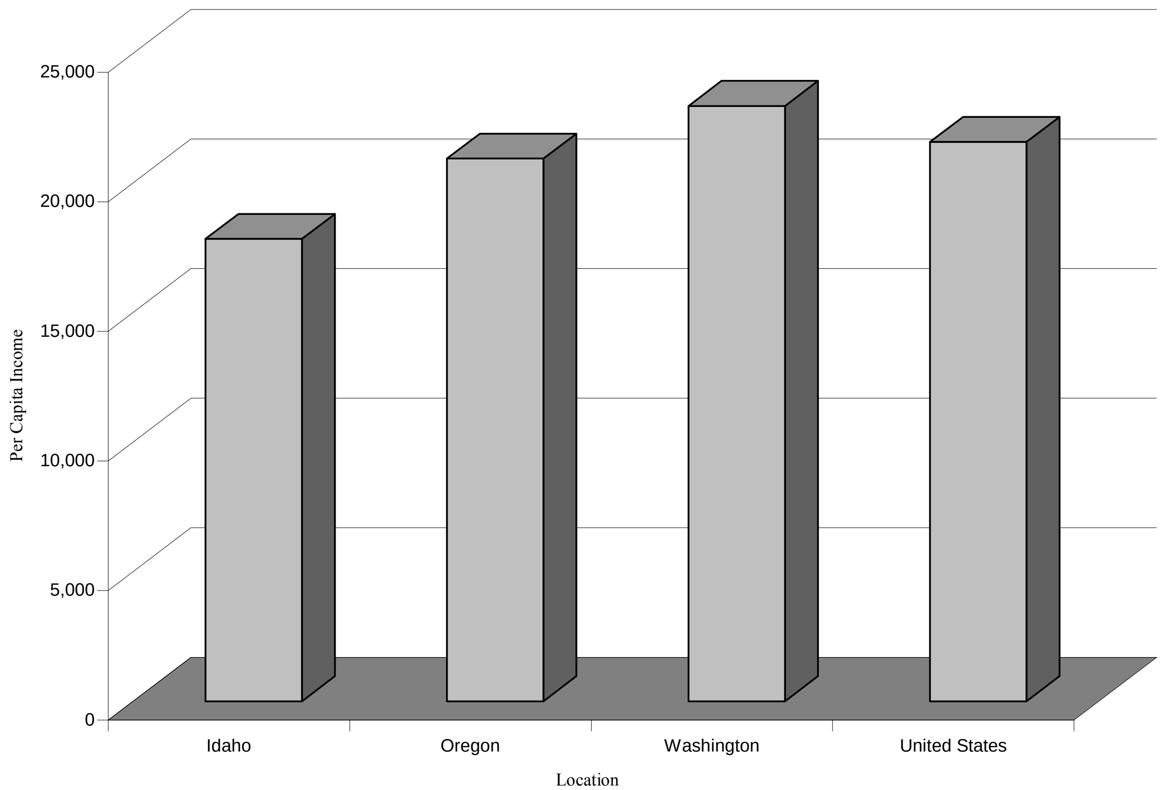

Figure 10. Per capita income in the United States and in Idaho, Oregon, and Washington in 1999 (U.S. Census Bureau 2000b).

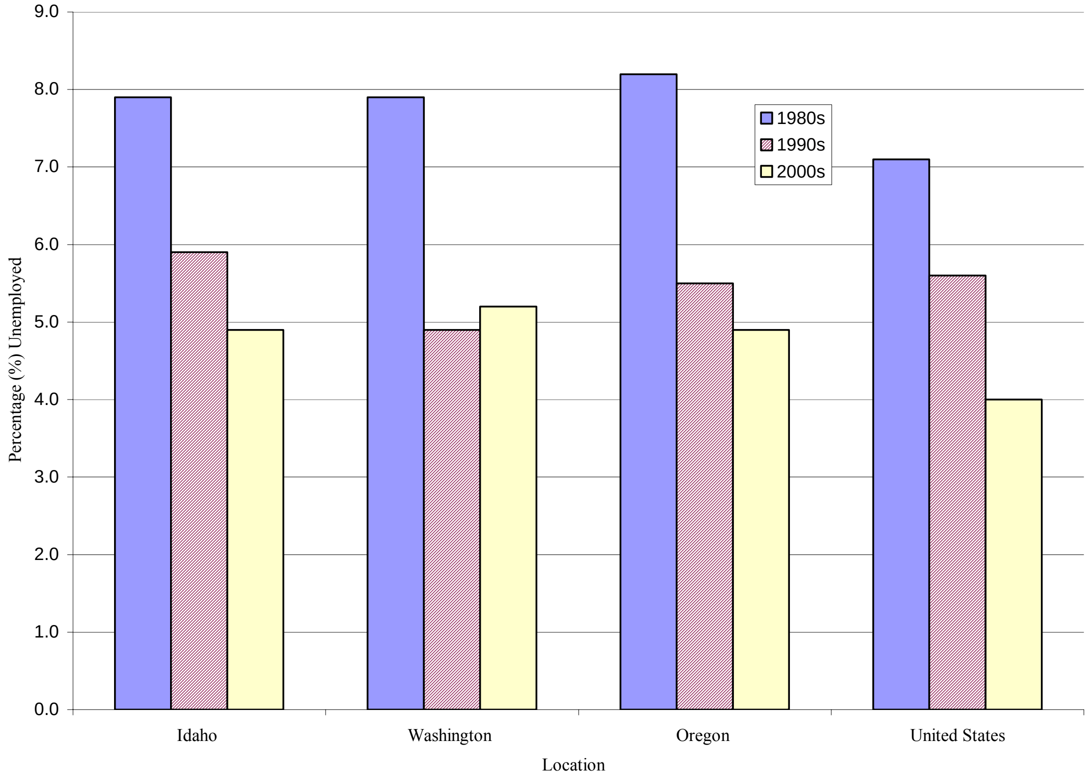

Figure 11. Trend in civilian labor-force percent unemployment as per decade averages in Idaho, Washington, Oregon, and the United States.

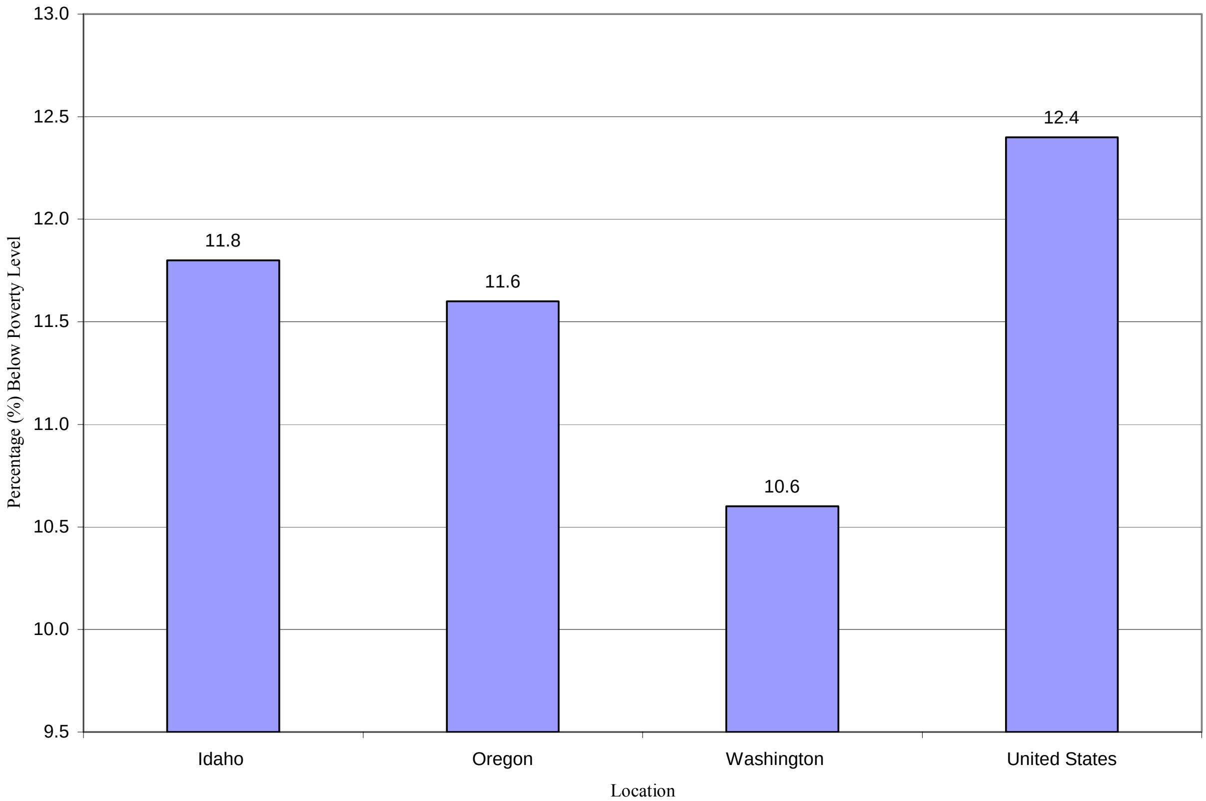

Figure 12. Percentage of persons below the poverty level (1999) in Idaho, Oregon, Washington, and the United States (U.S. Census Bureau 2000b).

Comparison by County

Asotin County in Washington; Wallowa County in Oregon; and Nez Perce, Lewis, and Idaho counties in Idaho all supply land base to the Snake Hells Canyon subbasin (Table 3).

Land Base and Population

The lower portion of the subbasin, which contains the town of Asotin and portions of Clarkston and Lewiston, is being developed at a much faster rate than the rest of the subbasin. Populations in all five counties partially contained in the Snake Hells Canyon subbasin increased between 1990 and 2000 (Table 3). This population increase is reflected both in more residents inhabiting the lower subbasin towns of Asotin, Lewiston, and Clarkston and in greater recreational pressure from residents of neighboring communities. In the upper half of the subbasin, some residential housing with septic systems exists, but the density is very low (IDEQ and ODEQ 2001). Communities within the boundaries of the subbasin are in the lower Hells Canyon portions of Idaho, Nez Perce, and Asotin counties (Figure 1).

Geographically, the largest counties in the subbasin are Idaho (8,500 sq. mi.), Wallowa (3,100 sq. mi.), and Adams (1,400 sq. mi.). However, each of these counties has fewer than 3 people per square mile, compared with 30 to 45 people per square mile found in the smaller Asotin and Nez Perce counties (Figure 13).

Table 3. Changes in population in counties partially contained within the Snake Hells Canyon subbasin, 1990–2000 (U.S. Census Bureau 2000b).

County (State)	Population 1990 Census	Population 2000 Census	Change 1990–2000	
			Number	Percent
Asotin (WA)	17,605	20,551	2,946	16.7
Idaho (ID)	13,783	15,511	1,728	12.5
Nez Perce (ID)	33,754	37,410	3,656	10.8
Adams (ID)	3,254	3,476	222	6.8
Wallowa (OR)	6,911	7,226	315	4.6

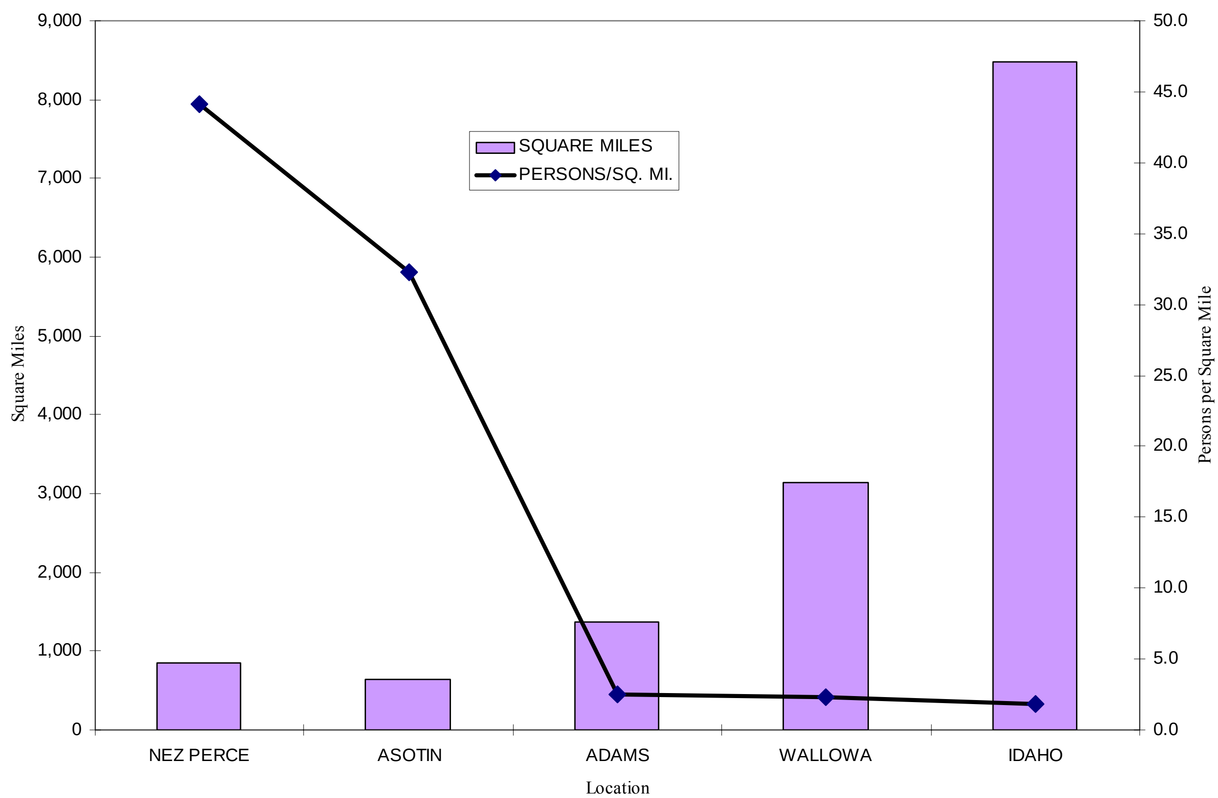

Figure 13. Land base in square miles compared with people per square mile in each of the counties within the Snake Hells Canyon subbasin.

Economics

Employment by Industry

Farming is not as important in the Snake Hells Canyon subbasin as in surrounding areas because geology and topography make the area less suitable for agriculture. The number of people employed in nonfarming industries has increased from the 1960s to the present in all of the counties within the subbasin (WSU 2003). The more populated counties have experienced more growth in the nonfarming sectors than the less populated counties have (Figure 14).

Currently, the service sector employs the highest percentage of employees in all of the counties within the subbasin (U.S. Census Bureau 2000b). Nez Perce and Asotin counties, the counties with the highest populations, have the highest percentage of workers in the service sector. Wallowa and Adams counties are the least populated but have the highest percentage of employees working in industries that utilize natural resources (Figure 15). Manufacturing and construction are most important in the lower subbasin counties, which are experiencing growth.

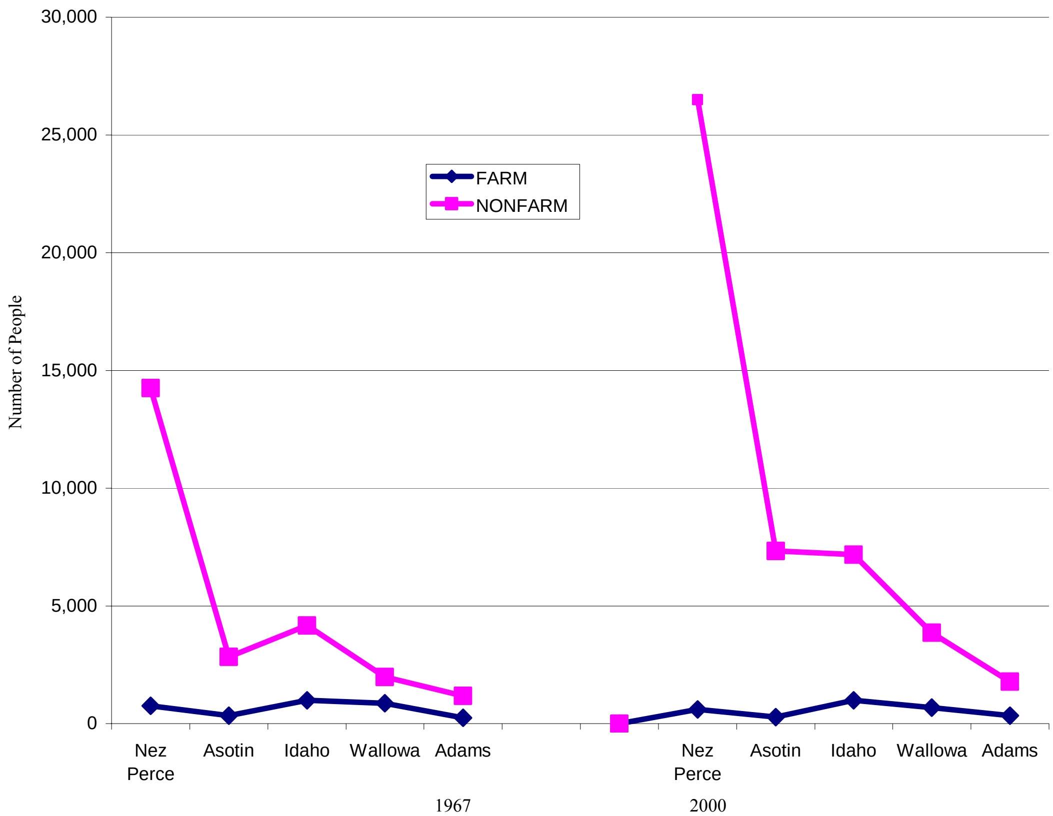

Figure 14. Number of people employed in the farm and nonfarm sectors in 1967 and 2000 by counties partially within the Snake Hells Canyon subbasin.

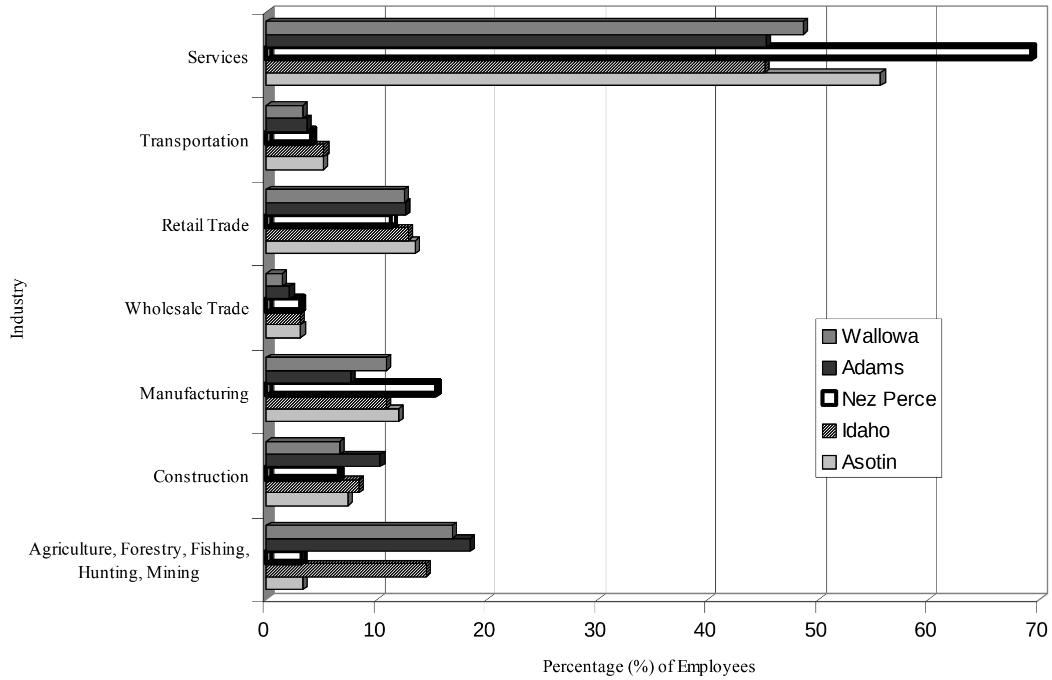

Figure 15. Percentage of employees that work in each industrial sector in 2000 by county within the Snake Hells Canyon subbasin (services include financial or professional services, education, arts, other services, and public administration). Agriculture is included with natural resource-based industries to provide a contrast between industries that utilize land resources and those that are service and skill oriented.

Major Employers

Table 4 lists major employers in counties with area in the Snake Hells Canyon subbasin (IDOC 2003, Palouse EDC 2003, Wallowa County 2003). Note the dual importance of the forestry and service-oriented sectors. Data are county based rather than subbasin based, and employers may or may not be active in the Snake Hells Canyon subbasin.

Table 4. Major employers and types of business, by counties partially within the Snake Hells Canyon subbasin.

Major Employer	Type of Business
Adams County, ID	
Adams County government	Government Services
U.S. Forest Service	Government Services
Evergreen Forest Products	Forest Products Manufacturing
S & S Drywall, Inc.	Construction
JI Morgans	?

Major Employer	Type of Business
Meadowcreek Properties	Real Estate
Council Community Hospital	Health Care Services
Seven Devils Mountains	Recreation/Tourism
Hells Canyon	Recreation/Tourism
Brundage Ski Area	Recreation/Tourism
Idaho County, ID	
Clearwater Forest Products, Inc.	Forest Products Manufacturing
School District #241	Education
U.S. Forest Service	Forestry
Pankey's Foods	Retail Sales
Grangeville School District	Education
Nez Perce National Forest	Forestry
Idaho County	Government Services
Nez Perce County, ID	
Potlatch	Forest Products
St. Joseph Regional Hospital	Health Care Services
Lewis Clark State College	Education
Alliant Techsystems	Manufacturing
Swift Transportation, Inc.	Transportation
City of Lewiston	Government Services
Deatly Company	Mineral Retail Sales
Lewiston Tribune	Publishing
Northwest Childrens Home, Inc.	Other Services
Nez Perce Tribe	Government Services
Wallowa County, OR	
School Districts	Education
U.S. Forest Service	Government Services
Wallowa County government	Government Services
Wallowa Health District	Health Care Services
Wallowa Forest Products	Forest Products Manufacturing
Safeway	Retail Food Sales
Moffit Brothers	?
Valley Bronze	?
Community Bank	Finances
Wallowa County Grain Growers	Agriculture
OR Fish and Wildlife Department	Government Services

Major Employer	Type of Business
Parks Bronze	?
Asotin County, WA	
Federal Government	Government Services
Garfield County	Government Services
Pomeroy Public Schools	Education
Garfield County Mem. Hospital	Health Services
Dye Seed Ranch Inc.	Retail Sales
Clarkston School District	Education
Tri-State Memorial Hospital	Health Services
Poe Asphalt	Construction
Costco	Retail Sales
Walla Walla Community College	Education

Employment by Recreation and Tourism

The recreation and tourism industry is difficult to measure on a county-by-county basis. In 2001, 486,000 Idaho residents and nonresidents (16 and older) spent nearly $755 million in Idaho for fishing and hunting and an additional $982 million for wildlife viewing and related activities (USFWS and USDC 2003). The International Association of Fish and Wildlife Agencies (Southwick Associates 2002) estimated that 6,197 jobs were created in Idaho from all hunting activities. The number of jobs created from all fishing activities was not included in this modeled estimate, but it may be higher than the number of hunting-related jobs, since fishing expenditures outweigh hunting expenditures in Idaho. Rural community economies are generally considered to benefit more from hunting and fishing activities than urban economies do, and some depend highly on these activities (Southwick Associates 2002).

A summary of 2002 sales of resident hunting and fishing licenses by county illustrates the areas where most hunters and anglers live in the subbasin (assuming that people buy licenses in their counties of residence). Nez Perce County had the highest number of license sales with 11,700 resident hunting and fishing licenses sold (Figure 16). The 1991 *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* found that 49% of all hunters and 52% of freshwater anglers traveled less than 25 miles to the sites they used most often (USFWS and USDC 2003).

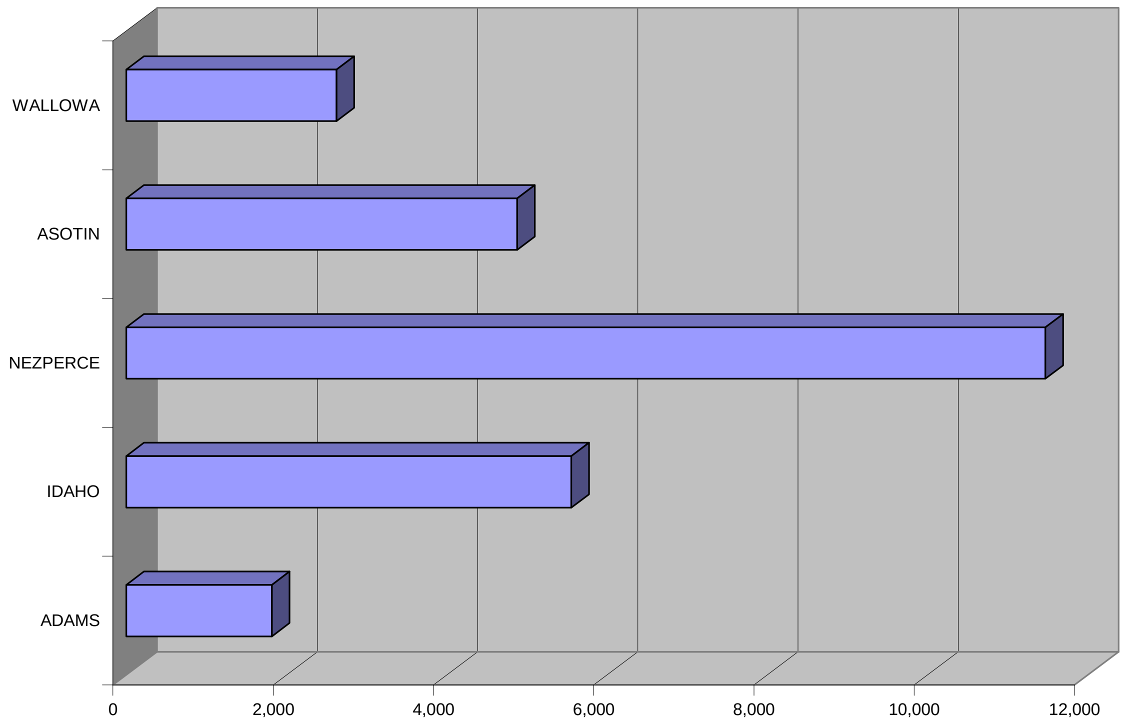

Figure 16. Resident hunting and fishing license sales in 2002 for counties in the Snake Hells Canyon subbasin (IDFG 2003a, ODFW 2003a, WDFW 2003a).

1.6.2 Social, Historical, and Cultural Values

The major social and cultural values of this area have been recently studied and discussed as part of the process to relicense Idaho Power Company's Hells Canyon Complex (Brownlee, Hells Canyon, and Oxbow dams). The following activities have significant social and cultural importance attached to them (BLM 2003; Gribskov 2002a,b; HCNRA 2003; Martin 2002; Melland 2002a,b; Orman 2002):

- Fishing
- Recreation
- Ecotourism (which includes viewing striking geological features)
- Traditional tribal uses
- Archaeology

1.7 Human Disturbances to Aquatic and Terrestrial Environments

Ranching and grazing, recreation, timber harvest, transportation, mining, urban development, and agriculture are primary land uses that potentially affect, or historically have affected, terrestrial and aquatic resources in the Snake Hells Canyon subbasin.

1.7.1 Ranching and Grazing

The horses of the Nez Perce Indians were the first domestic livestock grazed within the Snake Hells Canyon subbasin, probably as early as 1730. When the Nez Perce War ended around 1879, Euro-American settlers began grazing large livestock herds, primarily in the valley bottoms and lower slope areas. By 1900, more than 100 families were raising livestock along the Snake River between Battle Creek and the confluence with the Imnaha River. This period is considered the peak of livestock grazing by homesteaders in the area. The remoteness of the area made obtaining supplies and getting animals to market difficult, and when livestock prices declined, many of the 160-acre homesteads reverted to federal ownership or were purchased and consolidated into larger livestock operations.

Livestock grazing continues to be one of the main land uses at Craig Mountain and throughout privately owned lands in the subbasin. Sheep and cattle allotments on the Snake and Imnaha portions of the HCNRA peaked in 1920, with approximately 108,000 animal unit months (AUMs). The amount of grazing was reduced to 38,260 AUMS permitted on the same approximate area in 1998 (USFS 1999).

The preference for raising cows or sheep has changed a number of times. At first, cattle predominated, but large losses were incurred during the drought and bitterly cold years of 1884 through 1886, so many ranchers began to try sheep. Cattle-to-sheep ratios were 80 to 20% by 1915. During World Wars I and II, sheep grazing in the subbasin again increased due to government encouragement to increase the supply of wool for uniforms and meat for the troops. In 1940, cattle-to-sheep ratios on the HCNRA were 30 to 70%. Because domestic sheep could spread fatal bacterial pneumonia to bighorn sheep, domestic sheep grazing was eliminated on the Oregon portion of HCNRA on August 2, 1995 (USFS 1999). Grazing by domestic sheep continues on the Idaho portion of the HCNRA and on privately owned rangelands.

Overgrazing has negatively impacted both terrestrial and aquatic habitats in the subbasin. Livestock grazing has helped cheatgrass and other nonnative vegetation species establish, reduced the quantity and quality of riparian vegetation, and increased erosion and streambank failures. Most of this damage occurred in the late 1800s and early 1900s. Recently, strategies have been implemented to reduce negative impacts of grazing in the subbasin, including rotation of pastures, fencing of riparian areas, and overall reduction of livestock numbers. Since the mid-1900s, and especially in the past 20 years, the impacts of livestock grazing have been significantly reduced (USFS 1999).

1.7.2 Recreation

The Hells Canyon area is a world-renowned recreational destination, in large part because of unique whitewater rafting opportunities. Other recreational opportunities provided by the subbasin include hiking, horseback riding, camping, sightseeing, mountain biking, limited all-terrain vehicle riding, snowmobiling, swimming, power boating, photography, wildlife watching, hunting, and fishing (USFS 1999). The Snake River portion of the HCNRA received an average of 32,415 visitors per year between 1995 and 1997. Sightseeing was the primary reason for visits to the HCNRA (30%), followed by fishing (12%) (USFS 1999). Recreational activities peak in the summer season, with heavy usage observed between Memorial Day and Labor Day weekends. Recreational use of the subbasin is expected to increase, mirroring increases in nearby populations and the population of the country as a whole (USFS 1999, IDEQ and ODEQ 2001).

Snowmobiling is a substantial use within the HCNRA. The total area on the HCNRA dedicated to motorized oversnow use is approximately 40,786 acres, which is 6.25% of the total land base. There are approximately 132 miles of groomed trails.

1.7.3 Timber Harvest

Timber harvest on USFS-managed lands in the subbasin has been relatively limited. The designation of the HCNRA in 1975 legally prevented harvest of even-aged timber, including clearcutting or seed tree harvests. Regulations adopted in 1994 restricted the commercial harvest of timber on the HCNRA to harvests that enhance ecosystem health, wildlife habitat, or recreational and scenic uses; reduce the risk of harm posed by hazards; or respond to natural events such as fire, flood, earthquake, volcanic eruption, high winds, and disease or insect infestation. In addition to these restrictions, forest openings created by logging must be less than 2 acres in size. No timber harvest is permitted on the wilderness portion of the HCNRA (USFS 1999).

Timber harvest before the 1975 HCNRA designation impacted the ecosystem to some degree. Selective harvest has contributed to the loss of the ponderosa pine-dominated, open, parklike forest that probably historically characterized Craig Mountain and many of the forested lands in the subbasin (Mancuso and Moseley 1994). There has been a corresponding increase in mid-seral stands of Douglas-fir and grand/white fir; however, the changes in forest structure exhibited on the HCNRA are thought to be less severe than those in other parts of the subbasin and throughout the Columbia Basin (USFS 1999).

Many of the privately owned forested lands in the subbasin have been harvested. The extent and impact of this harvest on the Craig Mountain area have been studied by Narolski (1996). Prior to its purchase by the BPA in 1992, the Peter T. Johnson Wildlife Mitigation Unit was owned by the Pene Land Company and heavily logged in around 1986. According to Narolski (1996),

> …most of the valuable and larger trees were removed, leaving predominantly smaller, submerchantible, diseased, lower-value, and shade-tolerant species such as grand fir. Because of these past logging activities, poletimber stands comprised mainly of lodgepole pine can be found over much of the upland plateau within the WMU. The mid-1980s entry also affected the understory plant community, encouraging shade-tolerant grand fir regeneration along with assorted brush species, native grasses, and some noxious weeds.

Forest management activities taking place after the establishment of the Idaho Forest Practices Act (FPA) have had a lesser impact on fish habitat. The principal concerns with current and past forest management activities are increased sediment from roads, loss of riparian shade, and loss of riparian trees that enhance recruitment of large woody debris to stream channels. The FPA contains a number of rules on roads and stream shading related to these concerns. Carefully designed, constructed, and maintained roads minimize sediment input to streams. In addition, locating roads outside riparian areas helps maintain stream shade.

1.7.4 Transportation

The only state highway within the Snake Hells Canyon subbasin is Highway 129, located in Asotin County and connecting Clarkston, Washington, and Enterprise, Oregon. In 1999, traffic volume between Asotin and Clarkston was 5,600 vehicles per day at Critchville Road. However, the traffic volume quickly drops to 640 vehicles per day at Fairgrounds Road on the south end of the Asotin city limits (WSDOT 2000).

No rail service has ever been available in the subbasin (K. Frederickson, Washington State Department of Transportation, Rail Office, personal communication, May 2001; T. Long, Idaho Department of Transportation, Lewiston Office, personal communication, May 2001), although the Camas Prairie Line follows the north shore of the Snake River in Washington into Clarkston and Lewiston where it continues along the south shore of the Clearwater River. Even though the Camas Prairie Line is neither located within the subbasin nor heavily used, it does transport goods, especially dryland crops, from the area (K. Frederickson, Washington State Department of Transportation, Rail Office, personal communication, May 2001).

There are 735 miles of existing USFS roads on the HCNRA, of which 533 are currently open to travel. Fifty percent have natural surfaces, 4% have improved pit run, 12% have a crushed rock surface, 6% have been surface treated, and less than 1% have an asphalt concrete surface. The areas with the highest road density in the HCNRA fall outside the Snake Hells Canyon subbasin.

About 88% of the HCNRA is accessible by trail. An extensive trail system features 925 miles of trail, with approximately 361 miles occurring within the Hells Canyon Wilderness. Trail use in higher-elevation areas is limited to summer, while most lower-elevation trails are used year-round. Trails on the HCNRA evolved from Indian travel routes and big game migration routes; later, they were used for access for grazing, mining, and fire control. Because trails blazed by early users were not constructed for current patterns and levels of use, erosion affects some trails on steep grades.

Areas with low road density are associated with special management designation such as the Hells Canyon Wilderness, HCNRA, and areas without extensive historical logging activity. Road densities range from zero to over 5 miles of road per square mile for the various subwatersheds (IDEQ 1998).

Impacts of the transportation system to fish and wildlife populations are variable and potentially numerous, depending on the area and species present. Aquatic resources are most directly impacted by riparian degradation, altered hydrologic and sediment regimes, and passage issues related to roading. Terrestrial species are directly impacted by habitat fragmentation and disturbance/harassment, and habitat loss related to the transportation system. By providing access to areas, the transportation system may also be linked indirectly to impacts of various other land-use activities including recreation, timber harvest, mining, exotic species, and others.

1.7.5 Mining

In the 1860s, gold was discovered on the river bars of the Snake Hells Canyon subbasin. This discovery led to Euro-American settlement of the region. Placer mining for these deposits turned out to be relatively unsuccessful, but hundreds of rock piles still dot the river corridor as evidence of the attempt (USFS 1999). Later efforts focused on hard rock mining. Minerals excavated from the subbasin include gold, silver, copper, iron, and lead (Figure 17). Historical mining operations were widespread, but only sand, gravel and stone are currently excavated from the subbasin. These operations occur in the lower subbasin within 20 linear miles of Lewiston.

Impacts of mining activities are largely related to disturbance of spawning gravels (placer mining) and sediment production, and impacts may be long-lived. Tailings from historical placer mining activities still pose a sedimentation problem during peak flows (Mancuso and Moseley 1994). Mining activity may be detrimental to some wildlife species (e.g., stone mining may negatively impact amphibians and reptiles living in rocky habitats) while benefiting other species (e.g., hard rock mines create artificial caves that may benefit bats).

1.7.6 Agriculture

Cultivated land comprises 41,639 acres, or 7%, of the subbasin, with small grain crops in the lower 20 miles of the subbasin composing the vast majority of the region's agriculture (Figure 6). Small grains are grown on a three-year dryland crop rotation of wheat, barley, and a legume, oilseed, or fallow crop. Therefore, each crop in the rotation makes up about one-third of the acreage. Soft white, hard red spring, and hard red winter are the three classes of wheat. Both feed and malt barley are grown.

The legumes and oilseed crops are evenly divided into approximately one-sixth of the total rotation each. The variety of crops increases eastward as precipitation increases. The fallow rotation is found only on the western edge of the subbasin where a lack of adequate moisture prevents continuous cultivation. Legume crops include peas, lentils, and garbanzo beans, with the latter two the most common. Oilseed crops include mustard, flax, spring and winter rape, and spring and winter canola, the latter of which is the most prevalent. Traditionally, most of the legume–oilseed rotation was planted in legumes; however, poor prices for these crops have caused a shift toward more oilseed production, which is now equal to and will soon overtake production of legumes (S. O'Connell, Columbia Grain Growers, personal communication, May 2001).

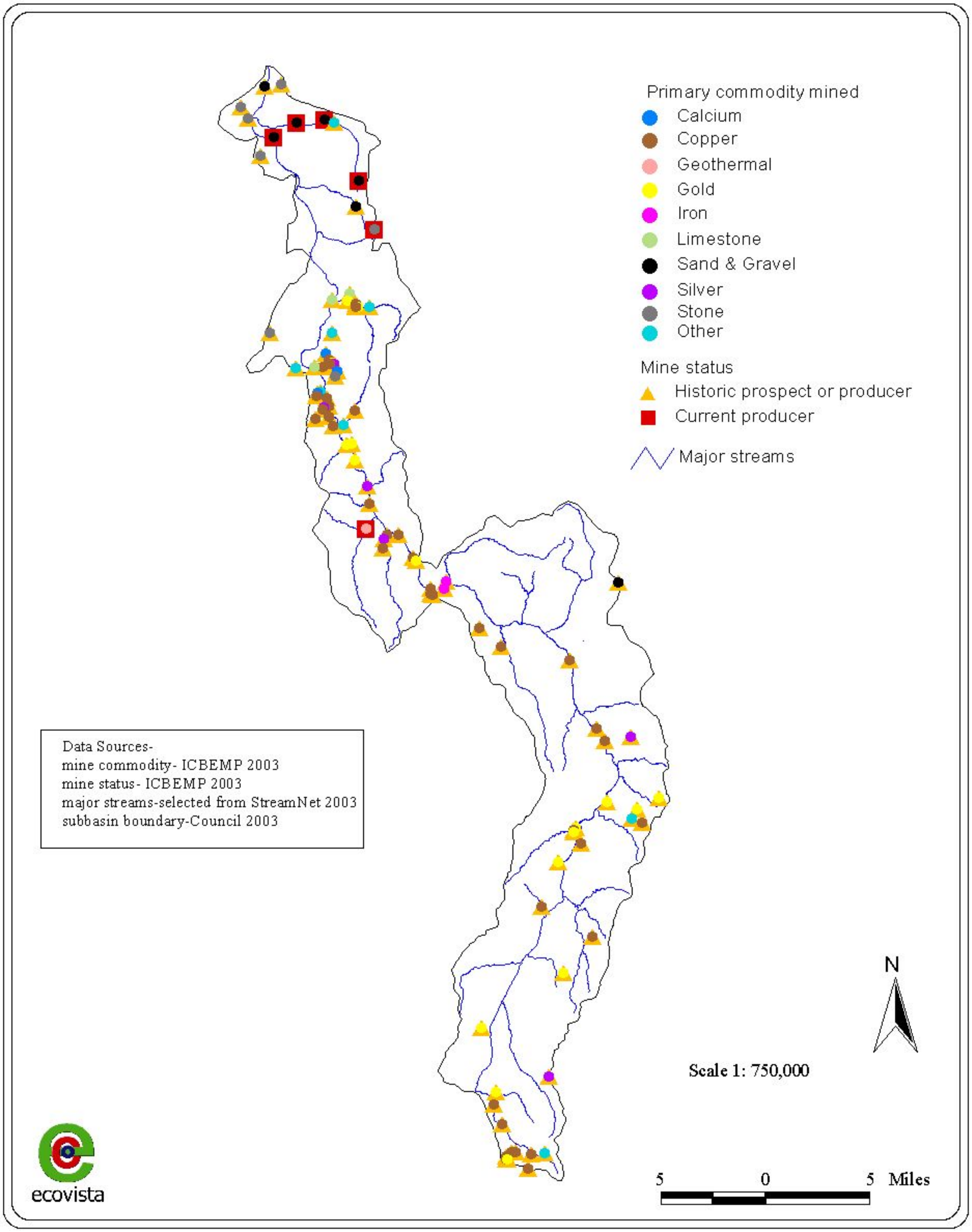

Figure 17. Current and historical mining activities in the Snake Hells Canyon subbasin.

As fertilizer costs increase, prompted by higher natural gas prices, farmers are applying commercial fertilizers with much more scrutiny. This situation has led to an increase in malt barley production because malt barley has a lower protein content and requires less nitrogen than feed barley. There is also a trend toward reduced tillage practices for the benefit of soil conservation as well as savings in labor, time, and wear on equipment (L. Smith, University of Idaho Cooperative Extension, Nez Perce County, personal communication, May 2001).

In the upper subbasin, agricultural activity ranges from small hay fields in the canyons located on bars and benches to larger hay fields located in the upland prairie, meadows, or plateau areas. Large dryland farming occurs north of the Salmon River (Camas Prairie) and in the lower portion of the Snake Hells Canyon subbasin on the upland plateau areas (Figure 6).

Agricultural impacts to aquatic systems are most commonly related to sediment production, introduction of excess nutrients or other contaminants to waterways, loss or degradation of riparian areas, and altered hydrologic regimes. Terrestrial impacts are most greatly related to loss of key habitat types (e.g., native grassland communities) through conversion to agriculture.

1.7.7 Urban Development

Urban development impacts the lower portion of the subbasin, which contains the town of Asotin and portions of Clarkston and Lewiston. The remainder of the subbasin is either rural or undeveloped. Populations in all five counties partially contained in the Snake Hells Canyon subbasin increased between 1990 and 2000 (Table 3). This population increase is reflected in both more residents inhabiting the lower subbasin towns of Asotin, Lewiston, and Clarkston and greater recreational pressure from the residents of neighboring communities. In the upper half of the subbasin, some residential housing with septic systems exists, but the density is very low (IDEQ and ODEQ 2001).

Direct impacts of urban development on aquatic ecosystems include alteration and degradation of aquatic habitat areas and alteration of hydrologic regimes. Habitat loss, degradation, and fragmentation are the primary direct impacts of urban development on wildlife species. Indirect impacts to both fish and wildlife species include introduction of pollutants, harassment, and increases in other land uses (transportation, recreation, etc.).

1.7.8 Diversions, Impoundments, and Irrigation Projects

Idaho Power Company (IPC) operates the Hells Canyon Complex (Hells Canyon, Oxbow, and Brownlee dams) at the upstream end of the Snake Hells Canyon subbasin. This three-dam complex has significantly altered hydrologic regimes downstream (see section 1.8). In addition, there are numerous small water rights (less than 0.02 cubic feet per second [cfs]) used for irrigation, livestock, and domestic use. The USFS and BLM are currently filing on many springs and creeks in accord with Snake River Adjudication protocols.

1.7.9 Barriers

Although the original Federal Energy Regulatory Commission (FERC) license for Hells Canyon Dam included fish passage, no fish passage was ever built. Access to spawning areas upstream of Hells Canyon Dam was blocked starting in 1955 by a three-dam complex. Although other anadromous species formerly used the area above Hells Canyon Dam, fall chinook may have been most impacted by impoundment. Snake River fall chinook were historically distributed from the mouth of the Snake River to a natural barrier at Shoshone Falls, Idaho, at RM 615 (Haas 1965). The upper reaches of the mainstem Snake River, particularly near the town of Marsing, Idaho (RM 390, 144 miles upstream of Hells Canyon Dam; Haas 1965), were the primary areas used by fall chinook salmon, with only limited spawning activity reported downstream of RM 272 (NMFS 2000a). After construction of the dams, the areas available for spawning included 104 miles of free-flowing Snake River downstream of Hells Canyon Dam and associated tributaries, including the Imnaha, Salmon, Grande Ronde, and Clearwater rivers (Rondorf and Tiffan 1997). An estimated 80% of the Snake River drainage formerly used by fall chinook salmon for spawning and rearing has been eliminated due to habitat changes or lack of access (USFS 1999).

No artificial barriers are known to occur on main tributaries to the Snake River in the subbasin. However, natural barriers to salmonid migration, such as low flows or high gradients, have been identified on many of the small tributaries that drain into the Snake River on the Idaho side. Specifically, in the lower portion of the subbasin, natural barriers (falls) occur on Captain John Creek (RM 5.8) and the South Fork of Captain John Creek (RM 1.7) (BLM 2000b). Low-flow barriers have been documented on Madden Creek, a tributary to Captain John Creek, and are suspected to occur at the mouth of Corral Creek when Snake River flows are low (BLM 2000b). In the upper portion of the subbasin (above the Salmon River confluence), natural barriers have been identified in Dry Creek, Wolf Creek (about 0.75 miles upstream of the confluence with the Snake River), Getta Creek (during periods of low flow), and Highrange Creek (because of steep gradient and low flows) (BLM 2000a).

1.7.10 Fire Suppression

Natural (lightning-caused) fires are a primary factor perpetuating natural forest ecosystems and landscape diversity in the Snake Hells Canyon subbasin (Cooper et al. 1991). Planned and unplanned burning by Native Americans had an extensive impact on maintaining stand composition and structure. The high frequencies in some of the fire-scar samples in certain studies may have resulted from Indian-caused fires (Barrett and Arno 1982 *in* Cooper et al. 1991). Prospectors and settlers also set fires to expose mineral outcrops (Space 1964 *in* Cooper et al. 1991) and improve range. In recent history, numerous wildfires have burned within the Snake Hells Canyon ecosystem (Figure 18).

Fire-free intervals can be inferred to some extent by climax tree series and habitat type. *Pinus ponderosa-Pseudotsuga menziesii*/bunchgrass types have a mean fire-free interval of six years, compared with *Abies lasiocarpa* habitat types that have an interval of over 40 years (Arno and Peterson 1983 *in* Cooper et al. 1991). Modern fire suppression has, however, resulted in plant communities that have greater biomass and less vigorous vegetative growth, with increased susceptibility to pathogens and wildfires of greater severity and size (Johnson 1998). These changes are illustrated by comparing historical and current severity ratings for plant communities within the subbasin (Figure 19 and Figure 20, respectively). There has been a significant reduction in the extent of the nonlethal and mixed fire regimes.

Years of fire suppression in the subbasin have resulted in dramatically altered fire-return intervals or frequencies (Figure 21 and Figure 22). These fire regimes maintained late seral single-layer types by thinning shade-tolerant tree species in early, mid-, and late seral multilayer types. Reductions in fire frequency have increased fuel loads and resulted in hotter burning, more intense fires and a shift from nonlethal to lethal fire regimes in many areas (Quigley and Arbelbide 1997).

Successional processes following wildfire and logging have been described for some northern Idaho habitat types (Lyon and Stickney 1976, Arno et al. 1985, Green and Jensen 1991). In general, the composition of post-disturbance plant communities is dependent on environmental site conditions, existing vegetation, severity of disturbance, life history characteristics of individual species, and (to some degree) chance (Morgan and Neuenschwander 1984). Research by Lyon and Stickney (1976) has shown that immediately following a fire, forest plant communities were composed largely of species present prior to the event. Even five years post-disturbance, species composition was 80% similar to the prefire community, and all species had established during the first year. These findings suggest that many local plant species are well adapted to surviving and propagating after fires.

The most abundant trees in the Snake Hells Canyon subbasin are seral species adapted to periodic fire disturbance (Table 5). Adaptations to fire include thick, corky, fire-resistant bark (*Larix occidentalis*, *Pinus ponderosa*, *Pseudotsuga menziesii*), light or winged seeds (*L. occidentalis*, *P. ponderosa*, *P. menziesii*, *Pinus monticola*), serotinous cones (*Pinus contorta*), and rapid initial growth in height (Cooper et al. 1991). As evidenced by even-aged stand structure, a considerable amount of viable seed survives even catastrophic fires.

Successional processes in riparian areas, shrub fields, and grasslands have been less well studied than coniferous forest types of the subbasin have been. Fire is a common occurrence within low-elevation grasslands and shrub fields. Within bluebunch wheatgrass communities, light to moderate fires can enhance cover of wheatgrass, but severe fires can be detrimental to bunchgrass survival (Johnson 1998). Cheatgrass and other annual grasses can increase following severe fires in the wheatgrass zone. The timing and intensity of livestock grazing can also influence the composition of successional plant communities following disturbance. Idaho fescue is more sensitive to damage from fire than some other native bunchgrasses are (Johnson 1998). Even moderate fires can result in significant decreases in Idaho fescue coverage for several years following the event.

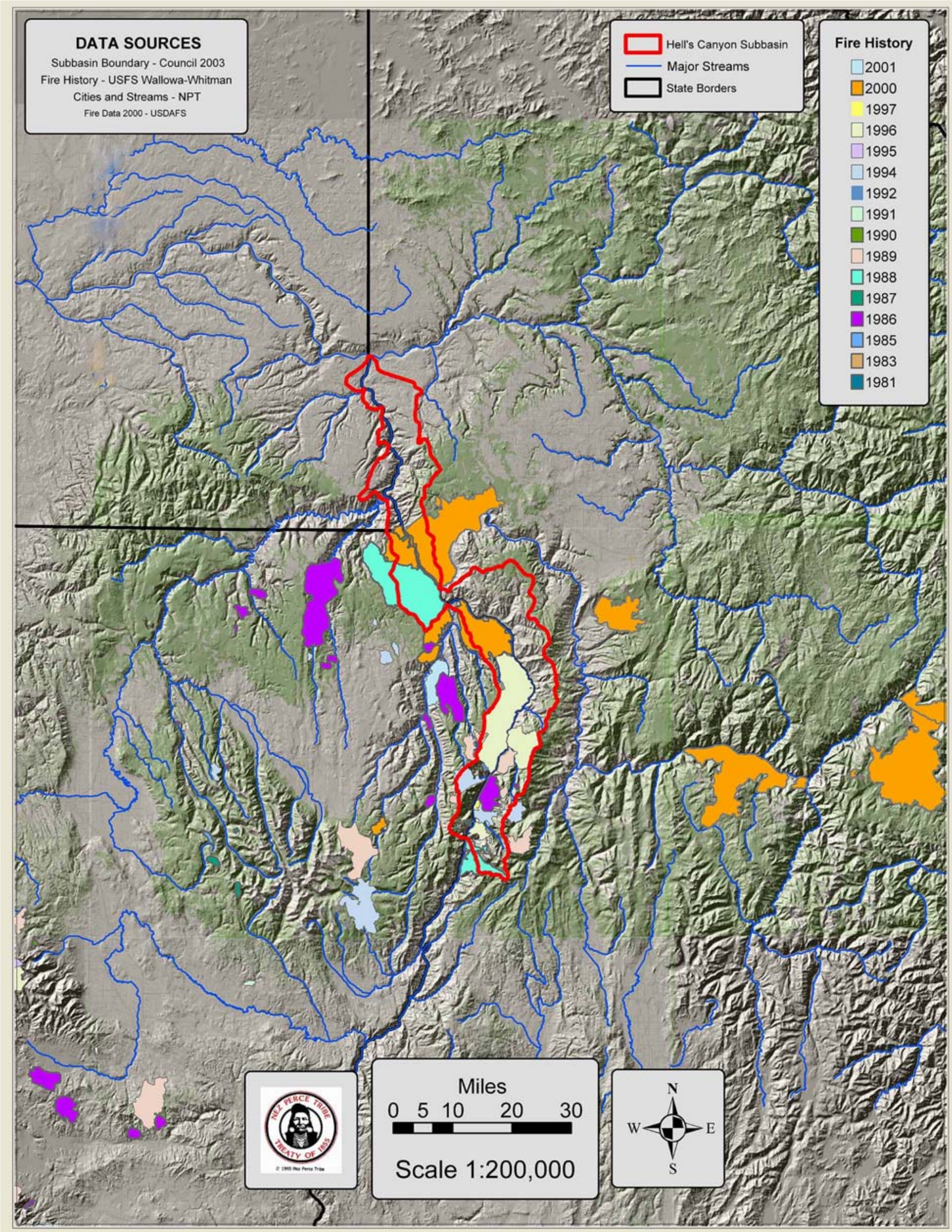

Figure 18. Recent fire activity within and adjacent to the Snake Hells Canyon subbasin.

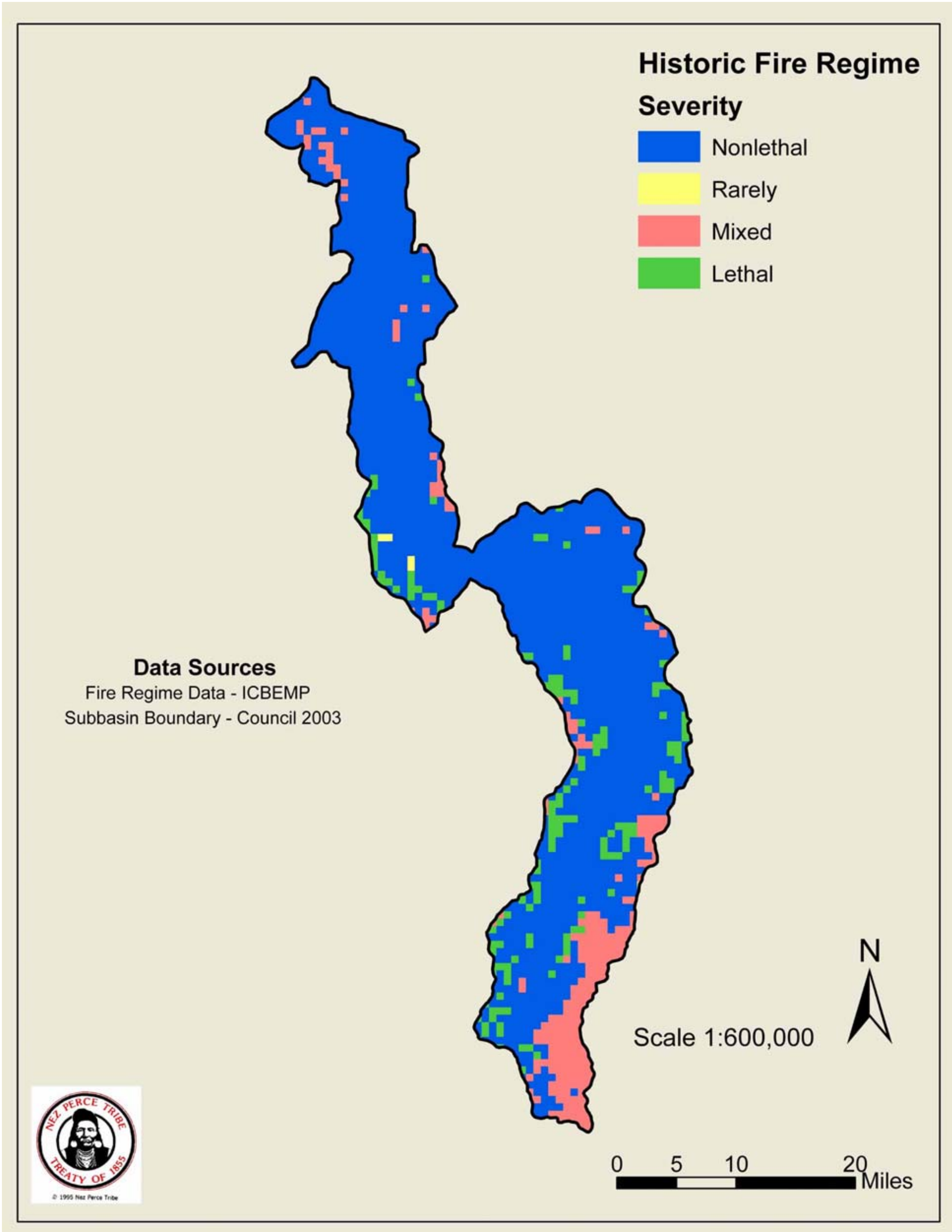

Figure 19. Historic fire regime severity ratings for the Snake Hells Canyon subbasin.

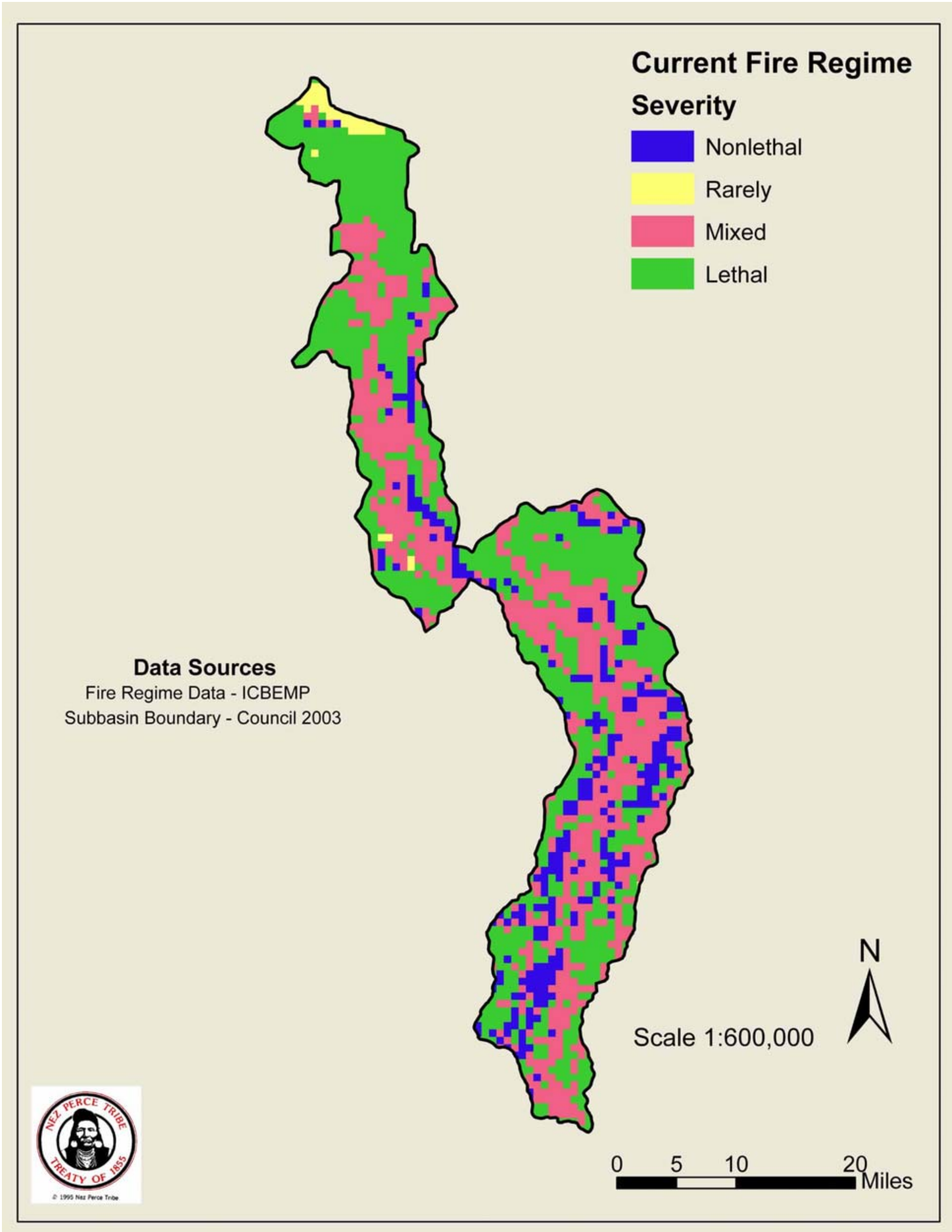

Figure 20. Current fire regime severity ratings for the Snake Hells Canyon subbasin.

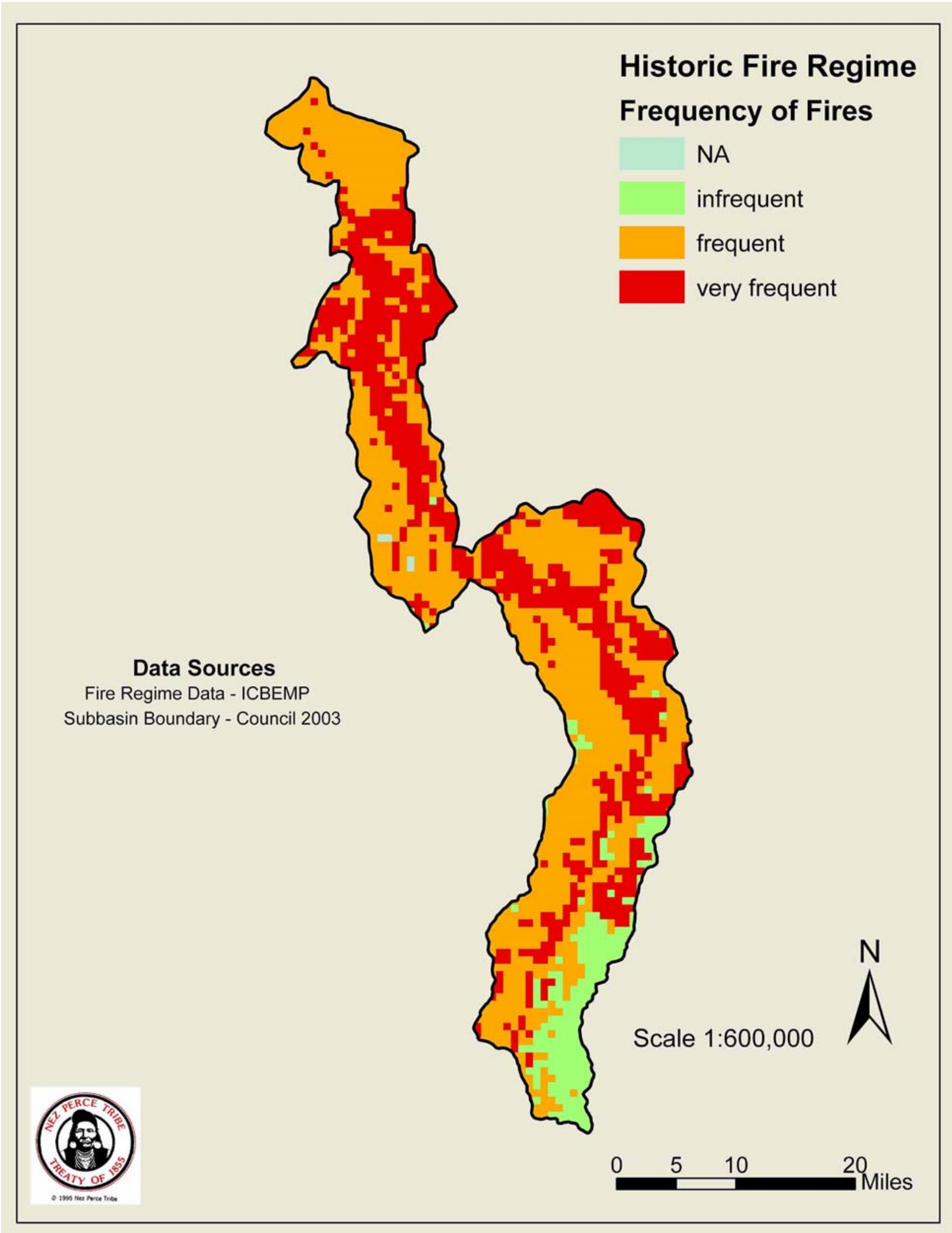

Figure 21. Historic fire frequency for the Snake Hells Canyon subbasin.

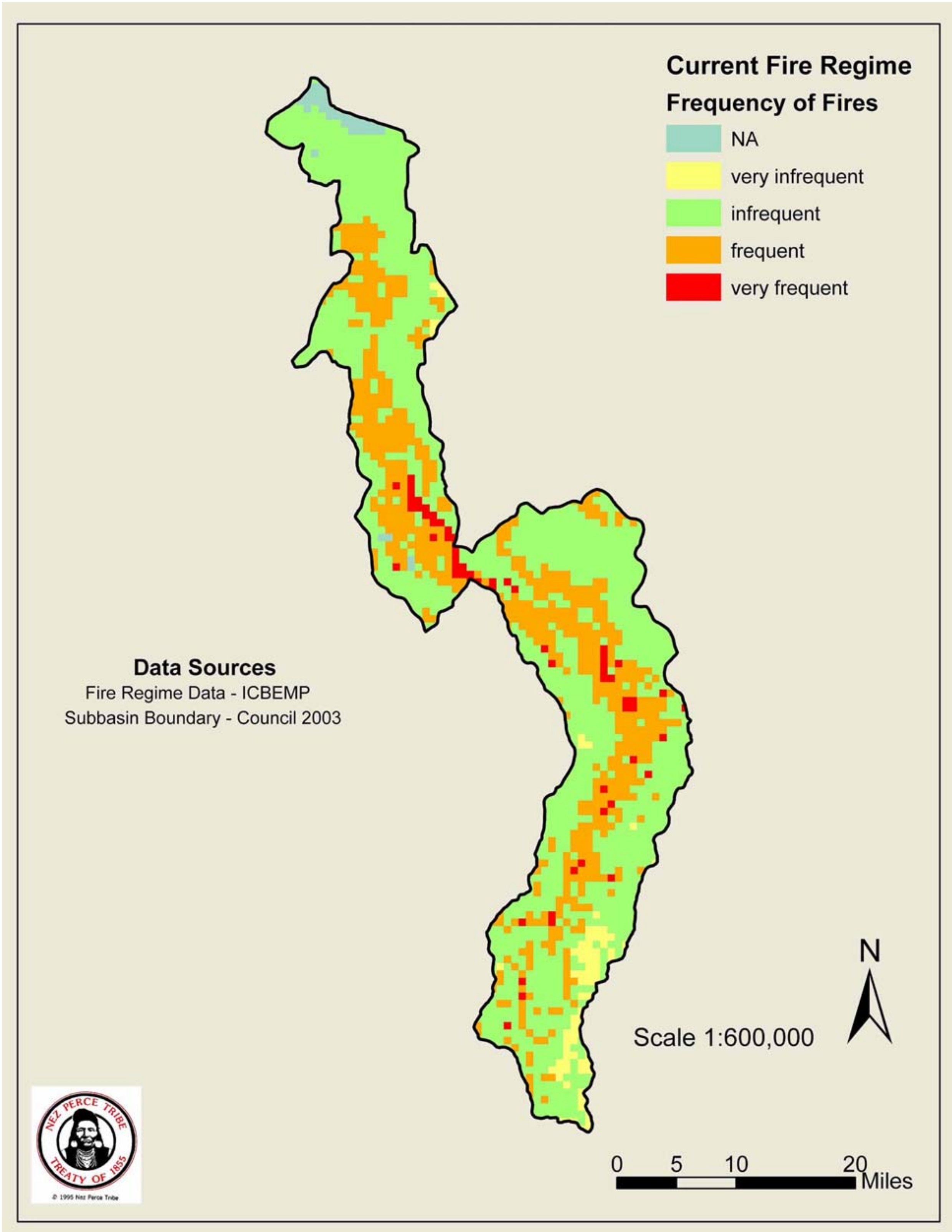

Figure 22. Current fire frequency for the Snake Hells Canyon subbasin.

Table 5. Tolerance of tree species to fire (Fischer and Bradley 1987).

Species	Tolerance							
	Bark Thickness of old trees	**Root Habit**	**Resin in old bark**	**Branch habit**	**Stand habit**	**Relative inflammability of foliage**	**Lichen growth**	**Degree of fire resistance**
Western Larch	Very thick	Deep	Very little	High and very open	Open	Low	Medium to heavy	Most resistant
Ponderosa Pine	Very thick	Deep	Abundant	Moderately high and open	Open	Medium	Medium to light	Very resistant
Douglas-fir	Very thick	Deep	Moderate	Moderately low and dense	Mod. - dense	High	Heavy medium	Very resistant
Grand Fir	Thick	Shallow	Very little	Low and dense	Dense	High	Heavy medium	Medium
Lodgepole Pine	Very thin	Deep	Abundant	Moderately high and open	Open	Medium	Light	Medium
Western White Pine and Whitebark Pine	Medium	Medium	Abundant	High and dense	Dense	Medium	Heavy	Medium
Western Red Cedar	Thin	Shallow	Very little	Moderately low and dense	Dense	High	Heavy	Medium
Engelmann Spruce	Thin	Shallow	Moderate	Low and dense	Dense	Medium	Heavy	Low
Mountain Hemlock	Medium	Medium	Very little	Low and dense	Dense	High	Medium to heavy	Low
Western Hemlock	Medium	Shallow	Very little	Low and dense	Dense	High	Heavy	Low
Supalpine Fir	Very thin	Shallow	Moderate	Very low and dense	Mod.- dense	High	Medium to heavy	Very low

Shrubland plant communities vary widely in their response to fire. Dryland shrub communities such as ninebark often respond favorably to moderate fires (Johnson 1998) due to their ability to resprout from root crowns (Lyon and Stickney 1976). Vigorous regrowth following fire can create highly palatable forage for elk, deer, rabbits, and other browsers. Idaho fescue associated with ninebark communities, however, often responds poorly following fire because the greater fuel loads in shrub fields result in hotter, longer-duration fires that can damage or kill the plants (Johnson 1998).

Shrub species that respond poorly to fire include big sagebrush and mountain mahogany. Both of these species are often killed by even moderate fires, although mountain mahogany seed germination increases following light fires (Johnson 1998).

1.7.11 Introduction of Exotic Species

Land-use activities in the subbasin have contributed to significant changes to the vegetative composition of communities in the subbasin; these changes are particularly notable in grassland habitats. Habitats in the lower subbasin have been the most impacted by noxious weeds and other invasive plant species. Yellow starthistle has altered the composition of large areas of the canyon grassland. In areas where disturbance has been severe, native perennial grasses have been eliminated and noxious weed such as whitetop, Scotch thistle, and yellow starthistle occupy the sites, along with other weedy species such as cheatgrass and St. Johnswort (USFS 2003a). In other areas of the subbasin, invasive plant species and noxious weeds are less pervasive, but preventing their spread is a management priority (see section 0 and the management plan for details).

1.8 Hydrography and Hydrology

The macroclimate patterns previously described (see section 1.3) have little functional impact on the hydrology of the mainstem Snake River within the Snake Hells Canyon subbasin. Mainstem hydrology is dictated primarily by dam operations through the Hells Canyon Complex and inflows from surrounding subbasins (such as the Salmon River).

Macroclimate has a more substantial impact on the hydrology of smaller tributaries within the subbasin. In lower-elevation areas, occasional thunderstorms occurring from late spring through summer may result in flash floods that produce annual peak flows in localized areas. However, because thunderstorms are generally brief and limited in size, their impacts are highly localized.

Timing, duration, and volume of peak flows are driven by snowmelt and/or seasonal rainstorms at lower elevations (less than 5,000 feet) in the Snake Hells Canyon subbasin. Therefore, interannual variability in both the timing and volume of peak flows is likely to be much greater than that at higher elevations. Rainstorms having the greatest impacts to hydrology at lower elevations occur during winter or spring, with precipitation falling on frozen or snow-covered ground. Such rain-on-snow events can occur from November through March (Thomas et al. 1963) and may result in hydrograph peaks throughout this period.

Hydrological features of the Snake Hells Canyon subbasin are best described by dividing the reach into two sections: the lower section, which extends below the confluence of the Salmon River to the Clearwater River, and the upper section, which extends from the confluence of the Salmon upriver to Hells Canyon Dam.

The lower section flows 50 miles from the mouth of the Salmon River (RM 188) to the mouth of the Clearwater River (RM 138). This segment of river is regulated by Hells Canyon Dam (RM 247) and large contributing tributary rivers, which include the Clearwater and Grande Ronde rivers. Lower order tributaries joining the Snake River in this reach include Asotin Creek, Tammany Creek, Redbird Creek, and several other streams, many of which flow only during periods of runoff. The Clearwater River contributes approximately 30% of the total flow of the Snake River at that point. Water discharge records are from a U.S. Geological Service (USGS) discharge station located 1.2 miles downstream of the Grande Ronde River (period of record 1958–1997). The average annual discharge is 35,900 cfs, highest daily mean is 191,000 cfs (maximum of 195,000 cfs on June 18, 1974), and lowest daily mean is 6,630 cfs (minimum of 6,010 cfs on September 2, 1958). High flows average 80,000 to 140,000 cfs, and mean low flows generally range from 8,000 to 15,000 cfs. Stream flows follow a pattern of low flows during the late summer and fall months and high flows in the spring and early summer months. The lowest portion of the subbasin includes several miles of Lower Granite Reservoir, which extends upstream to Asotin at RM 146.8. With three major dams upstream—Brownlee, Oxbow and Hells Canyon—water levels fluctuate daily and weekly for power generation and are seasonally impacted to moderate flooding and provide water for irrigation.

The upper section of the Snake River through Hells Canyon flows 58.8 miles from Hells Canyon Dam (RM 247) to the mouth of the Salmon River (RM 188). This segment of river is regulated by Hells Canyon Dam. The largest tributary in this river segment is the Imnaha River (RM 192). Water discharge records are from a USGS discharge station located 0.6 mile downstream of Hells Canyon Dam (period of record 1966–1997). The average annual discharge is 20,650 cfs, highest daily mean is 98,100 cfs (maximum of 103,000 cfs on January 2, 1997), and lowest daily mean is 4,360 cfs (minimum of 4,360 cfs on May 8, 1977; Figure 23).

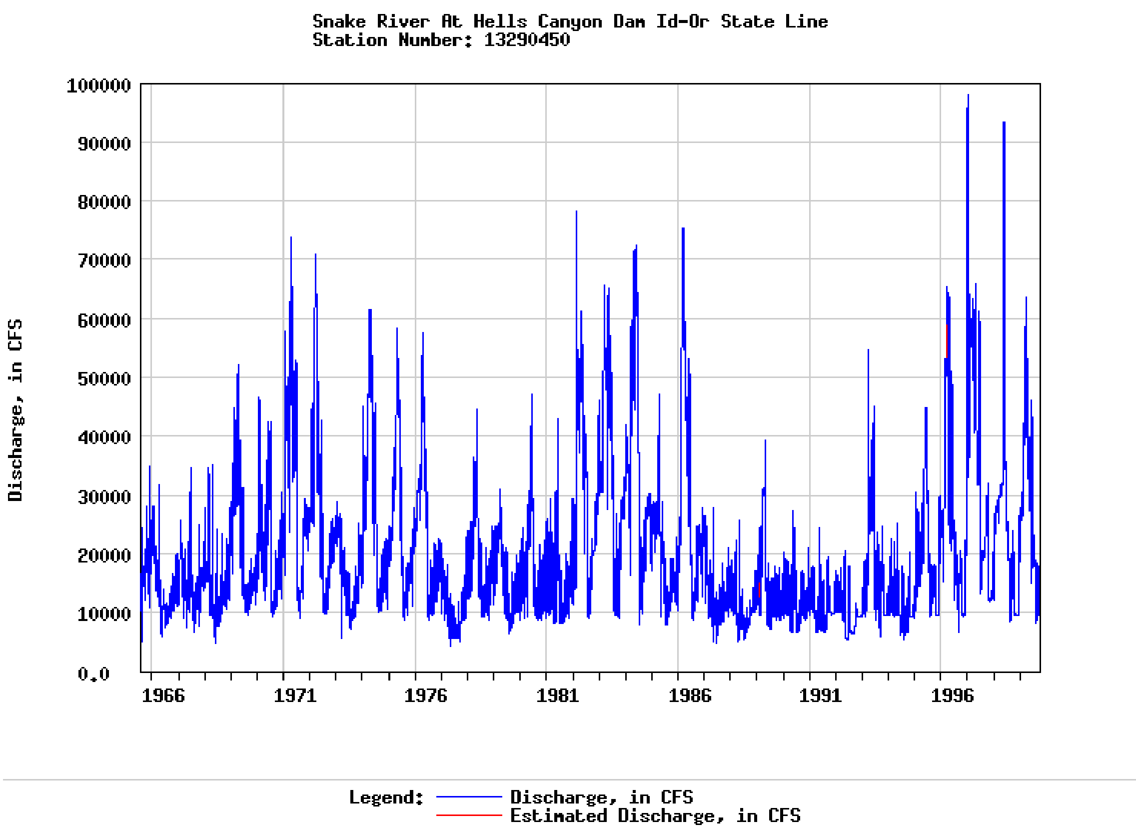

Figure 23. Average daily flows measured at Hells Canyon Dam gage 13290450 (1966–1997).

Mean high flows generally range from 60,000 to 80,000 cfs, and mean low flows generally range from 7,000 to 10,000 cfs. Currently, a minimum discharge at Hells Canyon Dam is maintained at 10,000 cfs during fall chinook salmon spawning and incubation periods. Again, stream flows are low during the late summer and fall and high during the spring and early summer.

More than 95% of total inflow into the subbasin down to the Salmon River is contributed from upstream flows through Hells Canyon Dam (Figure 24 and Figure 25) (IDEQ and ODEQ 2001). These flows are heavily influenced by upriver water uses. The Hells Canyon Complex provides irrigation storage for more than 3.5 million acres of land upstream of Brownlee Dam, for a total estimated annual consumptive use of 6 to 8 million acre-feet (IDEQ and ODEQ 2001). Currently, high flows are not usually as high as those recorded in the early 1900s, and in most areas, average low flows are not generally as low. Although the volume of water that passes through the subbasin annually has not changed substantially, the timing of flows has been altered by the Hells Canyon Complex.

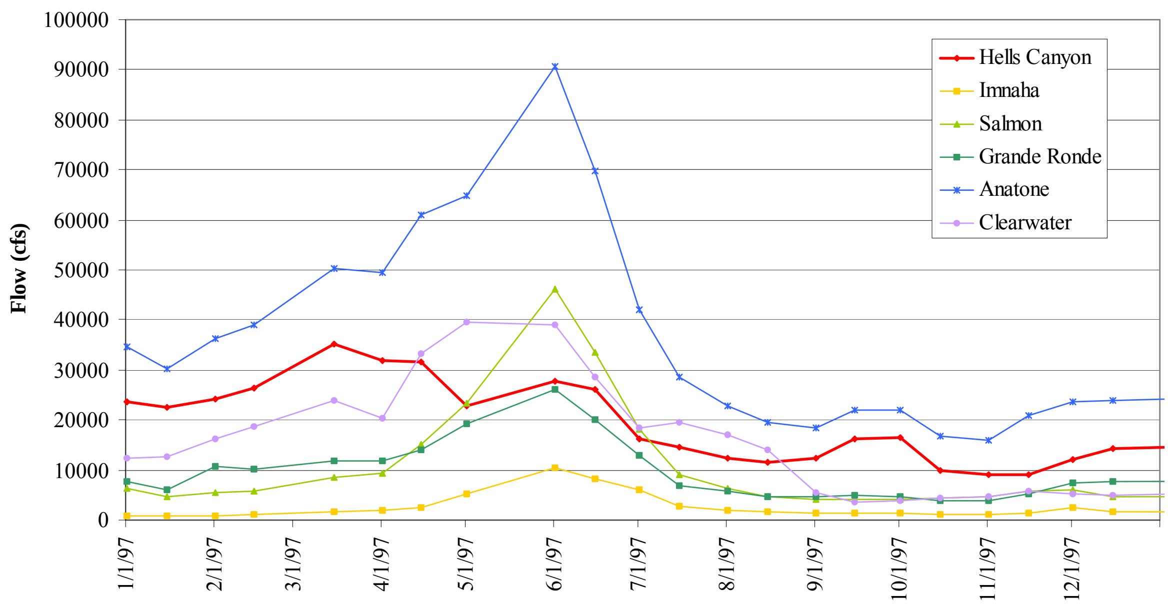

Figure 24. Flow in the Snake River (at the Hells Canyon and Anatone gages) and contributing flows from four main tributaries during 1997.

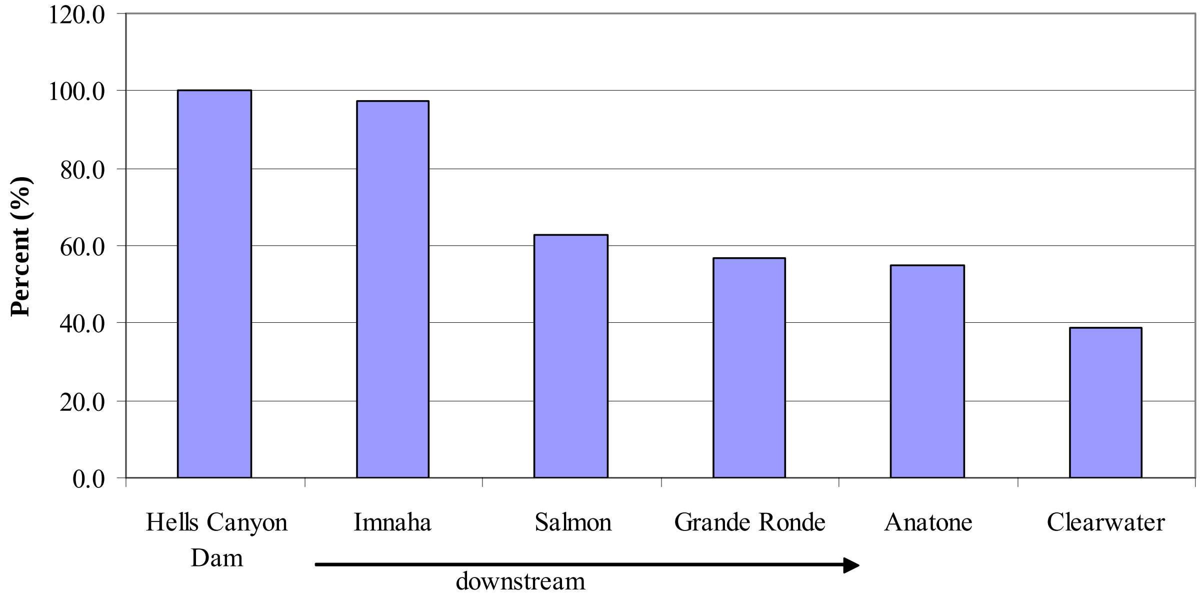

Figure 25. Percentage of the contribution of flow from Hells Canyon Dam at various points in the Snake Hells Canyon subbasin during 1997.

Water releases through Hells Canyon Dam cause the Snake River to fluctuate dramatically each day due to the effects of power peaking (Figure 26) (USGS 2001). These effects are most pronounced above the confluence with the Salmon River (Kern 1976). Above the Salmon River, these fluctuations cause severe enough disturbances to vegetation to prevent the establishment of anything more than early successional plants within the fluctuation zone. The flow of the Salmon River moderates the impacts of the flow enough to allow more complex vegetative communities below the confluence (Kern 1976).

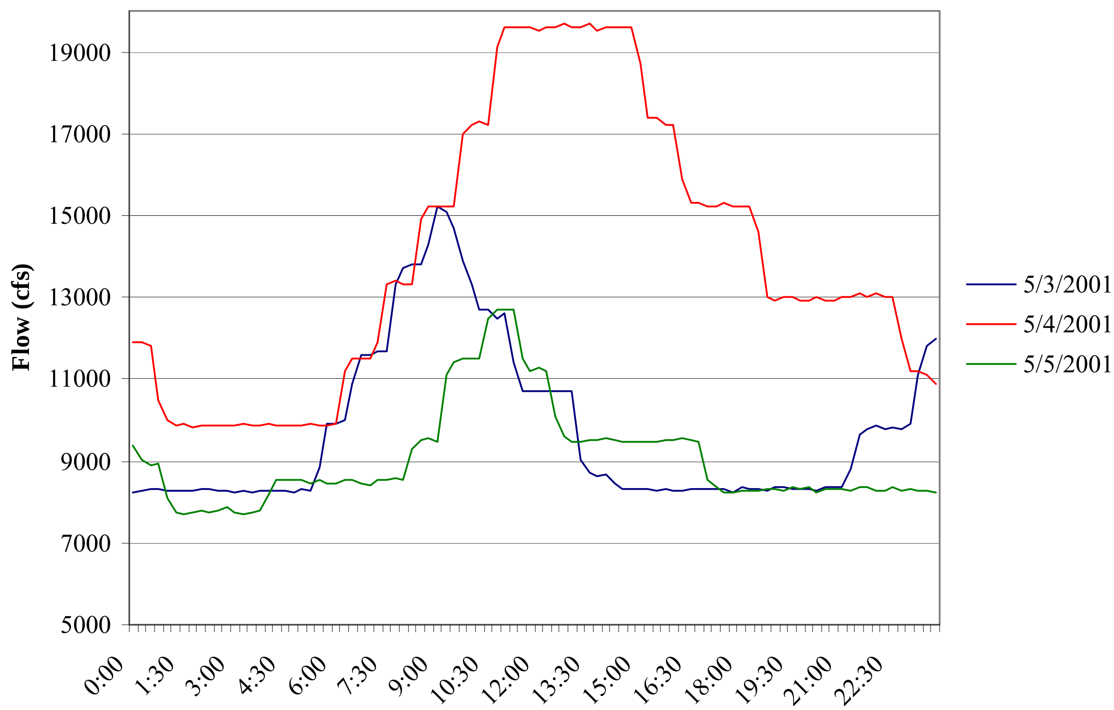

Figure 26. Daily flow fluctuations at Hells Canyon Dam for three days in March 2001.

As mentioned earlier, the FERC relicensing process for the Hells Canyon Complex is currently underway. IPC filed the draft license application in November 2002 and the final license application in July 2003. In addition, section 401 of the Clean Water Act (CWA) requires IPC to file for certification with the states of Idaho, Oregon, and Washington (IDEQ and ODEQ 2001).

1.9 Water Quality

Little water quality information exists for the Snake Hells Canyon subbasin. Water quality data—including temperature, flow, conductivity, oxygen, oxygen saturation, pH, suspended solids, total persulfate nitrogen, ammonia nitrogen, total phosphorus, dissolved soluble phosphorus, turbidity, fecal coliform, and nitrate-nitrite—is collected by the Washington Department of Ecology at the Snake River station (gage 35A150) just above the confluence of the Clearwater River.

In the mainstem, above and below the confluence with the Salmon River, water quality is generally excellent (IDEQ 1998). It fully supports all beneficial uses identified for the river (recreation, primary and secondary contact recreation, salmonid spawning, domestic water supply, agricultural water supply, and cold water biota). However, elevated summer water temperatures are not optimum for salmonid rearing conditions, and high sediment concentration occurs during high-flow events (WDFW et al. 1990, IDEQ 1998).

1.9.1 303(d) Listed Segments

Water quality limited segments are streams or lakes listed under section (§) 303(d) of the CWA for either failing to meet their designated beneficial uses or exceeding state or tribal water quality criteria. States assume a responsibility to develop a 303(d) list and establish a total maximum daily load (TMDL) for the impaired parameter(s). Streams listed under §303(d) within the Snake Hells Canyon subbasin are summarized in Table 6.

Water quality in the Snake Hells Canyon subbasin is subject to different criteria of three states. Idaho, Washington and Oregon each use different methodologies to determine what constitutes a water quality violation. In the reach between Oregon and Idaho, the river must meet the criteria of both states due to the water mixing at the state line in the middle of the river (IDEQ and ODEQ 2001).

Temperature and sediment are the two factors listed under §303(d) of the CWA that have limiting effects on fish populations within the subbasin. Total dissolved gas, although not included under 303(d) listings, had been recommended for listing and was addressed in the recent TMDL developed for the Snake River (IDEQ and ODEQ 2001).

1.9.2 Temperature

According to the U.S. Environmental Protection Agency (USEPA, cited in IDEQ and ODEQ 2001),

> Data collected roughly monthly from 1975 to 1991 by the USEPA in the Downstream Snake River segment at RM 247 (below Hells Canyon Dam) show temperatures ranging from 1 °C in January, 1979 and 1985 (air temperature at –4.5 °C and 2 °C respectively) to 24 °C in July, 1975 and September, 1987 (air temperature at 35 °C and 30 °C respectively). When compared to the 13 °C absolute maximum temperature target identified by the SR-HC TMDL for salmonid spawning in interstate waters (because these are instantaneous data, there is no way to determine an average) the data show that the target was routinely not met during September (82%) and October (47%). Targets were not met in November only 7% of the time. Roughly 22% of all available data show temperatures above 17.8 °C (all occurring during late July, August or September). Roughly 1% of all available data show temperatures above 22 °C (all occurring in July or September). This set contained 148 data points. These data were collected over a variety of seasonal variations, but do not represent continuous monitoring.

During the winter, the average temperature of inflowing water from Hells Canyon Dam is approximately 6 °C (43 °F), and the average summer temperature for inflowing water is 20 °C (68 °F) (IDEQ and ODEQ 2001). Water temperatures at RM 192 (just above the confluence with the Imnaha River) are warmer in the summer and cooler in the fall than those measured just below Hells Canyon Dam (Anderson 2000). Daily maximum and minimum temperatures have a wider range and greater variance as distance from Hells Canyon Dam increases. IDEQ and ODEQ (2001) found that water temperatures in the Snake River generally decrease by an average of 3 °C during the summer between Hells Canyon Dam and the Salmon River. However, Anderson (2000) found that water temperatures changed by approximately 10% of the difference between air and water temperatures between Hells Canyon Dam and the Salmon River, warming about 1 °C as the water flowed through the canyon during summer. Anderson also found that, during the summer, the outflow from Hells Canyon Dam may be either warmer or cooler than water temperatures measured in primary Snake River tributaries. This finding means that the tributaries can either warm or cool the Snake River (Anderson 2000). Downstream temperatures in the Snake River, recorded just above the confluence of the Clearwater River at the Washington Department of Ecology station 35A150, regularly fail state water quality criteria during summer months (July–September; Figure 27). Although flow datasets for 1999–2000 are incomplete, flow and temperature do not appear to be correlated ($\rho_{x1,x2} = -0.09$).

Table 6. Stream segments in the Snake Hells Canyon subbasin listed as impaired or with beneficial uses under §303(d) of the CWA.

Listing State	Segment	303(d) Listed Parameters	Designated Beneficial Uses
Idaho	Snake River—Hells Canyon Dam downstream to confluence with Clearwater River	not listed	cold water biota salmonid spawning primary contact recreation domestic water supply
Idaho	Divide Creek	sediment	
Idaho	Wolf Creek	sediment	
Idaho	Getta Creek	sediment	
Idaho	Cottonwood Creek	sediment	
Idaho	Deep Creek	metals sediment pH	
Idaho	Tammany Creek	sediment	
Oregon	Snake River—Hells Canyon Dam downstream to Washington Border	mercury, temperature	public/private domestic water supply industrial water supply irrigational water livestock watering salmonid rearing and spawning resident fish and aquatic life water contact recreation wildlife hunting, fishing, boating aesthetics anadromous fish passage commercial navigation and transport
Washington	Snake River—confluence with Clearwater River to 1 mile upstream	temperature	water supply (domestic, industrial, agricultural) stock watering fish and shellfish wildlife habitat, recreation commerce and navigation

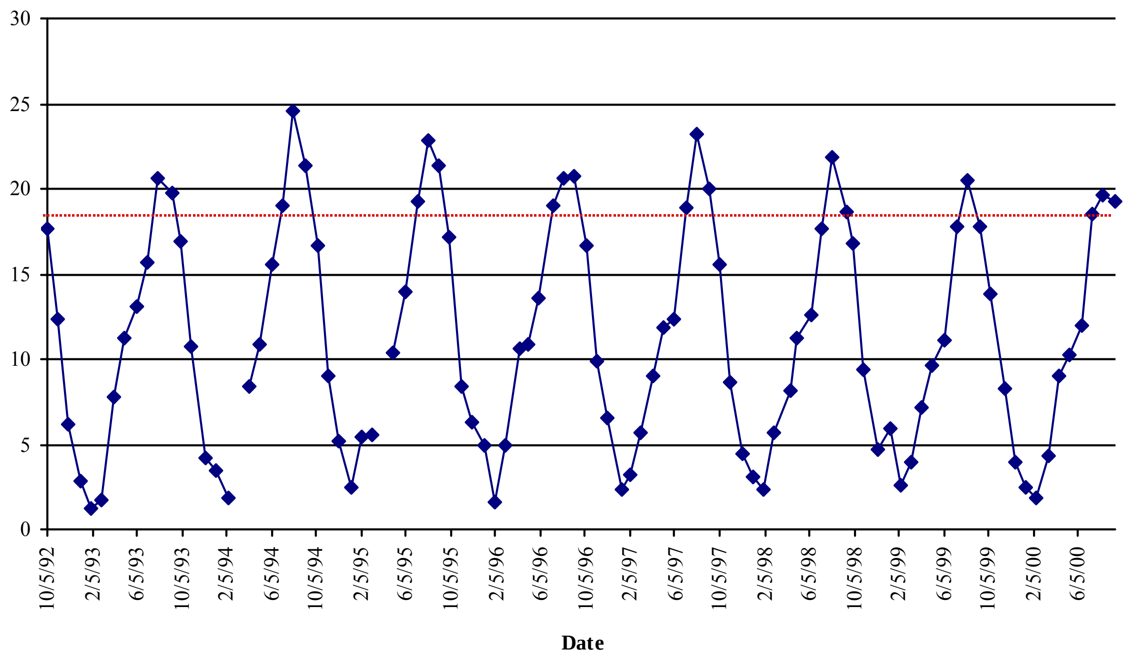

Figure 27. Stream temperatures recorded at Washington Department of Ecology station 35A150 on the mainstem Snake River above the confluence of the Clearwater River (1992–2000).

1.9.3 Sediment

Excessive fine sediment is the most common pollutant in impaired streams in Idaho (Rowe et al. 2003). Within the Snake Hells Canyon subbasin, six tributary streams in Idaho are listed under §303(d) for sediment concerns: Tammany, Divide, Wolf, Getta, Cottonwood, and Deep creeks (Table 6). The Tammany Creek sediment TMDL (IDEQ 2001) was completed in September 2001. TMDLs for the other five listed streams are planned but not yet complete.

Total maximum daily load (TMDL) plans prepared to address excessive fine sediment in these streams must comply with the existing Idaho narrative water quality standard for sediment, which states that "Sediment shall not exceed quantities...which impair beneficial uses" (IDAPA 58.01.02.200.08). Rowe et al. (2003) suggest appropriate water column and streambed measures for gaging attainment of the narrative sediment goal during TMDL development. Water column and instream measures that were determined to be the best indicators of sediment-related impairment of beneficial uses include light penetration, turbidity, total suspended solids and sediments, embeddedness, extent of streambed coverage by surface fines, percent subsurface fines in potential spawning gravels, riffle stability, and intergravel dissolved oxygen. Targets for each of these measures will be recommended in sediment TMDLs to allow attainment of the narrative Idaho sediment standards.

For clarification it is important to note that, although not listed under §303(d) for sediment concerns, the mainstem Snake River below Hells Canyon Dam is often referenced as having sediment limitations. Rather than excess fine sediments (which would be listable), the Snake River below Hells Canyon Dam is deficient in sediment due to operation of the Hells Canyon Complex and would benefit from added sediment (USFS 1999). The three upriver dams trap suspended sediment and bedload, while fluctuating water levels increase rates of streambank erosion downstream. The upstream entrapment of sediments has retarded recruitment and/or development of new sandbars and silt deposits. These deposits provide substrate for riparian growth (Kern 1976).

1.9.4 Total Dissolved Gas

The Snake River is not currently listed as limited by total dissolved gas (TDG) in Oregon or Idaho, although IDEQ and ODEQ (2001) recommend that TDG limitation be added to the 2002 303(d) list for each state. Both Oregon and Idaho have a TDG criterion of 110%; excess TDG in the water column has been shown to be detrimental to the survival of numerous fish species. IPC has been monitoring TDG below Hells Canyon Dam and found that, at all spill levels, the criterion was exceeded from below Hells Canyon Dam to at least RM 180 (IPC 1999). A declining trend in TDG occurred with distance from the dam, and a direct relationship exists between distance from compliance with the criterion and the amount of spill (IDEQ and ODEQ 2001).

1.9.5 Mercury

Oregon lists the upper half of the Snake River (above the confluence with the Salmon River) as water quality limited due to mercury contaminants, which may pose threats to humans through fish consumption (IDEQ and ODEQ 2001). Only one sample has been collected within the reach, and that sample included tissue from only two fish. All other samples used were from sites upstream of Hells Canyon Dam. The major source of mercury is assumed to be from Brownlee Reservoir and upstream tributary flows (IDEQ and ODEQ 2001). The one data point available shows the mercury level at 0.15 mg/kg dry weight fish tissue, which is below the level used by the Oregon Division of Health to establish a mercury fish tissue advisory (IDEQ and ODEQ 2001).

In rare cases, when concentrations are extremely high, mercury can result directly in the death of aquatic biota. More commonly, bioaccumulation and concentration affect designated beneficial uses (fishing and wildlife habitat) by building up concentrations within the food chain to levels where consumers (human or other predators) can be adversely affected (IDEQ and ODEQ 2001).

1.9.6 Point Sources of Water Pollution

Within the Snake Hells Canyon subbasin, no point sources of water pollution are known to exist above (IDEQ and ODEQ 2001) or below the Salmon River confluence.

2 Regional Context

2.1 Relation to the Columbia Basin and other Ecoprovinces and Subbasins

Due to its relatively centralized setting within the Snake River basin, the Snake Hells Canyon subbasin has strong ties with surrounding ecoprovinces and their component subbasins. The Snake Hells Canyon subbasin is one of four subbasins within the Blue Mountain Ecoprovince and one of the eleven ecoprovinces in the Columbia Basin
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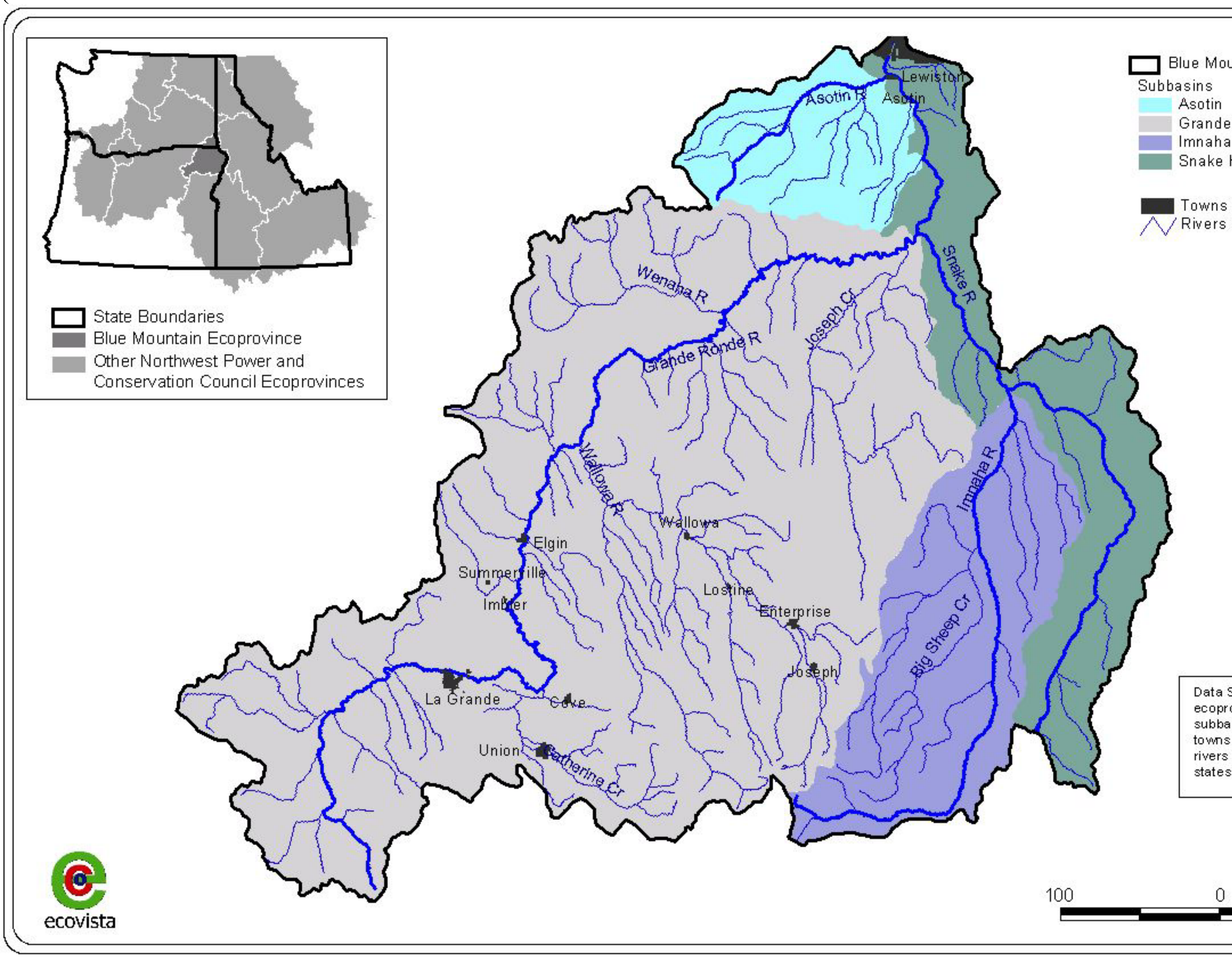

Figure 28). From within the Blue Mountain Ecoprovince, the Imnaha, Grande Ronde, and Asotin subbasins contribute substantial inflows to the Snake Hells Canyon subbasin

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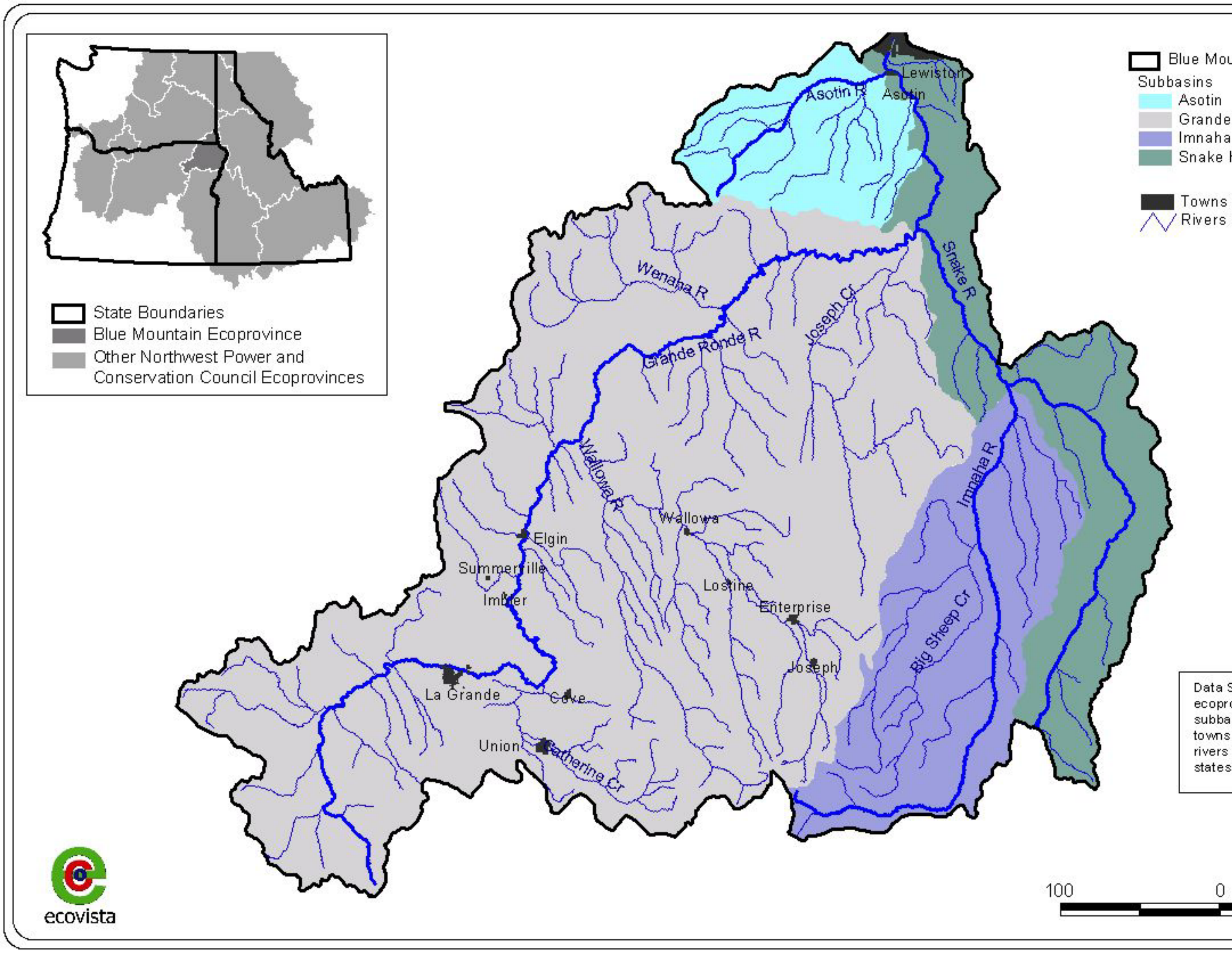

Figure 28). Additionally, the Salmon subbasin in the Mountain Snake Ecoprovince provides substantial inflow to the Snake Hells Canyon subbasin. Inflow from upstream into the Snake Hells Canyon subbasin is derived from the Middle Snake Ecoprovince, which includes flows generated from the Upper Snake Ecoprovince; outflow from the subbasin joins with that from the Clearwater subbasin (Mountain Snake Ecoprovince) to provide inflows to the Columbia Plateau Ecoprovince.

The Snake Hells Canyon subbasin has a variety of characteristics that make it unique in the Blue Mountain Ecoprovince, most related to its being a mainstem subbasin. The Snake Hells Canyon subbasin is the only mainstem subbasin within the Blue Mountain Ecoprovince, and it consists primarily of a single large river and surrounding face drainages rather than a "classic watershed" where tributaries combine to form a mainstem prior to emptying into an even larger water body. Rather than being defined by headwaters and ridgetops, the upstream boundary of the Snake Hells Canyon subbasin is Hells Canyon Dam.

The prevalence of large mainstem river habitats within the Snake Hells Canyon subbasin in particular results in aquatic resources that are relatively unique within the Blue Mountain Ecoprovince. Although other areas within the ecoprovince are used by fall chinook salmon and white sturgeon, the mainstem habitats within the Snake Hells Canyon subbasin are disproportionately important to these two fishes. The mainstem Snake River below its confluence with the Salmon River also provides a critical component of the migration corridor for endangered Snake River sockeye salmon migrating back to Redfish Lake in Idaho. The mainstem Snake River also provides migration and rearing habitat for steelhead, spring chinook, and bull trout.

The mainstem nature of the subbasin makes a variety of management situations within this subbasin unique within the Blue Mountain Ecoprovince. Mainstem subbasins do not operate as independent units: a decision in one subbasin, such as the Lower Middle Snake subbasin, could have significant impacts on other mainstem subbasins both upstream and down. This relationship complicates the ability to address "out-of-subbasin effects," which differ for upstream and downstream directions. (Upstream examples include water use and reduced sediment transport through reservoir systems. Downstream examples include mainstem transportation and passage, flow, harvest, ocean conditions, and the systemwide effects of artificial production.) These out-of-subbasin effects are often major drivers in biological performance or habitat conditions within mainstem subbasins, and, because of their magnitude and complexity, are difficult to define and characterize from a subbasin perspective.

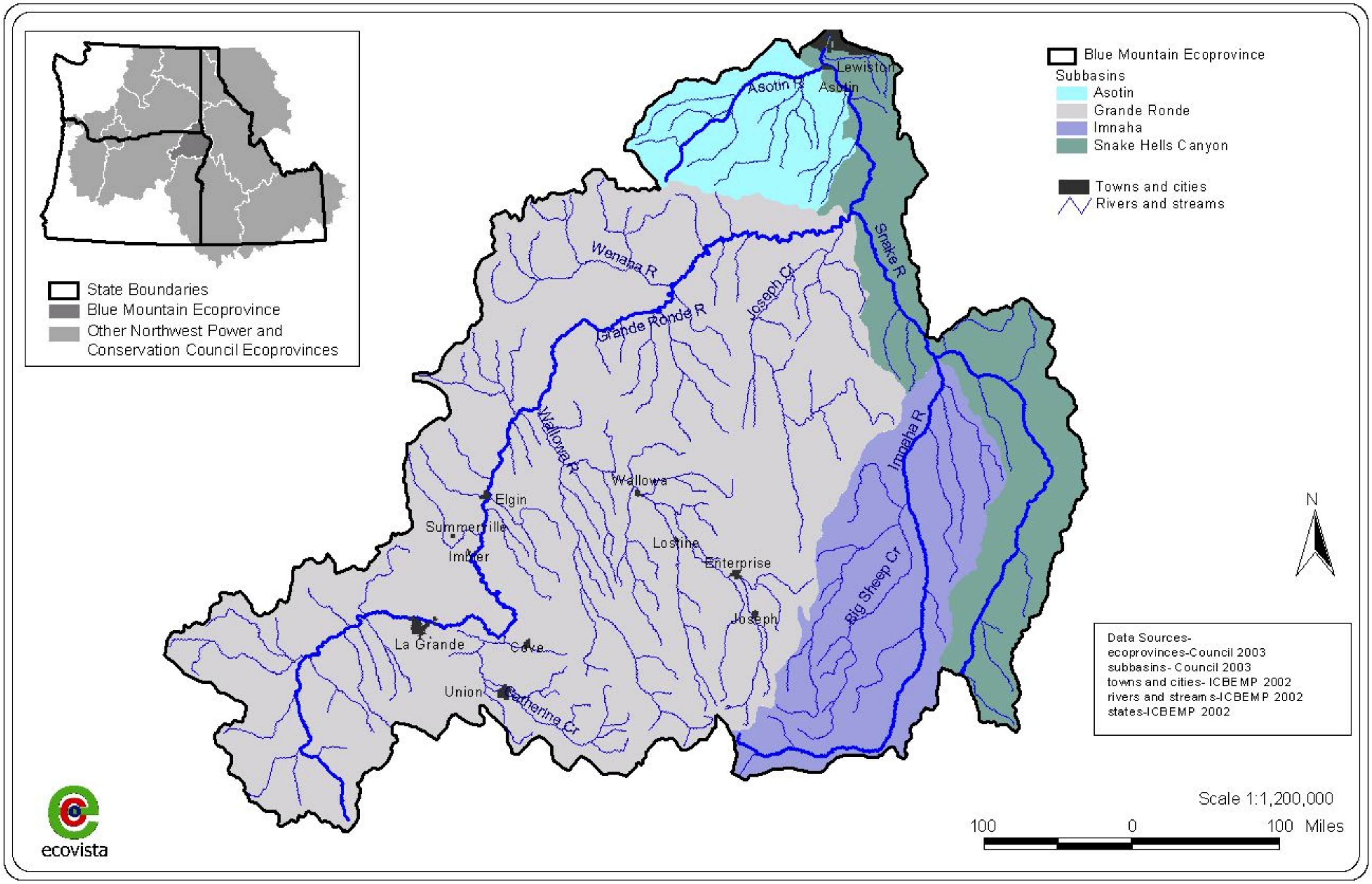

Figure 28. Location of the Snake Hells Canyon subbasin in the Blue Mountain Ecoprovince

Two recent regional assessment efforts have identified portions of the Snake Hells Canyon subbasin as being areas of regional conservation importance based on high biodiversity and/or the presence of rare or endemic organisms. The Interior Columbia Basin Ecosystem Management Project (ICBEMP) mapped centers of biodiversity and endemism/rarity, across the Interior Columbia Basin in 1994. In 2003, The Nature Conservancy used the SITES model to develop a conservation portfolio for the Middle Snake-Blue Mountain Ecoregion. These regional efforts, which help to establish the importance of the Snake Hells Canyon subbasin in efforts to protect and restore the fish and wildlife species of the region, are discussed below.

2.1.1 ICBEMP Centers of Biodiversity and Endemism

ICBEMP expert panels of agency and nonagency scientists were convened between October 1994 and May 1995 to identify areas of rare and endemic populations of plant, invertebrate, and vertebrate species (ICBEMP 1997). The panels of experts produced maps showing areas having unusually high biodiversity and areas containing high numbers of rare or locally or regionally endemic species (Figure 29 and Figure 30). The centers of concentration were developed at the coarse scale and in a short time frame and were mostly based on the panel's personal knowledge of areas and species locations. These developers suggested that they be considered a first approximation of identifying areas with particularly diverse collections of rare or endemic species or areas with high species richness. Centers of concentration might be candidates for RNAs or other natural area designations pending further local assessment and refinement (ICBEMP 1997). Forty-one percent of the subbasin was identified as a center of plant biodiversity (Table 7 and Figure 29). These areas occurred along the Snake River corridor of the mid- to upper subbasin. A small area on Craig Mountain was identified as an animal center of biodiversity. Seventy-seven percent of the Snake Hells Canyon subbasin was selected as a center of plant endemism and rarity (Table 7). This area runs the length of the Snake River corridor in the subbasin (Figure 30).

Table 7. Areas selected as centers of biodiversity or centers of endemism and rarity in the Snake Hells Canyon subbasin.

Interior Columbia Ecosystem Management Project Designation	Area of Snake Hells Canyon Subbasin Selected (acres)	% of Snake Hells Canyon Subbasin Selected
Centers of Biodiversity—Plants	229,072	41
Centers of Biodiversity—Animals	6,284	1
Centers of Endemism and Rarity—Animals	0	0
Centers of Endemism and Rarity—Plants	425,030	77

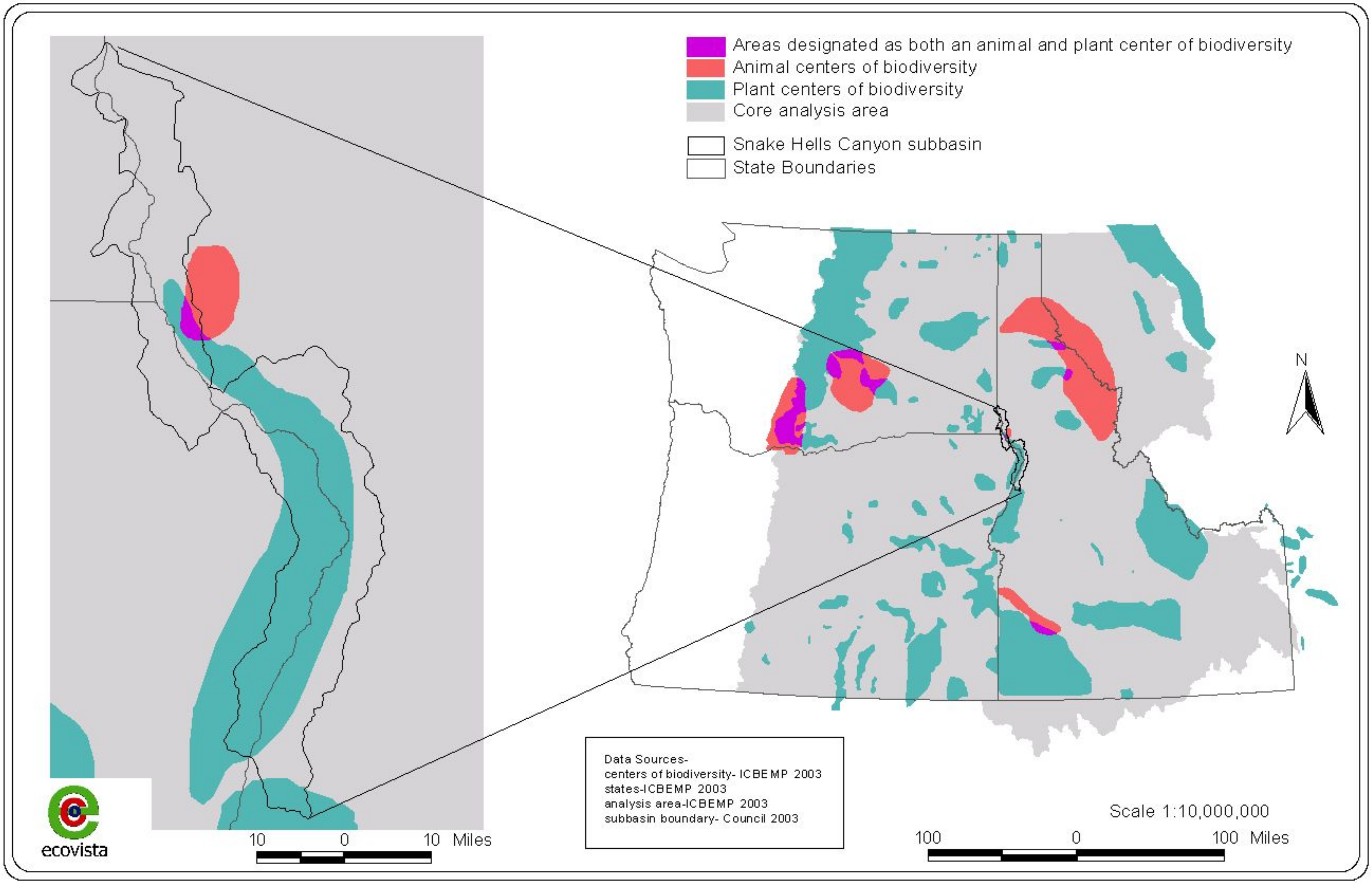

Figure 29. Centers of biodiversity in the ICBEMP analysis area and the Snake Hells Canyon subbasin.

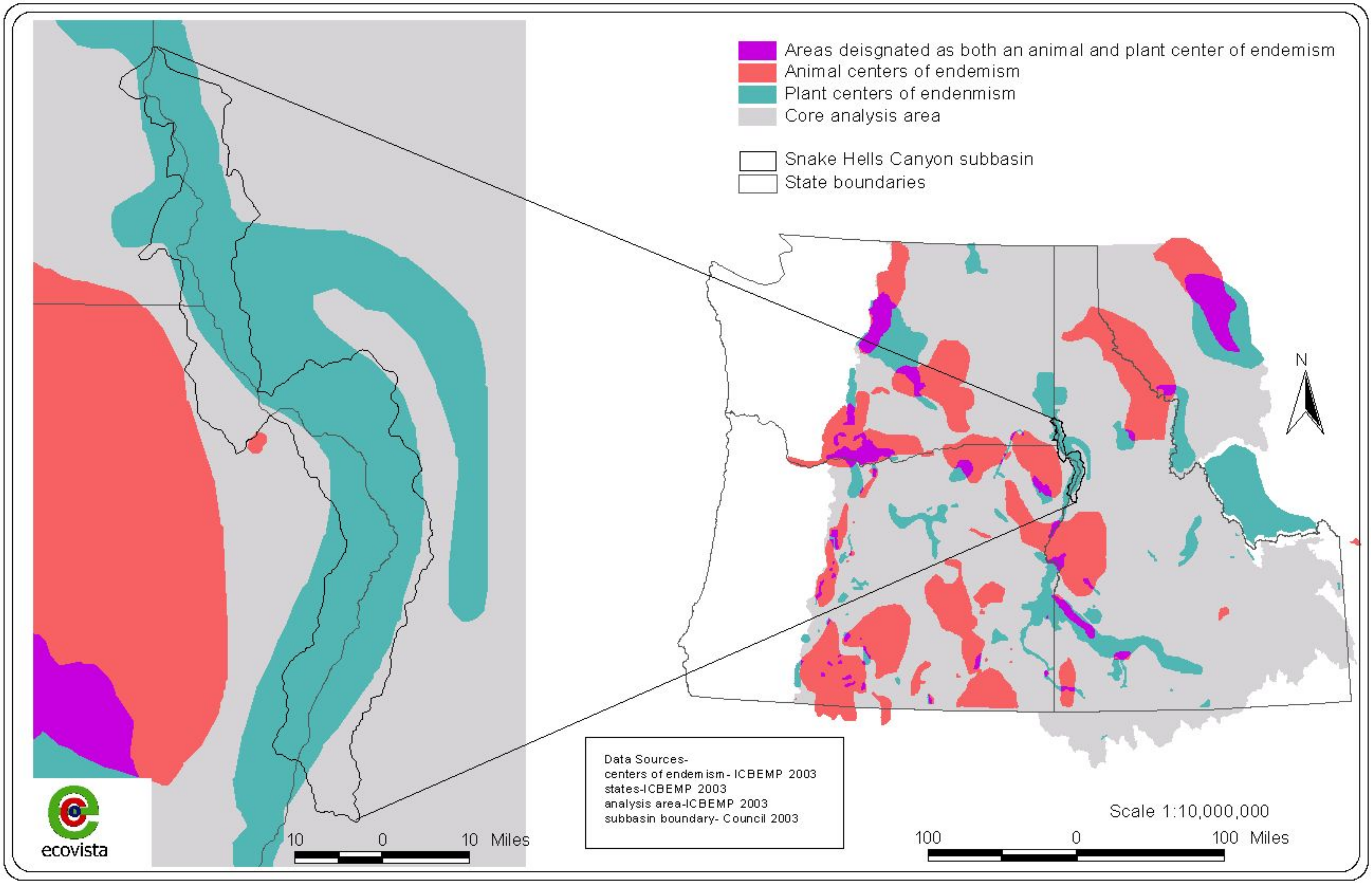

Figure 30. Centers of endemism and rarity in the ICBEMP analysis area and the Snake Hells Canyon subbasin.

2.1.2 The Nature Conservancy's Sites Model

The Nature Conservancy has recently completed an ecoregional conservation plan for the Middle Rockies-Blue Mountain Ecoregion, which covers 81,587 square miles (52,215,958 acres) in Oregon, Idaho, Montana, and a small part of Washington. Eighty-seven percent of the Snake Hells Canyon subbasin is contained within this ecoregion. The goal for the Middle Rockies-Blue Mountains Ecoregion conservation plan was to identify the suite of conservation sites and strategies that will ensure the long-term survival of all viable native plant and animal species and natural communities in the ecoregion. Due to the complexity of the Middle Rockies-Blue Mountain Ecoregion, a site-selection model was used to help design a portfolio that will achieve this goal in the most cost-effective manner possible. The site-selection model used in this project is an optimization model that applies a combination of simulated annealing and iterative improvement to the portfolio design problem (SITES). The simulated annealing used by SITES is a minimization method, where biodiversity is a constraint and the goal is to minimize the cost or size of the portfolio. The model was run at the 6th field hydrologic unit code (HUC) scale (TNC 2003).

Preparing to run the SITES model involves three main steps:

- Identifying the conservation targets that will help to maintain the biodiversity of the area
- Identifying the desired representation of the conservation targets in the ecoregion
- Identifying the costs and suitability of protection of different areas

Conservation Targets

The Nature Conservancy planning team utilized a coarse filter/fine filter approach to biodiversity conservation. The coarse filter is a community-level conservation strategy whereby natural community types are used as conservation targets to represent 85 to 90% of species and ecological processes in a community. However, given current knowledge, this ecosystem approach cannot be counted on to maintain and protect all biodiversity. Some species, especially the rarest, will fall through the pores of the coarse filter. Therefore, a fine filter of rare species conservation planning is needed as a complement (Noss and Cooperrider 1994, cited in TNC 2003).

The Nature Conservancy planning team selected 978 coarse and fine filter conservation targets for the Middle Rockies-Blue Mountain Ecoregion (Table 8). Most data, such as the distribution of all plant and animal species targets in the ecoregion, were obtained from the four state Natural Heritage Programs. Species are classified into five classes based on their global distribution: G1 = critically imperiled globally, G2 = imperiled globally, G3 = globally rare or uncommon, G4 = globally widespread and apparently secure, and G5 = globally widespread and secure. The following conservation ranks were considered in the selection of conservation targets from this database:

- All G1, G2, and federally listed species were included.
- G3 species were considered individually.
- G4 and G5 species were included if the species were declining over all or part of their range, the populations were disjunct from distant ecoregions, or they were endemic.

Data obtained from other sources included the predicted distribution maps for wide-ranging birds and mammals such as the greater sage-grouse, wolverine, gray wolf, and lynx and were obtained from the state Gap Analysis Programs (GAPs). Distribution data for wide-ranging fish were obtained from StreamNet. Aquatic community distribution data were developed by the planning team using a physically based classification model that was applied in a geographic information system (GIS) to represent aquatic communities in the ecoregion (TNC 2003).

Representation Goals

The Nature Conservancy planning team developed conservation goals for the representation of each target element or surrogate in the portfolio. Portfolio representation goals were developed based on three primary factors:

- Distribution of the targets across the ecoregion
- Number of occurrences or amount of area occupied
- Degree of endangerment for the conservation target

Table 8. Type, distribution sources, and representation goals for the 978 coarse and fine scale conservation targets selected for the Middle Rockies-Blue Mountain Ecoregion SITES run.

Conservation Targets	Number of Targets	Source of Distribution Data	Representation Goal for Portfolio
Fine Filter Targets	**Total = 269**		
Plant	127	EOR[a]	Dependent on conservation rank and degree of endemism
Terrestrial Animals	54	EOR[a]	Dependent on conservation rank and degree of endemism
		GAP models	20% of distribution per section for species of high conservation concern, 10% for others
Aquatic Animals	33	EOR[a]	Dependent on conservation rank and degree of endemism
		StreamNet	Dependent on rarity and degree of historical decline
Rare Plant Communities	55	EOR[a]	Dependent on conservation rank and degree of endemism
		HUC 6	Dependent on degree of rarity
Coarse Filter Targets	**Total = 709**		
Aquatic Macrohabitats	207	Modeled	Dependent on abundance of type in ecoregion
Riparian Plant Communities	209	Modeled	10% of distribution
Nonriparian Plant Communities	293	GAP cover types	Dependent on biodiversity and rangewide distribution and ecoregional abundance
TOTAL TARGETS	**978**		

[1] EOR = Element Occurrence Record database that is maintained by state Natural Heritage Programs/Conservation Data Centers

Cost and Suitability

The following are factors considered in determining the cost and suitability of conservation of terrestrial habitats for the Middle Rockies-Blue Mountain Ecoregion conservation plan:

- The conservation suitability of private land was considered to be somewhat lower than the same area of public land. Cost would rise faster as private land area increased in a 6th field HUCs than for a similar increase in public land area.
- The Nature Conservancy planning team wanted the model to choose areas of public land that were less roaded. So they chose a parameter that causes the first few roads in a 6th field HUC to dramatically increase the cost, but the rate of increase declines beyond a certain density threshold. In other words, it is the first roads that decrease the suitability the most and, after a point, the cumulative effect of additional roads becomes less.
- The opposite is true of private land. They did not want the model to automatically shy away from private land, so they chose a parameter where a low level of roads and converted land does not dramatically increase the cost (decrease suitability). The cost rises slowly at first for private land but more rapidly as the percentage of converted and roaded land increases in a 6th field HUC.

Several factors were considered when rating the cost and suitability of conservation in aquatic habitats:

- ICBEMP aquatic integrity scores
- Dams within the HUC
- Length of the 303(d)-listed segment within the HUC
- Number of point sources within the HUC

To account for the relatively low cost of continuing to protect areas with existing protection, 6th field HUC watersheds that were completely or partially contained by a protected area greater than 25 acres in size were locked into the portfolio selection (i.e., these areas were always selected in the development of the conservation strategy) (TNC 2003).

SITES Outputs

The model begins by generating a completely random portfolio. Next, it iteratively explores trial solutions by making sequential random changes to this portfolio. Either a randomly selected selection unit (6th field HUC watershed) that is not yet included in the portfolio is selected or a selection unit already in the system is deleted. At each step, the new solution is compared with the previous solution, and the best one is accepted.

The modeled solution constituted the first draft of the conservation portfolio. The Nature Conservancy planning team and an independent review team then reviewed the first draft and modified it based on personal experience in the ecoregion. The final recommended portfolio encompasses 37% of the ecoregion and meets the representation goal for over 90% of the terrestrial community targets, aquatic community targets, invertebrate species targets, and federally listed targets (TNC 2003).

Snake Hells Canyon Subbasin's Contribution to Selected Conservation Portfolio

Seventy-two percent of the Snake Hells Canyon subbasin was selected as part of the conservation portfolio for the Middle Rockies-Blue Mountain Ecoregion (Figure 31). This is a reflection of both the area's biological importance and the large amount of land in the subbasin that is protected. Because of the low cost of continuing to protect these areas, they were locked into the conservation portfolio. Areas selected for the Middle Rockies-Blue Mountain conservation portfolio within the Snake Hells Canyon subbasin contributed to meeting the representation goals for 26 fish and wildlife species target, 16 rare plant species targets, and 27 rare plant association or habitat type species targets (Appendix B).

2.2 NOAA Fisheries Evolutionarily Significant Units

The Snake Hells Canyon subbasin is an important area for a variety of endangered, threatened, and/or sensitive species and is included in the Snake River evolutionarily significant units (ESUs) designated by the National Oceanic and Atmospheric Agency (NOAA Fisheries [also known as the National Marine Fisheries Service or NMFS]) for steelhead trout, spring/summer chinook, and fall chinook, all listed as threatened under the Endangered Species Act (ESA). In addition, a portion of the Snake River within the Snake Hells Canyon subbasin provides a migration corridor for endangered sockeye salmon included in the Snake River ESU (NMFS 2002).

2.3 USFWS Designated Bull Trout Planning Units

The subbasin lies within the Columbia River Distinct Population Segment for bull trout listed as threatened under the ESA by the U.S. Fish and Wildlife Service (USFWS). The Snake Hells Canyon subbasin is part of two bull trout recovery units—the Imnaha-Snake River Basin Recovery Unit and Snake River Basin Recovery Unit. Within the Imnaha-Snake River Basin Recovery Unit, the Snake River Critical Habitat Subunit defined by the USFWS contains all of the proposed critical habitat designations for bull trout within the Snake Hells Canyon subbasin. Proposed critical habitat includes the Sheep and Granite creek drainages in Idaho (USFWS 2002a).

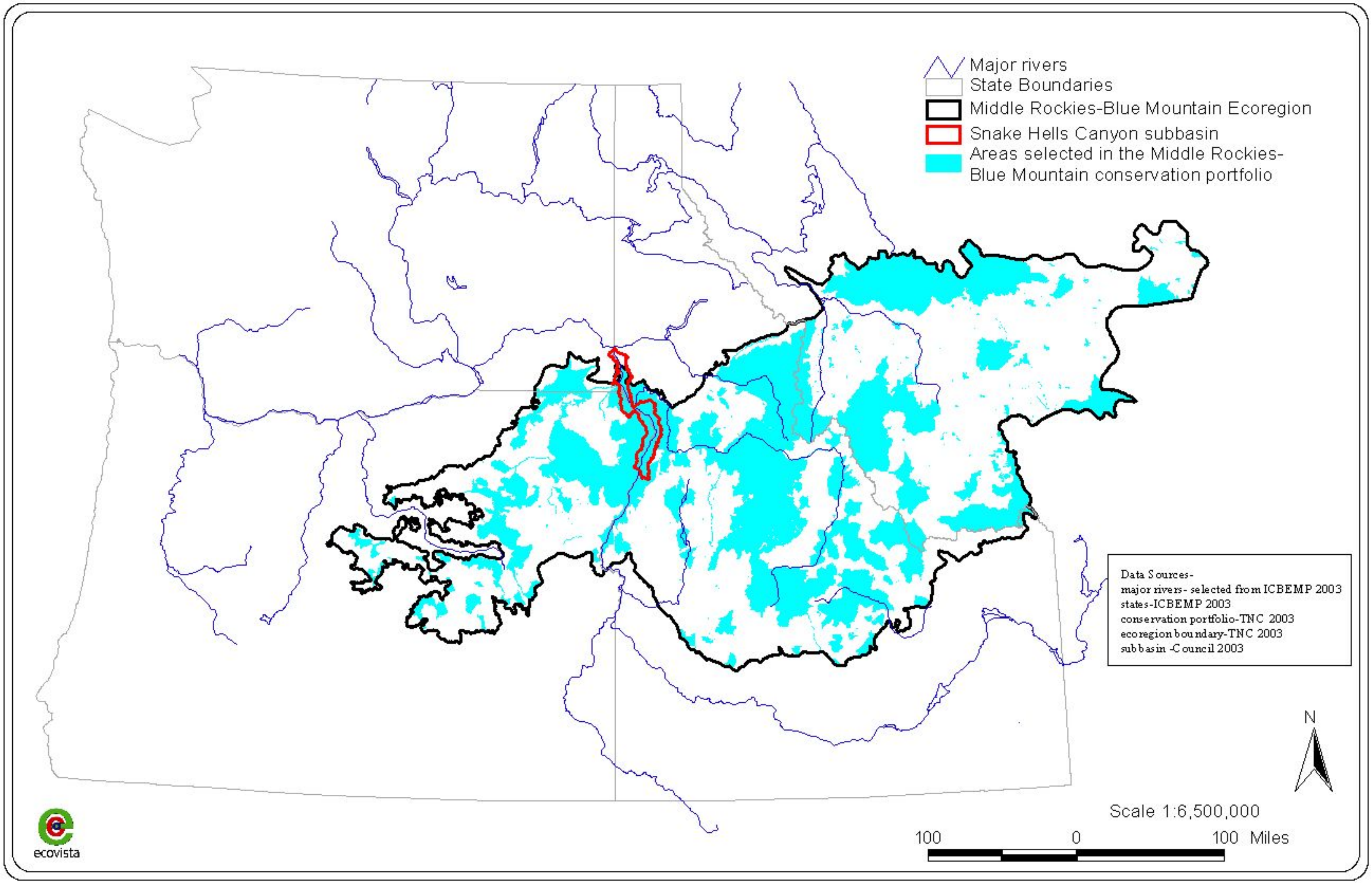

Figure 31. Areas selected by SITES for the Middle Rockies-Blue Mountain Ecoregion conservation portfolio (TNC 2003).

3 Species Characterization and Status

3.1 Species of Ecological Importance

The Snake River within the Hells Canyon Snake subbasin is currently inhabited by at least 30 species/races of fish, 23 of which are endemic to the region (see Appendix C). A variety of key fish species use the Snake Hells Canyon subbasin during various stages of their lives (Table 9 and Table 10). Currently, the mainstem Snake River provides upstream and downstream passage (a migration corridor) for all anadromous and many resident salmonids. It is used by fall chinook and white sturgeon to support all of their life history stages (WDFW et al. 1990, BLM 2000a). Subadult bull trout also use the mainstem for rearing and overwintering, whereas use by juvenile spring chinook is less common. Sockeye salmon, a federally listed (endangered) species, use the mainstem Snake River (below the confluence with the Salmon River) during downstream and upstream migration.

Table 9. General life history stages of various focal salmonid species occurring in the Snake Hells Canyon subbasin (from BLM 2000a, IDEQ and ODEQ 2001, Columbia Basin Research 2004).

Life History Stage	Fall Chinook Salmon[1]	Spring/Summer Chinook Salmon	Sockeye Salmon	Steelhead Trout	Bull Trout
Adult migration	August–October	April–July	June–September	September–May	August–September
Spawning	September 15–December 15	August 1–July 15	NA	February 1–July 15	September 1–April 1
Adult/subadult rearing	NA[2]	NA	NA	NA	Year-long
Adult overwintering	NA	NA	NA	November–March	Winter
Incubation and emergence	October–April	August–April	NA	March–July	September–March
Rearing	May–August	1 year	NA	1–3 years	2–3 Years
Smolt emigration	June–August	April–July	April–July	April–July	NA

[1] Occur in mainstem Snake River only
[2] Not applicable

Table 10. Salmonid life history stages and their general occurrence in the Snake Hells Canyon subbasin (BLM 2000a; M. Hanson, Oregon Department of Fish and Wildlife, personal communication, April 19, 2001).

Species	Life History	Occurrence
Fall chinook	Spawning/rearing	Mainstem Snake River
Spring/summer chinook	Spawning/rearing	Accessible tributaries (i.e., Granite and Sheep creeks)
Spring/summer chinook	Rearing (limited)	Mainstem Snake River
Sockeye salmon	Adult/Juvenile migration	Mainstem Snake River
Summer steelhead	Spawning/rearing	Accessible tributaries
Bull trout	Rearing (subadult and adult)	Mainstem Snake River
Bull trout	Overwintering	Mainstem Snake River
Bull trout	Spawning/early rearing	Accessible tributaries (i.e., Granite and Sheep creeks)
Westslope cutthroat trout (resident forms)	Spawning/rearing	Granite and Sheep creeks
White sturgeon	Spawning/rearing	Mainstem Snake River

The Snake Hells Canyon subbasin provides suitable habitat for an estimated 373 species of wildlife during at least some portion of the year. This number includes 12 species of amphibians, 258 birds, 87 mammals, and 16 reptiles (IBIS 2003; Appendix C). All of these species depend on features of the habitat provided by the subbasin's vegetation, rocks, soils, and climate (see section 1 for details on vegetation, soils, geology, and climate; see also section 3.5.10 for details on habitat use). In addition, wildlife species perform ecological roles within their environment, and these roles can influence and alter the biotic and abiotic environments they inhabit. These interactions are termed key ecological functions (KEFs). Critical functional link species are the only species that perform a specific ecological function in a community. Their removal would signal loss of that function in the community. Thus, these species are critical to maintaining the full functionality of a system (IBIS 2003). Thirty-two species have been identified as critical functional link species in the Blue Mountain Ecoprovince. Examples of the critical functions contributed by critical functional link species in the subbasin include the physical fragmentation of standing wood by the black bear in herbaceous wetland and alpine grassland habitats, the impoundment of water behind diversions or dams by the American beaver in numerous habitat types, and the creation of roosting, denning, or nesting opportunities by the red squirrel in various forest habitats (see Appendix D for a complete list of critical functional link species and their critical functions).

3.1.1 Species Designated as Threatened or Endangered

Federal

In 1973, the Endangered Species Act (ESA) was passed, building on and strengthening the provisions of the Endangered Species Preservation Act of 1966, the Endangered Species Conservation Act of 1969, and the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The purpose of the ESA is to "conserve the ecosystems upon which threatened or endangered species depend" and conserve and recover listed species. Under the law, species may be listed as either threatened or endangered. Endangered means that a species is in danger of becoming extinct throughout all or a significant portion of its range. Threatened means that a species is likely to become endangered within the foreseeable future. All species of animals and plants are eligible for listing (Kilpatrick 2001).

The ESA makes it illegal for any person subject to the jurisdiction of the United States to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any endangered species of fish or wildlife within the United States. The USFWS and NOAA Fisheries (or NMFS) jointly administer the act. The USFWS administers terrestrial species, freshwater species, and migratory birds, while NOAA Fisheries administers marine species (Kilpatrick 2001). Three species listed as endangered, eight listed as threatened, and four designated as candidate species under consideration for listing occur or potentially occur within the Snake Hells Canyon subbasin (Table 11).

Table 11. ESA-listed or candidate species that are known to or potentially occur in the Snake Hells Canyon subbasin.

Status	Common Name	Scientific Name
Endangered	Idaho springsnail	*Pyrgulopsis idahoensis*
Endangered	Snake River physa	*Physa natricina*
Endangered	Sockeye salmon	*Oncorhynchus nerka*
Threatened	Bald eagle	*Haliaeetus leucocephalus*
Threatened	Bull trout	*Salvelinus confluentus*
Threatened	Chinook salmon	*Oncorhynchus tshawytscha*
Threatened	Gray wolf	*Canis lupus*
Threatened	Lynx	*Lynx canadensis*
Threatened	MacFarland's four o'clock	*Mirabilis macfarlanei*
Threatened	Spalding's catchfly	*Silene spaldingii*
Threatened	Steelhead trout	*Oncorhynchus mykiss*
Candidate	Columbia spotted frog	*Rana luteiventris*
Candidate	Pacific lamprey	*Lampetra tridentata*
Candidate	Slender moonwort	*Botrychium lineare*
Candidate	Yellow-billed cuckoo	*Coccyzus americanus occidentalis*

State

Oregon, Idaho, and Washington also maintain lists of threatened and endangered fish and wildlife species (Table 12). Ten species that occur or potentially occur in the subbasin are listed by Idaho, Oregon, or Washington as threatened or endangered.

Table 12. Species that occur or potentially occur in the Snake Hells Canyon subbasin and are listed as threatened or endangered by Oregon, Idaho, or Washington.

Common Name	Scientific Name	Status
American peregrine falcon	*Falco peregrinus anatum*	Oregon–Endangered Idaho–Endangered
American white pelican	*Pelecanus erythrohynchos*	Washington–Endangered
Bald eagle	*Haliaeetus leucocephalus*	Idaho–Endangered Oregon–Threatened Washington–Threatened
Chinook	*Oncorhynchus tshawytsha*	Oregon–Threatened
California wolverine	*Gulo gulo luteus*	Oregon–Threatened
Ferruginous hawk	*Buteo regalis*	Washington–Threatened
Fisher	*Martes pennanti*	Washington–Endangered
Gray wolf	*Canis lupus*	Idaho–Endangered Oregon–Endangered Washington–Threatened
Lynx	*Lynx canadensis*	Washington–Threatened
Pacific lamprey	*Lampetra tridentata*	Idaho–Endangered

3.1.2 Status of Federally or State Listed Endangered or Threatened Species

Aquatic Species

Four species occurring within the subbasin are currently under the jurisdiction of NOAA Fisheries because of their listing under the ESA. These species include Snake River fall chinook salmon and spring/summer chinook salmon, listed as threatened on May 22, 1992 (Federal Register 57:14653), Snake River sockeye salmon, listed as endangered on November 20, 1991 (Federal Register 56:58619), and Snake River summer steelhead, listed as threatened on October 17, 1997 (Federal Register 62:43937, August 18, 1997). Bull trout, under the jurisdiction of the USFWS were also listed under the ESA on July 10, 1998 (Federal Register 63:31647, June 10, 1998). Pacific lamprey is a candidate for federal listing but is listed as endangered by the state of Idaho.

All of the federally listed and candidate fish species within the Snake Hells Canyon subbasin (spring/summer and fall chinook salmon, sockeye salmon, steelhead trout, Pacific lamprey, and bull trout) have been selected as focal species for this assessment. Detailed discussions of each of these species are presented in section 3.4.

Terrestrial Species

American Peregrine Falcon

The American peregrine falcon (*Falco peregrinus anatum*) was listed as endangered in 1970 under a precursor to the ESA of 1973. A Pacific states peregrine recovery plan (USFWS 1982) was completed in 1982 for the Pacific recovery zone. The plan identified recovery objectives that needed to be met in order to have a self-sustaining population. These goals were met and contributed to the delisting of the American peregrine falcon on August 20, 1999. The bird has made a remarkable comeback. For example, in the 1960s, it was considered extirpated from Oregon, but in 1994, there were 37 known nest sites that produced 60 young (Marshall et al. 1996). The American peregrine falcon is still considered an endangered species in Oregon and Idaho, but as recovery continues, changes in status are being considered.

Numerous sightings of peregrine falcons have occurred within the subbasin, and in 1996, a nest was observed in the canyons cliffs just downstream of Hells Canyon Dam (Akenson 2000). This nest successfully produced one female young in 1996. Observers of the nest between 1997 and 2000 monitored a pair of birds at the eyrie exhibiting behaviors indicative of occupancy (prey delivery, copulation, and patrolling the territory). But due to the location of the nest, observation is difficult and the current status of young production at the nest is unknown (Turley and Holthuijzen 2002).

American White Pelican

American white pelicans (*Pelecanus erythrohynchos*) potentially migrate through the subbasin on their way to breeding locations in southern Oregon and Idaho. This use has not been documented.

Bald Eagle

Because of concern over declining populations of bald eagle (*Haliaeetus leucocephalus*), primarily due to habitat destruction, human-caused mortality, and DDT-caused eggshell thinning, the bald eagle was designated as threatened in the conterminous United States on March 11, 1967, under a law that preceded the ESA of 1973. On July 4, 1976, the USFWS officially listed the bald eagle as a federally endangered species. In July 1995, the USFWS upgraded the status of bald eagles in the lower 48 states to threatened. Currently, the agency is evaluating the bald eagle for delisting (USFWS 1999). The bald eagle was selected as a focal species for this assessment, so information on habitat use and status in the Snake Hells Canyon subbasin is included in section 3.5.7.

California Wolverine

The California wolverine (*Gulo gulo luteus*) occurs in Alaska and across the boreal forests of Canada south into the northwestern United States. Hash (1987) described a contradiction in the North American range of the wolverine beginning around 1840 with the onset of extensive exploration, fur trade, and settlement. State records suggest very low wolverine numbers in Montana, Idaho, Oregon, and Washington from the 1920s through 1950s, with increases in wolverine sightings since the 1960s (Banci 1994). In the continental United States, the presence of wolverines has been confirmed in Wyoming, Washington, Oregon, Idaho, and Montana. Only Idaho and Montana are known to support reproducing populations of wolverines (Turley and Holthuijzen 2002).

The California wolverine is not federally listed, but it is listed as threatened in Oregon under the state ESA. Reasons for this listing include susceptibility to forest fragmentation and expanding human populations (Marshall et al. 1996).

Surveys conducted by the Wallowa-Whitman National Forest between 1991 and 1994 documented the presence of wolverines in the HCNRA although densities were low (USFS 2003c). This finding is typical of the species since, even under the best of conditions, wolverine densities tend to be low. Hornocker and Hash (1981) concluded that wolverine densities are greatest when there is a large and diverse big game population such as that which occurs within the subbasin. Wolverines are normally solitary and so sparsely distributed that difficulty in finding mates may limit populations (Edelmann and Copeland 1999).

The wolverine inhabits tundra and coniferous forest zones, generally at higher altitudes during summer and mid- to lower elevations during winter. Low-elevation riparian areas may be important winter habitat. They are solitary except during the breeding season and when females are rearing young (Spahr et al. 1991). Den sites in Idaho are typically associated with large boulder talus, caves, rocks, or downed logs. They are most commonly found on northerly aspects, in subalpine cirque basins with little overhead canopy cover, and above 8,000 feet in elevation. The den entrances are located in soft snow near trees or rocks, with a vertical tunnel extending 1 to 5 meters to ground level (Copeland 1996).

The best den sites in the HCNRA are located in the Seven Devils area (USFS 2003c). During a helicopter survey conducted in 1998, one set of wolverine tracks was located and then confirmed with ground inspection. No den or other indication of reproductive activity was detected (Edelmann and Copeland 1999). Because female wolverines are extremely sensitive to human disturbance near natal dens, protection of natal denning habitat from human disturbances is considered critical for the persistence of wolverines (Copeland 1996). Disturbance of den sites in the Seven Devils Mountains is unlikely since the main road entering the area is closed through the denning season each year (USFS 2003c).

Mapping of wolverine sightings suggests that the Seven Devils Mountains may provide the only suitable habitat linking wolverine subpopulations in Idaho and Oregon. Wolverines dispersing from source habitats in central Idaho may be reluctant to cross canyon habitats. The narrow canyon and forested habitats of the Seven Devils area may provide the only suitable travel corridor linking subpopulations in the two states. Low dispersal may impact the regional viability of wolverine by reducing genetic interchange and lowering the likelihood that all suitable habitat patches are continuously inhabited. Maintaining and enhancing the integrity of movement corridors between the Seven Devils Mountains and other contiguous mountain habitats in Idaho and Oregon may be essential for ensuring regional wolverine persistence (Edelmann and Copeland 1999).

Columbia Spotted Frog

The Columbia spotted frog (*Rana luteiventris*) has been a candidate for listing under the ESA since December 14, 1992 (Federal Register 57:59257). The Columbia spotted frog was selected as a focal species for this assessment, so information on habitat use and status in the Snake Hells Canyon subbasin is included in section 3.5.6.

Fisher

The fisher (*Martes pennanti*) is not federally listed, but it is listed as endangered by Washington and as sensitive on the Regional Forester's sensitive species lists for Regions 1, 4, and 6. Fisher are found in low to mid-elevation mixed conifer forests. They are almost exclusively found in mature and late/old-structure forests. Jones 1991 found that the majority of fisher travel was up and down riparian areas that contained a very dense canopy closure and high concentration of downed logs. Home ranges vary from 6 to 120 km^2. Home ranges of females were stable among seasons and years, but males moved extensively in late winter and early spring and shifted among years. Fishers tend to avoid openings. They will use large-diameter downed logs, snags, stumps, and rock cavities for rearing their young (USFS 2003c).

Trapping and habitat loss due to logging extirpated fisher from Oregon by the early 1900s. However, reintroductions in 1961 in the Eagle Cap Wilderness in Oregon reestablished fisher, at least for two decades. However, populations from this transplant never really increased, and fishers have not been documented within the Oregon side of the Wallowa-Whitman National Forest since the early 1980s. In north-central Idaho, fishers were also reintroduced in the early 1960s. This population has done well and now exists on the Payette, Nez Perce, and Clearwater National Forests. Their current distribution includes portions of HCNRA on the Idaho side near the Seven Devils area. On the Nez Perce National Forest, Jones (1991) indicated that a strong population of fisher exists in mature and late/old-structure forests. Connectivity between these areas is very important to maintain (USFS 2003c). Forest fragmentation, which reduces and isolates suitable habitat, is the greatest threat to fisher populations (Spahr et al. 1991, Marshall et al. 1996).

Gray Wolf

The status of the gray wolf (*Canis lupus*) differs within the HCNRA, depending on the state. In the Oregon portion of the HCNRA, wolves have recently been reclassified from endangered to threatened under the ESA. In the Idaho portion, wolves are classified as an experimental, nonessential population and managed under separate but similar guidelines (USFWS et al. 2003).

Wolves are currently not known to occur in the subbasin although suitable habitat exists. Wolves are considered to have been extirpated from Oregon by 1972. During 1995 and 1996, 35 wolves were reintroduced into central Idaho by the USFWS. The reintroduction was successful, and populations quickly expanded. By the end of 2002, approximately 263 wolves in at least 19 packs were living in Idaho (USFWS et al. 2003).

The subbasin contains ungulate populations and a large wilderness, both of which provide requirements sufficient for wolf habitation. Wolves are occasionally observed in the area, and with continued expansion of the wolf population in Idaho, resident wolves may soon become established within the area (USFS 2003b).

Canada Lynx

The Canada lynx (*Lynx canadensis*) was listed as a threatened species by the USFWS on March 24, 2000 (Federal Register 65:16051) (ODFW 2003b). The USFWS recently completed a reevaluation of the original listing and considered changing the listing of lynx to endangered. The agency concluded that this change was not warranted, and the lynx remains listed as threatened (Columbia Basin Bulletin July 11, 2003). Critical habitat has not been designated for the Canada lynx (ODFW 2003b).

Historical evidence indicates that lynx historically used or traveled through the subbasin. County court records of bounties paid for predators between 1899 and 1922 indicate that lynx once existed in Wallowa County, but densities or numbers cannot be determined from these records. In 1969, a lynx was shot in the Imnaha subbasin, which borders the Snake Hells Canyon subbasin to the west. According to Rust (1946), lynx were not abundant but were distributed throughout northern Idaho in the early 1940s. Over the past decade, numerous unconfirmed sightings have been recorded, suggesting that lynx may still inhabit portions of the Blue Mountains area although in extremely low numbers (USFWS 2003a). Several unconfirmed observations of lynx have been made in the subbasin (Edelmann and Pope 2001). An unconfirmed lynx sighting was made by IPC personnel in the subbasin below the confluence with the Salmon River near Cave Creek on the Idaho side of the Snake River (Turley and Holthuijzen 2002).

In accordance with the interagency Lynx Conservation and Assessment Strategy (LCAS), the USFWS, BLM, and USFS have cooperated to identify lynx analysis units (LAUs) where suitable habitat for lynx is present. These LAUs encompass forested lands that have vegetation characteristics and elevations typically used by lynx (USFWS 2003a). In the northern Rocky Mountains, the majority of lynx occurrences are associated within Rocky Mountain conifer forest. And within this type, most of the occurrences are in moist Douglas-fir and western spruce/fir forest. Most lynx occurrences are in the 1,500- to 2,000-meter (4,920–6,560-foot) elevation class (McKelvey et al. 2000). Of the 652,488 acres within the HCNRA, only about 73,600 acres (11%) meet the definition of potential lynx habitat. This habitat occurs in seven LAUs that are fully or partially contained within the HCNRA boundary (USFWS 2003a). Two LAUs have been delineated within the HCNRA portion of the subbasin (Figure 32); these LAUs entirely encompass the upper half of the subbasin. The LAUs in this subbasin are adjacent to LAUs in the neighboring Imnaha and Salmon subbasins.

Canada lynx habitat includes a mosaic of early seral stages that support snowshoe hare populations and late seral stages of dense old-growth forest that provide ideal denning and security habitat. The results of an analysis of lynx habitat conditions conducted by the Wallowa-Whitman National Forest for the subbasins LAUs are displayed in Table 13.

Table 13. Disposition of lynx habitat within the lynx analysis units of the Snake Hells Canyon subbasin.

LAU	Primary Forage		Marginal Forage		Denning		Unsuitable		Total acres of lynx habitat in LAU (Total acres in LAU)
	(acres)	% of total lynx habitat	(acres)	% of total lynx habitat	(acres)	% of total lynx habitat	(acres)	% of total lynx habitat	
Snake/Pittsburg	92	4	178	7	2,368	90	12	0	2,650 (196,636)
Snake/Hat Point	2,560	11	48	0	16,003	72	3,685	17	22,296 (149,561)

Although the Snake/Hat Point LAU is slightly smaller than the Snake/Pittsburg LAU, it contains much more habitat that meets the vegetative and elevational requirements of lynx (Table 13). The Snake/Hat Point LAU contains the Seven Devils area of the Hells Canyon Wilderness. This area is believed to be core lynx habitat, although resident lynx are not known to occur here. Habitat in this area may form part on an important link between lynx habitats in the Wallowa Mountains of Oregon and the Rocky Mountains of Idaho. The unsuitable lynx habitat in the Snake/Hat Point LAU is primarily a result of wildfire. Much of this habitat is composed of densely stocked stands of trees that will likely convert into primary forage within five years (USFWS 2003a).

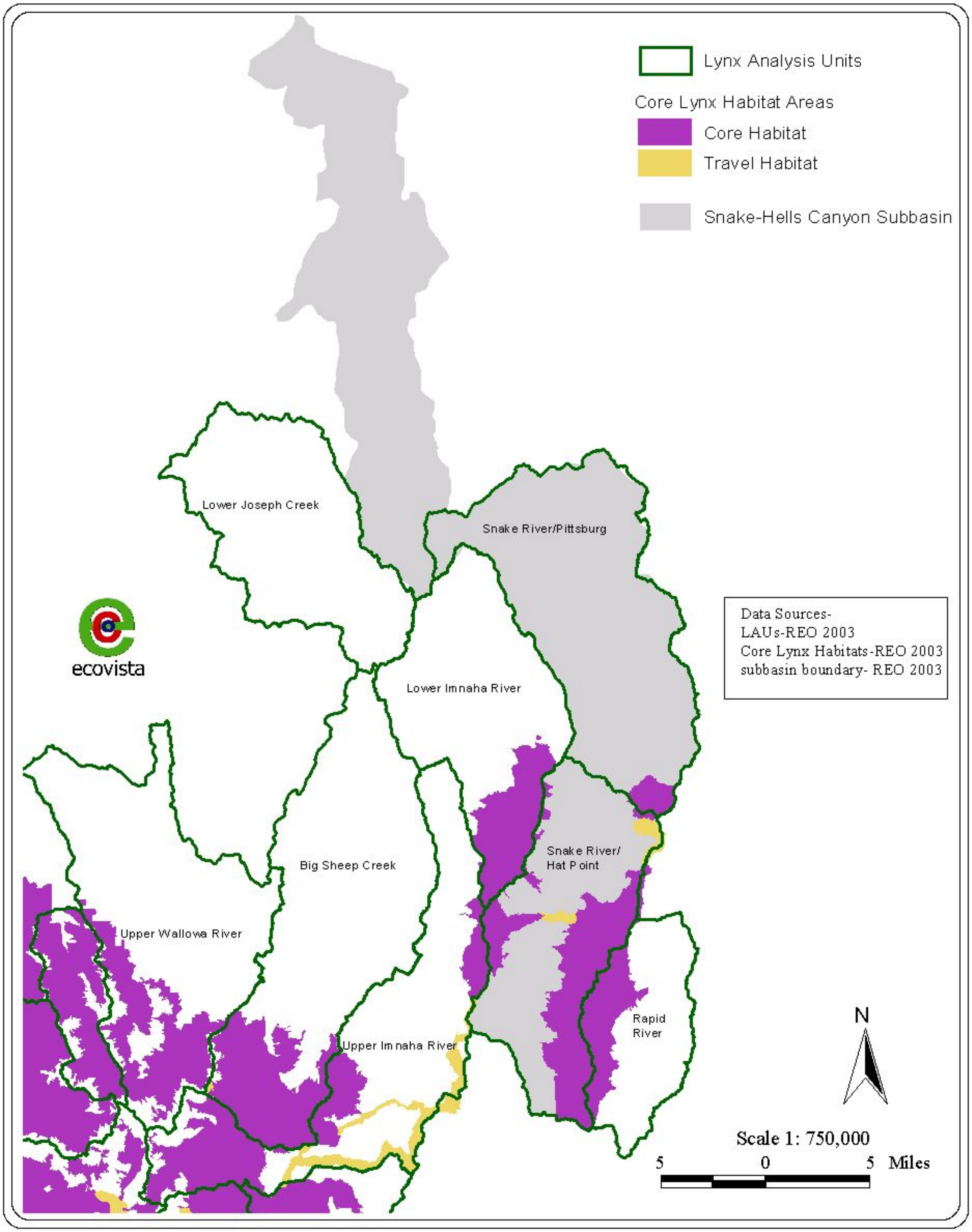

Figure 32. Lynx analysis areas and core lynx habitat areas on USFS lands of the Snake Hells Canyon subbasin.

MacFarlane's Four o'clock

At the time of its original listing as endangered in 1979 (USFWS 1979), MacFarlane's four o'clock (*Mirabilis macfarlanei*) was known from only three populations along the Snake River canyon in Oregon (HCNRA) and the Salmon River canyon in Idaho (BLM Cottonwood Field Office area), totaling approximately 25 plants on 25 acres (USFWS 2000a). As a result of additional surveys and active management of some populations on federal lands, MacFarlane's four o'clock was downlisted to threatened in March 1996 (USFWS 1996). The number of known individuals has increased 260-fold from 27 plants when listed to approximately 7,212 plants in 1991 (USFWS 1996).

MacFarlane's four o'clock is found on talus slopes in canyonland corridors where the climate is regionally warm and dry and precipitation occurs mostly in the winter and spring. It generally occurs as scattered plants on open, steep (50%) slopes of sandy or talus soils with west to southeast aspects (USFWS 1996). MacFarlane's four o'clock populations range from approximately 1,000 to 3,000 feet in elevation (USFWS 2000a).

Eleven populations of MacFarlane's four o'clock are currently known. Three of these populations are found in the Snake River canyon area (Idaho County, Idaho, and Wallowa County, Oregon), six in the Salmon River area (Idaho County, Idaho), and two in the Imnaha River area (Wallowa County, Oregon) (USFWS 1985, 1996). Of the three populations within the Snake Hells Canyon subbasin, all occur on USFS land administered by the Wallowa-Whitman National Forest. Population sizes range from approximately 3,000 individuals on 100 acres at Tyron Bar to only 100 plants on 1 acre at the Pleasant Valley site (USFS 2003b). The Pittsburg Landing site in Idaho has 2,024 plants scattered in eight distinct subgroups on a total of 9.3 acres. The Pittsburg Landing site occurs within an active cattle allotment, which has prompted managers to construct exclusion fences around some plants and initiate a long-term monitoring study in 2001 (USFS 2003b).

MacFarlane's four o'clock and its habitat have been, and continue to be, threatened by a number of factors, including herbicide and pesticide spraying, landslide and flood damage, insect damage and disease, exotic plants, livestock grazing, off-road vehicles, and possibly road and trail construction and maintenance. The collecting of MacFarlane's four o'clock has also been determined to be a limiting factor, as have mining, competition for pollinators, and inbreeding depression (USFWS 2000a). Construction of Hells Canyon Dam may also have inundated habitat and/or populations of MacFarlane's four o'clock, but estimates indicate that probably no more than 5% of potential habitat was impacted (USFS 2003b).

Spalding's Catchfly

Spalding's catchfly (*Silene spaldingii*) grows in grass/forb communities on undisturbed slopes or flats in swales and drainages and in small, undisturbed vegetation strips surrounded by cultivated fields (Lorain 1991). It occurs on mesic grasslands of the Palouse prairie region in southeastern Washington, channeled scablands in southeastern Washington, intermontane valleys in northwestern Montana and adjacent British Columbia, the Wallowa Plateau in northeastern Oregon, and the canyon grasslands of Idaho and Oregon (Hill and Gray 2003). Elevations range between 1,750 and 5,100 feet, and populations almost always occur on northerly aspects (USFS 2003b).

Federal action to protect Spalding's catchfly was initiated on January 9, 1975, when the Smithsonian Institute reported that this plant was considered threatened or endangered. In 1984, the species listing was found to be warranted but precluded by other pending listing actions. On February 27, 1995, a petition was received by the USFWS to list Spalding's catchfly as endangered. On October 22, 1999, the Federal Register published the listing priority guidance to clarify the rulemaking in setting priorities with this species (USFWS 1999b). A final rule listing Spalding's catchfly as a threatened species was published on October 10, 2001 (USFWS 2001). Active conservation of this species is ongoing. A conservation strategy has recently been drafted and should be complete in 2004 (Hill and Gray 2003), and the USFWS has initiated recovery plan development (Gina Glenne, USFWS Snake River office, personal communication, October 28, 2003).

Spalding's catchfly was first collected in the vicinity of the Clearwater River, Idaho, between 1836 and 1847 (USFWS 1999b). It is known from a total of 68 populations in the United States and British Columbia, Canada, with a combined population of approximately 24,400 plants (Hill and Gray 2003). The majority of populations occur in Washington (39 total), while Idaho and Oregon have 11 and 8 populations, respectively (Hill and Gray 2003).

Two known populations of Spalding's catchfly occur within the Snake Hells Canyon subbasin. The Redensky Flat population in the Corral Creek drainage is the largest in Idaho and jointly managed by The Nature Conservancy and BLM (Hill and Gray 2003). The Redbird Point population is on private land approximately 20 miles south of Lewiston, Idaho. Both of these sites were discovered during rare plant surveys in 1993 and represented the first locations found within canyon grassland communities (Mancuso 1994). No populations are known to occur farther south within the subbasin or on the Oregon side of the Snake River, although unexplored potential habitat exists throughout the Snake Hells Canyon subbasin.

Spalding's catchfly and its habitat have been, and continue to be, threatened by a number of human-related factors. These factors include invasion by invasive/nonnative species; destruction, modification, or curtailment of its habitat and range; herbicidal drift; changes in land use, grazing practices, agriculture development, and urbanization; disease or predation; and overutilization for commercial, recreational, scientific, or educational purposes (USFWS 1999b). Hill and Gray (2003) also suggest that reductions in pollinators, prolonged drought, and fire may pose threats to this species.

Yellow-billed Cuckoo

The yellow-billed cuckoo (*Coccyzus americanus*) migrates from its winter range in South America to breed throughout temperate North America south to Mexico and Greater Antilles. It has experienced severe declines and is now rare or absent in most of the western United States (Csuti et al. 2001). Western yellow-billed cuckoos were given candidate status for listing under the ESA in July 2001 (Federal Register 66:143).

Yellow-billed cuckoos are associated with thick, closed-canopy riparian forests with an understory of dense brush. These forests are usually composed of various species of willows and cottonwoods. Studies in California have suggested that patches of suitable habitat must be at least 37 acres in size and include over 7.5 acres of closed-canopy riparian forest (Csuti 2001). Due to its dependence on a combination of habitat features such as dense willow understory for nesting, a cottonwood overstory for foraging, and large contiguous patches of habitat, the yellow-billed cuckoo is consider to be more sensitive to habitat loss than other riparian obligate species (Turley and Holthuijzen 2002).

Although the Snake Hells Canyon subbasin provides potentially suitable habitat for the yellow-billed cuckoo (BLM 2002), surveys conducted by Cassirer (1995) during 1993 and 1994 and IPC during the late 1990s (Turley and Holthuijzen 2002) did not document any occurrences. Yellow-billed cuckoos have always been rare in the subbasin but more common in southeastern Idaho. Fifty-five percent (35 of 64) of the historical yellow-billed cuckoo records in Idaho are from southeastern Idaho, usually along the Snake River corridor (TREC, Inc. 2003).

Limiting factors for yellow-billed cuckoos include habitat loss and fragmentation, inundation from water management projects, lowered water tables, land clearing, cattle grazing, and pesticide use (Hughes 1999).

3.1.3 Species Recognized as Rare or Significant to the Local Area

State Sensitive and Species of Special Concern

Each of the three states with land in the Snake Hells Canyon subbasin maintains a list of species considered sensitive or vulnerable to population declines (IDFG 2003b, ODFW 2003c, WDFW 2003b) (Table 14). Each state uses similar criteria but different classifications.

In Oregon, native animals that may become threatened or endangered throughout all or any significant portion of their range in Oregon are listed as sensitive. Factors considered in this listing include the potential for natural reproductive failure because of limited population numbers, disease, predation, other natural or human-related factors, imminent or active deterioration of range or primary habitat, overutilization, and inadequate existing state or federal regulations or programs for species or habitat protection (ODFW 2003c). Sensitive species are organized into the following four categories:

Critical—Species for which listing as threatened or endangered is pending, or those for which listing as threatened or endangered may be appropriate if immediate conservation actions are not taken. Also considered critical are some peripheral species at risk throughout their range and some disjunct populations.

Vulnerable—Species for which listing as threatened or endangered is not believed to be imminent and can be avoided through continued or expanded use of adequate protective measures and monitoring. In some cases, populations are sustainable, and protective measures are being implemented; in others, populations may be declining, and improved protective measures are needed to maintain sustainable populations over time.

Undetermined—Species for which status is unclear. These species may be susceptible to population decline of sufficient magnitude to qualify for endangered, threatened, critical, or vulnerable status, but scientific study would be needed before a judgment could be made.

Peripheral or Naturally Rare—Species whose Oregon populations are on the edge of their range, and those that historically had low population numbers in Oregon because of naturally limiting factors, respectively. Maintaining the status quo is a minimum necessity. Disjunct populations of several species that occur in Oregon should not be confused with peripheral species.

Idaho maintains a list of species of special concern. These include native species low in numbers, limited in distribution, or affected by significant habitat losses (IDFG 2003b).

Washington lists as sensitive any species vulnerable or declining and likely to become endangered or threatened throughout a significant portion of its range in the state without cooperative management or removal of threats. Species being considered for listing as sensitive are designated as candidate, while a designation of monitor is used for species for which more data are needed to determine a listing (WDFW 2003b).

Table 14. Species considered sensitive or vulnerable to population declines for each of the states with land in the Snake Hells Canyon subbasin.

Common Name	Species Name	Idaho	Washington	Oregon
American marten	*Martes americana*			sensitive–vulnerable
American peregrine falcon	*Falco peregrinus anatum*		sensitive	
American white pelican	*Pelecanus erthrorhynchos*	species of special concern		
Ash-throated flycatcher	*Myiarchus cinerascens*		monitor	
Bank swallow	*Riparia riparia*			sensitive–undetermined
Barrow's goldeneye	*Bucephala clangula*			sensitive–undetermined
Black swift	*Cypseloides niger*		monitor	
Black tern	*Chilidonias niger*	species of special concern	monitor	
Black-backed woodpecker	*Picoides arcticus*	species of special concern	candidate	sensitive–critical
Black-crowned night-heron	*Nycticorax nycticorax*		monitor	
Black-tailed jack rabbit	*Lepus californicus*		candidate	
Bobolink	*Dolichonyx oryzivorous*		monitor	sensitive–vulnerable
Boreal owl	*Aegolius funereus*	species of special concern	monitor	sensitive–undetermined
Bufflehead	*Bucephala albeola*			sensitive–undetermined
Bull trout	*Salvelinus confluentus*		candidate	sensitive–critical
Burrowing owl	*Athene cunicularia*			sensitive–critical
Caspian tern	*Sterna caspia*		monitor	
Chinook salmon (fall)	*Oncorhynchus tshawytscha*		candidate	
Chinook salmon (sp., sum.)	*Oncorhynchus tshawytscha*		candidate	
Clark's grebe	*Aechmophorus clarkii*		monitor	
Columbia spotted frog	*Rana luteiventris*		candidate	sensitive–undetermined
Common loon	*Gavia immer*		sensitive	
Desert horned lizard	*Phrynosoma platyrhinos*			sensitive–vulnerable
Ferruginous hawk	*Buteo regalis*			sensitive–critical
Fisher	*Martes pennanti*	species of special concern		
Flammulated owl	*Otus flammeolus*	species of special concern	candidate	sensitive–critical

Common Name	Species Name	Idaho	Washington	Oregon
Forster's tern	*Sterna forsteri*		monitor	
Fringed myotis	*Myotis thysanodes*		monitor	sensitive–vulnerable
Grasshopper sparrow	*Ammodramus savannarum*		monitor	
Great blue heron	*Ardea herodias*		monitor	
Great egret	*Ardea Alba*	species of special concern	monitor	
Great gray owl	*Strix nebulosa*	species of special concern	monitor	sensitive–vulnerable
Greater sandhill crane	*Grus canadensis*			sensitive–vulnerable
Green-tailed towhee	*Pipilo chlorurus*		monitor	
Gyrfalcon	*Falco rusticolus*		monitor	
Harlequin duck	*Histrionicus histrionicus*	species of special concern		sensitive–undetermined
Horned grebe	*Podiceps auritus*		monitor	sensitive–vulnerable
Leopard dace	*Rhinichthys falcatus*		candidate	
Lesser goldfinch	*Carduelis psaltria*		monitor	
Lewis' woodpecker	*Melanerpes Lewis*		candidate	
Loggerhead shrike	*Lanius ludovicanus*	species of special concern	candidate	
Long-billed curlew	*Numenius americanus*		monitor	
Long-eared myotis	*Myotis volans*		monitor	sensitive–undetermined
Long-legged myotis	*Myotis volans*		monitor	
Merlin	*Falco columbarius*		candidate	
Merriam's shrew	*Sorex merriami*		candidate	
Mounatin quail	*Oreortyx pictus*	species of special concern		sensitive–undetermined
Night snake	*Hypsiglena torquata*		monitor	
Northern goshawk	*Accipiter gentilis*	species of special concern	candidate	sensitive–critical
Northern grasshopper mouse	*Onychomys leucogaster*		monitor	
Northern leopard frog	*Rana pipiens*			sensitive-–critical
Northern pygmy owl	*Glaucidium gnoma*	species of special concern		sensitive–critical
Olive-sided flycatcher	*Contoupus cooperi*			sensitive–vulnerable
Osprey	*Pandion haliaetus*		monitor	

Common Name	Species Name	Idaho	Washington	Oregon
Pacific lamprey	*Lampetra tridentata*			sensitive–vulnerable
Pallid bat	*Antrozous pallidus*			sensitive–critical
Pileated woodpecker	*Dryocopus pileatus*		candidate	sensitive–vulnerable
Prairie falcon	*Falco mexicanus*		monitor	
Preble's shrew	*Sorex preblei*		monitor	
Pygmy nuthatch	*Sitta pygmaea*	species of special concern		sensitive–critical
Pygmy shrew	*Sorex hoyi*		monitor	
Redband trout	*Oncorhynchus mykiss*	species of special concern		
Red-necked grebe	*Podiceps grisegena*			sensitive–critical
Red-tailed chipmunk	*Tamias ruficaudus*		monitor	
Ring-necked snake	*Diadophis punctatus*		monitor	
Sage sparrow	*Amphispiza belli*		candidate	
Sagebrush lizard	*Sceloporus graciosus*		candidate	
Sagebrush vole	*Lagurus curtatus*		monitor	
Silver-haired bat	*Lasionycteris noctivagans*			sensitive–undetermined
Small-footed myotis	*Myotis ciliolabrum*		monitor	
Sockeye salmon	*Oncorhynchus nerka*		candidate	
Spruce grouse	*Falcipennis canadensis*			sensitive–undetermined
Steelhead/redband trout	*Oncorhynchus mykiss*		candidate	sensitive–vulnerable
Striped whipsnake	*Masticophis taeniatus*		candidate	
Swainson's hawk	*Buteo swainsoni*		monitor	sensitive–vulnerable
Tailed frog	*Ascaphus truei*			sensitive–vulnerable
Three-toed woodpecker	*Picoides tridactylus*	species of special concern	monitor	sensitive–critical
Tiger salamander	*Ambystoma tigrinum*		monitor	
Townsend's western big-eared bat	*Corynorhinus townsendii townsendii*	species of special concern	candidate	sensitive–vulnerable
Turkey vulture	*Cathartes aura*		monitor	
Upland sandpiper	*Bartramia longicauda*	species of special concern		sensitive–critical

Common Name	Species Name	Idaho	Washington	Oregon
Vaux’s swift	*Chaetura vaui*		candidate	
Western grebe	*Aechmophorus occidentalis*		candidate	
Western pipistrelle	*Pipistrelle hesperus*	species of special concern	monitor	
Western rattlesnake	*Crotalus viridis*			sensitive–vulnerable
Western small-footed myotis	*Myotis ciiolabrum*			sensitive–undetermined
Western toad	*Bufo boreas*		candidate	sensitive–vulnerable
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	species of special concern		
White-headed woodpecker	*Picoides albolarvatus*	species of special concern	candidate	sensitive–critical
White sturgeon	*Acipenser transmontanus*	species of special concern		
Williamson’s sapsucker	*Sphyrapicus throideus*			sensitive–undetermined
Willow flycatcher	*Empidonax traillii*			sensitive-undetermined
Wolverine	*Gulo gulo luscus*	species of special concern	candidate	
Woodhouse’s toad	*Bufo woodhousii*		monitor	

USFS and BLM Sensitive Species List

The USFS region's sensitive species program provides goals and objectives for managing sensitive species and their habitats. These goals and objectives are included in the Regional Forester's sensitive species list to prevent the need for federal listing in the future. According to USFS policy, all actions and programs authorized, funded, or carried out by the USFS are to be reviewed to determine their potential effect on threatened and endangered species, sensitive species, and species proposed for listing. In addition, species on the current Regional Forester's sensitive species list (Table 15) are to be given the same management consideration as federally listed species (USFS 1995). The BLM also maintains a list of sensitive species (Table 16).

Table 15. USFS Region 1, 4, and 6 sensitive species with potential habitat in the Snake Hells Canyon subbasin (USFS 1995, IDFG 2003b).

USFS Region	Common Name	Species Name
6	American peregrine falcon	*Falco peregrinus anatum*
6	Black rosy finch	*Leucosticte arctoa atrata*
1	Black-backed woodpecker	*Picoides arcticus*
6	Blue Mountain cryptochian caddisfly	*Cryptochia neosa*
4	Boreal owl	*Aegolius funerus*
1, 4, and 6	California wolverine	*Gulo gulo luteus*
1 and 4	Common loon	*Gavia Immer*
6	Ferruginous hawk	*Buteo regalis*
1 and 4	Fisher	*Martes pennanti*
1 and 4	Flammulated owl	*Otus flammeolus*
4	Great gray owl	*Strix nebulosa*
6	Greater sandhill crane	*Grus canadensis tabia*
1, 4, and 6	Harlequin duck	*Histrionicus histrionicus*
6	Long-billed curlew	*Numenius americanus*
4 and 6	Lynx	*Lynx canadensis*
1 and 4	Mountain quail	*Oreortyx pictus*
6	Northern bald eagle	*Haliaeetus leucocephalus*
1 and 4	Northern goshawk	*Accipiter gentilis*
4	Three-toed woodpecker	*Picoides tridactylus*
1, 4 and 6	Townsend's western big-eared bat	*Corynorhinus townsendii townsendii*
6	Upland sandpiper	*Bartramia longicauda*
1and 4	White-headed woodpecker	*Picoides albolaravatus*
6	Yellow-billed cuckoo	*Coccyzus americanus occidentalis*

Table 16. Species listed as sensitive by the BLM with potential habitat in the Snake Hells Canyon subbasin (BLM 2002).

Common Name	Scientific Name
Black-backed woodpecker	*Picoides arcticus*
Brewer's sparrow	*Spizella breweri*
Columbia River tiger beetle	*Cincindela columbica*
Common gartersnake	*Thamnophis sirtalis*
Flammulated owl	*Otus flammeolus*
Fringed myotis	*Myotis thysanodes*
Grasshopper sparrow	*Ammodramus savannarum*
Lewis woodpecker	*Melanerpes lewis*
Mountain quail	*Oreotys pictus*
Northern goshawk	*Accipiter gentilis*
Peregrine falcon	*Falco peregrinus anatum*
Prairie falcon	*Falco mexicanus*
Shortface lanx	*Fisherola nuttalli*
Townsend's western big-eared bat	*Corynorhinus townsendii townsendii*
Vaux's swift	*Chaetura vauxi*
Western pipistrelle	*Pipistrellus hesperus*
Western toad	*Bufo boreas*
White-headed woodpecker	*Picoides albolarvatus*
Willow flycatcher	*Empidonax traillii*
Yellow-headed blackbird	*Xanthocphalus xanthocephalus*

Partners in Flight

Partners in Flight (PIF) was established in 1990 as a conservation effort focused on landbirds and their habitats. The collaborative effort was initiated because of concern over continental and local declines in numerous bird populations due in part to habitat loss, degradation, fragmentation on breeding and wintering grounds and along migratory routes, reproductive problems associated with nest predation, brood parasitism, and competition with exotic species. Partnerships among many agencies—including federal, state, and local government agencies; philanthropic foundations; professional organizations; conservation groups; industry; the academic community; and private individuals—have contributed to the great success of Partners in Flight. Partners in Flight works to enhance cooperation between private and public sector efforts in North America and the Neotropics in order to improve monitoring and inventory, research, management, and education programs involving birds and their habitats (PIF 2003).

The development of bird conservation plans for the entire continental United States is one of the primary activities of Partners in Flight. The group's goal is to ensure long-term maintenance of healthy populations of native landbirds. The planning process for the bird conservation plans has four steps: 1) identify species and habitats most in need of conservation (i.e., prioritization), 2) describe desired conditions for these habitats based on knowledge of species life history and habitat requirements, 3) develop biological objectives to be used as management targets or goals to achieve desired conditions, and 4) recommend conservation actions to be implemented by various entities at multiple scales to achieve biological objectives (PIF 2003).

Bird conservation plans are organized by physiographic areas and state. The Snake Hells Canyon subbasin lies within the Central Rocky Mountains physiographic area and is included in the bird conservation plan for Oregon and Washington (PIF 2003). This conservation plan emphasizes an ecosystem management approach to landbird preservation, but it includes components of single species and indicator species management. The most important habitat features and conditions for landbirds within the planning area were identified, and then focal species considered representative of those habitats were selected to help guide conservation planning (Table 17).

Table 17. Priority habitat features and associated landbird species for conservation in habitats of the Partners in Flight Northern Rocky Mountains Landbird Conservation region of Oregon and Washington.

Habitat Type	Focal Species Blue Mountain Subprovince	Habitat Feature/ Conservation Focus
Dry Forest (ponderosa pine and ponderosa pine/Douglas-fir/grand fir)	white-headed woodpecker (*Picoides albolarvatus*)	large patches of old forest with large trees and snags
	flammulated owl (*Otus flammeolus*)	old forest with interspersion, grassy openings, and dense thickets
	chipping sparrow (*Spizella passerina*)	open understory with regenerating pines
	Lewis' woodpecker (*Melanerpes lewis*)	patches of burned old forest
Mesic mixed conifer (late successional)	Vaux's swift (*Chaetura vauxi*)	large snags
	Townsend's warbler (*Dendroica townsendi*)	overstory canopy closure
	varied thrush (*Ixoreus naevius*)	structurally diverse; multilayered
	MacGillivray's warbler (*Oporornis tolmiei*)	dense shrub layer in forest openings or understory
	olive-sided flycatcher (*Contopus cooperi*)	edges and openings created by wildfire
Riparian woodland	Lewis' woodpecker (*Melanerpes lewis*)	large snags
Riparian shrub	willow flycatcher (*Empidonax trallii*)	willow/alder shrub patches
Unique habitats	hermit thrush (*Catharus guttatus*)	subalpine forest

Habitat Type	Focal Species Blue Mountain Subprovince	Habitat Feature/ Conservation Focus
Unique habitats	upland sandpiper (*Bartramia longicauda*)	montane meadows (wet/dry)
	vesper sparrow (*Pooecetes gramineus*)	steppe shrublands
	red-naped sapsucker (*Sphyrapicus nuchalis*)	aspen
	gray-crowned rosy finch (*Leucosticte tephrocotis*)	alpine

White Sturgeon

White sturgeon (*Acipenser transmontanus*), although common in the mainstem Snake River, is a locally significant species present in the Snake Hells Canyon subbasin and valued for both sport and ecological reasons. White sturgeon has been selected as a focal species for this assessment and is discussed in section 3.4.8.

Redband Trout

Although present in the Snake Hells Canyon subbasin, little information exists on redband trout (*Oncorhynchus mykiss*) because of the difficulty in morphologically distinguishing juveniles from anadromous juvenile rainbow trout (steelhead). Nonanadromous rainbow trout occurring in the Snake Hells Canyon subbasin may be divided into two groups: one group is sympatric with steelhead (evolving alongside), while the other is allopatric (evolving outside the historical range of steelhead) (BLM 2000b). The sympatric form, or nonanadromous steelhead, are considered to be historically derived or associated with steelhead (BLM 2000b). Cherry, Cook, and Deep creeks all provide several miles of rainbow habitat above natural migratory fish barriers. Cherry, Cook, and McGraw creeks are also believed to contain pure strains of redband trout (USFS 1999). Redband trout in the Snake Hells Canyon subbasin are considered to have special ecological significance because of their potentially limited distribution and relative abundance and their locally adapted life history.

3.1.4 Special Status Plants

Numerous rare plant species are known or suspected to occur in the Snake Hells Canyon subbasin. The unique geology, climate, elevational extremes, and topographic relief of the area provide a rich environment for speciation and specialization within the flora (Fiedler 1986, Kruckeberg 1986). Portions of the subbasin were identified as regional centers for plant biodiversity and endemism during the ICBEMP assessment (Figure 29 and Figure 30). Twenty-one species are endemic to the Hells Canyon ecosystem, of which six are considered rare (Table 18) (USFS 2003a). Many other species occurring in the Snake Hells Canyon subbasin are of conservation concern by one or more entities with management authority in the area.

Rare plant species are typically ranked based on factors including distribution, number of populations, population size, threats, and extinction risk. Typically, each state maintains its own list of rare plant taxa that are ranked using a system of codes. Federal land management agencies maintain similar lists of sensitive species (USFS) or special status species (BLM). These lists may or may not be ranked. In general, species having a 1 in their ranking are the most rare and/or at risk. Species with higher numbers are less imperiled but still of conservation concern. USFS sensitive species are not ranked by that agency but are generally included if they are on one or more state listings. IDFG (2003c), ODFW (2003c), USFS (2003a), and Washington Department of Fish and Wildlife (WDFW) (2003b) include more complete explanations of the codes.

Table 18. Rare and endemic plant species known or suspected to occur in the Snake Hells Canyon subbasin. Codes denote conservation status within the USFS, BLM, and state (IDFG 2003c, ODFW 2003c, USFS 2003a, WDFW 2003b).

Species	Endemic	USFS Sensitive			BLM	ID	OR	WA
		R-1	R-4	R-6				
Allium tolmeii var. *persimile*			S		3	S3	3	
Arabis crucisetosa	common							
Arabis hastatula	rare			S			1	
Astragalus vallaris	common							
Botrychium simplex		S				S2		
Bupleurum americanum							2	
Calochortus macrocarpus var. *maculosus*					2	S2	1	S1
Calochortus nitidus		S	S	S	2	S3	2	S1
Camassia cusickii			S			S2		
Carex hystericina				S			2	
Carex interior				S			3	
Chrysothamnus nauseosus ssp. *nanus*					5	S3		
Crepis bakeri ssp. *idahoensis*					2	S2		S1
Epipactus gigantea		S	S		3	S3		
Erigeron disparipilus				S			2	
Erigeron engelmanii var. *davisii*	rare			S			2	
Frasera albicaulis var. *idahoensis*	common							
Haplopappus hirtus var. *sonchifolius*		S				S1		
Haplopappus liatriformis					2	S2		S2
Haplopappus radiatus			S		3	S3	1	
Leptodactylon pungens	rare		S	S	3	S2	1	
Lomatium rollinsii	common						4	S2

Species	Endemic	USFS Sensitive			BLM	ID	OR	WA
		R-1	R-4	R-6				
Lomatium salmoniflorum		S			3	GP3	2	
Lomatium serpentinum	common							
Mimulus hymenophyllus	rare			S	5	S1	1	
Mirabilis macfarlanei[1]	rare	S	S	S	1	S2	1	
Nemophila kirtleyi	common							
Pediocactus simpsonii var. *robustior*	common				4	S3	4	S?
Penstemon elegantulus	common							
Pentogramma triangularis		S			3	S1		
Phacelia minutissima			S		3	S2	1	
Phlox colubrina	common							
Primula cusickiana				S			2	
Ribes cereum var. *colubrinum*	common							
Ribes wolfii						S2		
Rubus bartonianus	rare		S	S		S2	1	
*Silene Spaldingii**					1	S1	1	S2
Thelypodium laciniatum var. *streptanthoides*					5	S2		
Trifolium plumosus var. *plumosus*					3	S2	3	S1
Trollius laxus var. *albiflorus*				S			2	

3.1.5 Extirpated Species

Several species are known to have occurred in the Snake Hells Canyon subbasin and are suspected of having been extirpated. Table 17 lists these species and provides information about their current status.

Table 19. Species extirpated from the Snake Hells Canyon subbasin (based on Johnson and O'Neil 2001, exceptions noted)

Common Name	Scientific Name	Comments
Bighorn sheep	*Ovis canadensis*	Successfully reintroduced (see section 3.5.2)
Yellow-billed cuckoo	*Coccycuz americanus occidentalis*	Possibly extirpated; rare observations occasionally occur. Breeding pair in LaGrande in 1992
Gray wolf	*Canis lupus*	May be recolonizing from Idaho
Grizzly bear	*Ursus arctos*	Last grizzly in Oregon shot in Wallowa County in 1931
Sharp-tailed grouse	*Tympanuchus phasianellus*	Thought to be extirpated (BLM 2002)
White-tailed jackrabbit	*Lepus townsendii*	Thought to be extirpated (BLM 2002)

3.1.6 Game Species

One amphibian, 42 birds, and 22 mammal species in the subbasin are managed as game species by the states of Oregon, Washington, and Idaho (Table 20). Revenues generated through the harvest of many of these species provide significant economic gain to these states.

Table 20. Game species of the Snake Hells Canyon subbasin (IBIS 2003).

Common Name	Scientific Name	State Classification		
		ID	OR	WA
Bullfrog	*Rana catesbeiana*		game fish	game species
Greater white-fronted Goose	*Anser albifrons*	game bird	game bird	game bird
Ross's goose	*Chen rossii*	game bird	game bird	game bird
Canada goose	*Branta canadensis*	game bird	game bird	game bird
Wood duck	*Aix sponsa*	game bird	game bird	game bird
Gadwall	*Anas strepera*	game bird	game bird	game bird
Eurasian wigeon	*Anas penelope*		game bird	game bird
American wigeon	*Anas americana*	game bird	game bird	game bird
Mallard	*Anas platyrhynchos*	game bird	game bird	game bird
Blue-winged teal	*Anas discors*	game bird	game bird	game bird
Cinnamon teal	*Anas cyanoptera*	game bird	game bird	game bird

Common Name	Scientific Name	State Classification		
		ID	OR	WA
Northern shoveler	*Anas clypeata*	game bird	game bird	game bird
Northern pintail	*Anas acuta*	game bird	game bird	game bird
Green-winged teal	*Anas crecca*	game bird	game bird	game bird
Canvasback	*Aythya valisineria*	game bird	game bird	game bird
Redhead	*Aythya americana*	game bird	game bird	game bird
Ring-necked duck	*Aythya collaris*	game bird	game bird	game bird
Greater scaup	*Aythya marila*		game bird	game bird
Lesser scaup	*Aythya affinis*	game bird	game bird	game bird
Harlequin duck	*Histrionicus histrionicus*	game bird	game bird	game bird
Surf scoter	*Melanitta perspicillata*		game bird	game bird
Bufflehead	*Bucephala albeola*	game bird	game bird	game bird
Common goldeneye	*Bucephala clangula*	game bird	game bird	game bird
Barrow's goldeneye	*Bucephala islandica*	game bird	game bird	game bird
Hooded merganser	*Lophodytes cucullatus*	game bird	game bird	game bird
Common merganser	*Mergus merganser*	game bird	game bird	game bird
Red-breasted merganser	*Mergus serrator*	game bird	game bird	game bird
Ruddy duck	*Oxyura jamaicensis*	game bird	game bird	game bird
Chukar	*Alectoris chukar*	game bird	game bird	game bird
Gray partridge	*Perdix perdix*	game bird	game bird	game bird
Ring-necked pheasant	*Phasianus colchicus*	game bird	game bird	game bird
Ruffed grouse	*Bonasa umbellus*	game bird	game bird	game bird
Spruce grouse	*Falcipennis canadensis*	game bird	game bird	game bird
Blue grouse	*Dendragapus obscurus*	game bird	game bird	game bird
Wild turkey	*Meleagris gallopavo*	game bird	game bird	game bird
Mountain quail	*Oreortyx pictus*	game bird	game bird	game bird
California quail	*Callipepla californica*	game bird	game bird	game bird
Northern bobwhite	*Colinus virginianus*	game bird	game bird	game bird
American coot	*Fulica americana*	game bird	game bird	game bird
Common snipe	*Gallinago gallinago*	game bird	game bird	game bird
Mourning dove	*Zenaida macroura*	game bird	game bird	game bird
American crow	*Corvus brachyrhynchos*	game bird		

Common Name	Scientific Name	State Classification		
		ID	OR	WA
Eastern cottontail	*Sylvilagus floridanus*			game mammal
Nuttall's (mountain) cottontail	*Sylvilagus nuttallii*	game mammal		game mammal
Snowshoe hare	*Lepus americanus*	game mammal		game mammal
Black-tailed jackrabbit	*Lepus californicus*			game mammal
American beaver	*Castor canadensis*	game mammal		
Muskrat	*Ondatra zibethicus*	game mammal	game mammal	
Red fox	*Vulpes vulpes*	game mammal		
Black bear	*Ursus americanus*	game mammal	game mammal	game mammal
Raccoon	*Procyon lotor*	game mammal		
American marten	*Martes americana*	game mammal		
Mink	*Mustela vison*	game mammal		
American badger	*Taxidea taxus*	game mammal		
Northern river otter	*Lutra canadensis*	game mammal		
Mountain lion	*Puma concolor*	game mammal	game mammal	game mammal
Bobcat	*Lynx rufus*	game mammal		
Rocky Mountain elk	*Cervus elaphus nelsoni*	game mammal	game mammal	game mammal
White-tailed deer	*Odocoileus virginianus ochrourus*	game mammal	game mammal	game mammal
Moose	*Alces alces*	game mammal		game mammal
Pronghorn antelope	*Antilocapra americana*	game mammal	game mammal	game mammal
Mountain goat	*Oreamnos americanus*	game mammal	game mammal	game mammal
Bighorn sheep	*Ovis canadensis*	game mammal	game mammal	game mammal

3.2 Species Introductions and Artificial Production

3.2.1 Aquatic Species

Design hatchery capacity in the Snake River Basin is approximately 10 million steelhead, 17.6 million chinook, 1 million coho and a few hundred thousand sockeye. Although the majority of these fish are not produced or released within the Snake Hells Canyon subbasin itself, most must pass through the subbasin when migrating to or from the ocean. The following section provides a description of artificial production strategies and programs in place within or affecting the Snake Hells Canyon subbasin.

Idaho Department of Fish and Game

IDFG operates artificial production programs for anadromous species in the subbasin for harvest mitigation, supplementation, and conservation. These programs conform to statewide fisheries policies and management goals identified in the *2001–2006 Fisheries Management Plan* (IDFG 2001a). Hatchery and genetic management plans (HGMPs), specified in the NOAA Fisheries 2000 Federal Columbia River Power System and 1999 hatchery biological opinions (NMFS 2000a,b), have been prepared for all anadromous hatchery programs in Idaho. The complete HGMPs and associated draft reports and recommendations are available at www.nwcouncil.org/fw/apre/Default.htm.

Harvest Mitigation Programs

Chinook salmon and steelhead harvest mitigation is provided through hatchery programs funded by IPC and through the USFWS's Lower Snake River Compensation Plan (LSRCP). IDFG operates hatchery programs funded by IPC; LSRCP-authorized programs are operated by the IDFG and USFWS. The IDFG strongly emphasizes maintaining selective fisheries with the steelhead and chinook salmon programs. All harvest mitigation fish production (also called reserve production) is externally marked with an adipose fin clip to enable selective fisheries and provide for origin-specific stock monitoring and broodstock management at trapping and spawning sites.

IPC provides funding for operation of Oxbow and Rapid River fish hatcheries. Oxbow Fish Hatchery is in the Snake Hells Canyon subbasin at the Hells Canyon Complex on the Snake River. Rapid River Fish Hatchery is located on Rapid River, a tributary to the Little Salmon River, which is in turn a tributary to the Salmon River near Riggins. Chinook salmon trapped at the Oxbow facility are transferred to Rapid River Fish Hatchery for holding, spawning, incubation, and juvenile rearing.

IPC facilities mitigate for anadromous production habitat lost as a result of construction of the Hells Canyon Complex on the Snake River. The annual mitigation objective for IPC hatcheries is to release 400,000 pounds of steelhead smolts (at approximately 4.5 fish per pound) and 4 million chinook salmon smolts. No adult return objectives are specified in the IPC mitigation agreement.

The LSRCP program was authorized to mitigate losses caused by the construction and operation of the four lower Snake River dam and navigation lock projects. The program goals are unique in that they focus on replacing losses of returning adult salmon and steelhead rather than on releasing a given number of smolts or pound of smolts. The LSRCP adult return goals were allocated to the project area (above Ice Harbor Dam for fall chinook and above Lower Granite Dam for spring/summer chinook and steelhead) and not simply to the hatcheries. The measure of success in meeting LSRCP adult return goals is an estimate of the sum of adult returns to the various Snake River Basin fisheries, to the hatcheries of origin, and to natural spawning areas within the Snake River Basin. An extensive monitoring and evaluation program in the basin documents hatchery practices and evaluates the success of the hatchery programs at meeting LSRCP mitigation and cooperator objectives. The LSRCP hatchery monitoring and evaluation program identifies hatchery rearing and release strategies that allow LSRCP programs to meet their mitigation, ESA, and Tribal Trust responsibilities.

To properly evaluate the LSRCP program, adult returns to facilities, spawning areas, and fisheries that result from hatchery releases are documented. The IDFG's LSRCP program requires the cooperative efforts of its Hatchery Evaluation Study, Harvest Monitoring Project, and Coded Wire Tag Laboratory. The Hatchery Evaluation Study evaluates and provides oversight of certain hatchery operational practices (broodstock selection, size and number of fish reared, disease history, and time of release). Hatchery practices are assessed in relation to their effects on adult returns, and recommendations for improvement of hatchery operations are made. The Hatchery Evaluation Study and IDFG's BPA-funded supplementation research projects are continuously coordinated because these programs overlap in several areas including juvenile outplanting, broodstock collection, and spawning (mating) strategies. LSRCP hatchery production plays a substantial role in IDFG's supplementation research.

The Harvest Monitoring Project provides comprehensive harvest information to evaluate the success of the LSRCP in meeting adult return goals. It estimates the numbers of hatchery and wild/natural fish in the fishery and overall returns to the project area in Idaho. Data on the timing and distribution of the marked hatchery and wild stocks in the fishery are also collected and analyzed to develop LSRCP harvest management plans. Harvest data provided by the Harvest Monitoring Project are coupled with hatchery return data to estimate returns from LSRCP releases. Coded-wire tags are used extensively to evaluate fisheries contribution of representative groups of LSRCP production releases. However, most of these fish serve experimental purposes as well for evaluating hatchery-controlled variables such as size, time, and location of release; rearing densities; and natural rearing.

Supplementation Programs

Two tiers of supplementation programs are carried out in the subbasin. Tier 1 supplementation consists of intensive research projects approved within the Northwest Power and Conservation Council Fish and Wildlife Program and funded by BPA. Separate projects for steelhead (Steelhead Supplementation Studies in Idaho Rivers) and chinook salmon supplementation (Idaho Supplementation Studies) are currently active in the subbasin.

Broodstock and juvenile production for the Tier 1 supplementation programs are managed and maintained separately from other hatchery programs. Supplementation broodstock typically consists of natural-origin adult recruits and adult returns from prior supplementation broodstocks. Adults from the reserve (or harvest mitigation) production programs may be incorporated into some supplementation broodstocks. The progeny of a supplementation broodstock are marked differently (pelvic fin clip or coded-wire tag but, no fin clip) than reserve production fish. If a hatchery is at juvenile rearing capacity, the rearing of Tier 1 supplementation fish may displace some reserve production.

Tier 2 supplementation actions are those not associated with the ongoing intensive evaluations. Returns of reserve production adults in some years may exceed a hatchery's need with respect to an egg-take goal. Excess adults or their progeny (eggs, fry, parr) have primarily been used in on-site and off-site tribal supplementation programs. Tier 2 supplementation actions are coordinated and agreed to among state and tribal comanagers. Hatcheries may be involved in rearing eggs or juveniles for Tier 2 supplementation. Attempts are being made to identify unique marks for fish released as juveniles so they may be adequately monitored and managed when returning as adults. If they are at production capacity, priority for rearing space is 1) reserve production, 2) Tier 1 supplementation production, and 3) Tier 2 supplementation production.

Conservation Programs

The IDFG Chinook Salmon Captive Rearing program is the primary artificial production program in the Snake Hells Canyon subbasin that addresses anadromous fish conservation. This program differs from typical artificial production programs in that fish culture, not propagation, is the primary activity used to achieve program objectives. Hence, production, as used in classical hatchery terminology, is not an objective of the program. This program represents the application of two different captive culture strategies, broodstock and rearing, to achieve conservation and rebuilding objectives. This captive culture effort is consistent with section 9.6.4 (“Artificial Propagation Measures”) direction in the 2000 FCRPS biological opinion and with sections III.C (biological objectives) and III.D (strategies) of the Northwest Power and Conservation Council’s 2000 Columbia River Basin Fish and Wildlife Program (Northwest Power Planning Council 2000).

The IDFG initiated a captive rearing research program for populations at high risk of extinction to maintain metapopulation structure. Captive rearing is a short-term approach to species preservation. The main goal of the captive rearing approach is to avoid demographic and environmental risks of cohort extinction; maintaining the genetic identity of the breeding unit is an important but secondary objective. The strategy of captive rearing is to prevent cohort collapse in the specified target populations by providing captively reared adult spawners to the natural environment, which in turn maintain the continuum of generation-to-generation smolt production. Each generation of smolts, then, provides the opportunity for population maintenance or increase if environmental conditions prove favorable for that cohort. A captive rearing approach is most appropriate when the primary limiting factors depressing a population operate during the smolt-to-adult return life stage (outside the subbasin). In this case, captive rearing intervention for a portion of a cohort preempts exposure to external limiting factors. Freshwater spawning and production for the cohort is maintained while limiting factors external to the subbasin are addressed.

The captive rearing program was developed primarily as a way to maximize the number of breeding units cultured while minimizing intervention impacts through the collection and subsequent rearing of early life stages through adulthood. Only enough juveniles or eggs are collected from target populations to provide an adequate number of spawners, about 20, to ensure that acceptable genetic diversity can be maintained without additional natural escapement. (According to the Stanley Basin Sockeye Technical Oversight Committee, it is reasonable to assume that 20 fish could encompass 95% of the genetic diversity of the population.) However, this number remains somewhat speculative because of uncertainties associated with the ability of the captive rearing approach to produce adults with the desired characteristics for release into the wild (Fleming and Gross 1992, 1993; Joyce et al. 1993; Flagg and Mahnken 1995). Juveniles and/or eggs would be collected each year from cohorts of low-resiliency populations, those expected to return 10 or fewer spawning pairs to their respective spawning areas. To meet its objectives, the program must be able to produce an adequate number of adults with the proper morphological, physiological, and behavioral attributes to successfully spawn and produce viable offspring in their native habitats.

Little scientific information regarding captive culture techniques for Pacific salmonids was available at the inception of this program. Following Flagg and Mahnken's (1995) work, the IDFG captive rearing program was initiated to develop the technology for captive culture of chinook salmon and to monitor and evaluate captively reared fish during both the rearing and post-release/spawning phases. In addition to technology development, the IDFG program also addresses population dynamics and population persistence concerns. These population level concerns include 1) maintaining a minimum number of spawners in high-risk populations and 2) maintaining metapopulation structure by preventing local extinction.

Lower Snake River Compensation Plan

The LSRCP program was authorized to mitigate losses caused by the construction and operation of the four lower Snake River dam and navigation lock projects. The program has been modified through the years to meet its mitigation, ESA and Tribal Trust responsibilities. The Lyons Ferry Complex is comprised of Lyons Ferry and Tucannon hatcheries, operated by WDFW, and a system of acclimation ponds throughout Southeastern Washington. The Nez Perce Tribe operates three acclimation facilities above Lower Granite Dam for fall chinook from Lyons Ferry Hatchery, two in the Snake River and one in the Clearwater River. These hatchery and acclimation facilities rear and release fish to compensate for 18,300 Snake River fall chinook, 1,152 Tucannon River spring chinook, 4,656 Snake River summer steelhead, and 67,500 angler days of recreation on resident fish. Management intent for each species is different and will be discussed in each species section below.

Lyons Ferry Hatchery - Fall Chinook

The Lyons Ferry Hatchery (LFH) and Nez Perce Tribal Hatchery operations represents the sole fall chinook salmon compensation effort under the LSRCP in the Snake River basin. No information was provided for inclusion into this assessment regarding the NPTH program. The LFH utilizes native stock Snake River fall chinook for the program. These fish are part of the Snake River fall chinook ESU and have been identified by NOAA Fisheries as the appropriate stock for recovering the population.

While planning and designing the LSRCP facilities in the 1970s, the steep fall chinook decline caused concern that these fish might become extinct before mitigation facilities could be completed to maintain and enhance the run. An egg bank program for fall chinook was initiated in 1976 to preserve genetic material for compensation of 18,300 adults. Production releases from LFH began in the mid-1980s with fish from the egg bank program. Recent releases and returns have increased while the genetic integrity of the stock has been maintained.

Current management objectives for LFH are driven by the ESA and the *Columbia River Fish Management Plan*. These objectives are to 1) maintain genetic integrity of LFH/Snake River stock, 2) produce 900,000 yearling smolts (450,000 on-station release and 450,000 for three equal releases at Pittsburg Landing, Captain John, and Big Canyon acclimation sites above Lower Granite Dam) and produce subyearlings as possible for release at LFH and above Lower Granite Dam, and 3) reduce stray hatchery fish escaping above Lower Granite Dam to maintain the genetic integrity of Snake River fall chinook. The program produces subyearlings, even though their survival is lower than for yearlings, to mimic the natural life history of Snake River fall chinook.

Evaluation of the program has included 1) tagging all releases by the WDFW and a portion of those released above Lower Granite Dam, as well as monitoring adult returns to LFH and Lower Granite Dam, 2) determining the most effective release strategy between barging or direct stream releases, 3) determining adult fallback rate at Ice Harbor and Lower Granite dams and providing the recommendations for the best trapping location of broodstock, and 4) experimenting with cryopreserved semen. Evaluation work conducted in the early 1980s showed a nearly 11-fold survival advantage of releasing yearling smolts versus subyearling smolts at LFH. This work has supported management decisions to release yearling smolts to increased available broodstock, with subyearlings released occurring after baseline production is achieved. The Nez Perce Tribe and USFWS are conducting ongoing studies of fall chinook released above Lower Granite Dam, while the WDFW monitors hatchery operations and adult returns to the lower Snake River below Lower Granite Dam.

Future Plans

The WDFW has released subyearlings from LFH for the past three years, concurrently with the subyearling releases above Lower Granite Dam from tribal facilities. The WDFW is proposing continued LFH subyearling releases rather than solely releasing fish above Lower Granite Dam. Low broodstock numbers have been an obstacle to program success, which has been influenced by a small founding population, low smolt-to-adult survival of subyearling and yearling fall chinook in the mainstem corridor, and removal of stray Columbia River chinook from the broodstock during the late 1980s and early 1990s. However, recent increases in total smolt releases have had a positive effect on the number of adults returning to the Snake River basin. Spawning practices at LFH and trapping operations at Lower Granite Dam have maintained the genetic integrity of the stock. Production and monitoring and evaluation for fiscal year 2002 did not change significantly from past years but continued to focus on maximizing smolt-to-adult survival and maintaining stock integrity.

Lyons Ferry Hatchery - Summer Steelhead

Annually, approximately 60,000 to 120,000 hatchery summer steelhead smolts have been reared and released into the Snake River near LFH. The original intents of these releases were to build broodstock returns to LFH to support the mitigation program, return adults to meet the LSRCP goal, and reestablish successful steelhead fisheries. Although maintaining populations of wild steelhead in the basin was and is a management intent of the comanagers, no specific supplementation goals for Snake River populations were identified. Stocks of fish released into the river generally have been Wells (1983–1986), Wallowa (1984–1989), and Lyons Ferry (1987–present), with incidental releases of Clearwater, Oxbow, and Skamania stocks occurring infrequently in the past. However, during the life of the LSRCP program, wild populations throughout the Snake River basin generally declined (except for run years 1999 and 2000).

The LSRCP program is successfully returning adult hatchery-origin steelhead and therefore meets or exceeds LSRCP goals. These fish have created and supported successful sport fisheries within the Snake River basin and some of its tributaries. Releases of summer steelhead for the Washington portion of the Snake River decreased in 2000, but these releases have not been agreed to through the negotiation process specified in the 1988 *Columbia River Fish Management Plan* negotiation process. Decreased releases of LFH stock into the Snake River resulted from a management response following the NOAA Fisheries determination that this stock constitutes a jeopardy to the listed natural populations (April 2, 1999, biological opinion issued by NOAA Fisheries). Concurrent with this mitigation success has been increasing concern with possible effects of hatchery returns on wild populations as they return to their release sites or stray into adjacent subbasins that support natural populations.

Future Plans

Past evaluations have focused on increasing the survival of hatchery-reared steelhead and assessing the contribution of LFH-released fish to Columbia and Snake basin fisheries. Areas of concern include stray rates of hatchery-stock steelhead into tributary rivers, the degree of incidental hooking mortality on natural adults, contribution of hatchery steelhead to the decline in wild populations, and the availability of a more appropriate stock for compensation and proposed supplementation in the basin. Evaluations will continue to monitor Snake River steelhead releases and harvest and to focus on ways to minimize effects of the compensation program on natural populations, such as size and timing of releases or other release strategies that may decrease the potentially negative interactions between hatchery and wild fish. Further, the evaluation programs will continue to assess the potential for mitigation fisheries (identified in the original LSRCP legislation and consistent with the Northwest Power and Conservation Council's recognition of the value of "Harvest Hatcheries") where possible. In addition, expanded genetic evaluation of hatchery and naturally produced steelhead has begun to more fully describe the genetic stock structure within the basin and possibly help determine the availability of an acceptable, locally adapted broodstock for use in the program.

Nez Perce Tribe Supplementation Programs

In 1996, Congress instructed the U.S. Army Corps of Engineers (USCOE) to construct, under the Lower Snake River Compensation Plan (LSRCP), final rearing and acclimation facilities for fall chinook in the Snake River basin to complement their activities and efforts in compensating for fish lost due to construction of the lower Snake River dams. Fisheries co-managers of *U.S. v Oregon* supported and directed the construction and operation of acclimation and release facilities for Snake River fall chinook from Lyons Ferry Hatchery at three sites above Lower Granite Dam. The Nez Perce Tribe (NPT) played a key role in securing funding and selecting acclimation sites, then assumed responsibility for operation and maintenance of the Fall Chinook Accllimation Facility (FCAP). In 1997, Bonneville Power Administrative (BPA) was directed to fund operations and maintenance (O&M) for FCAP satellites. Two acclimation facilities, Captain John Rapids and Pittsburg Landing, are located on the Snake River between Asotin, WA and Hells Canyon Dam and one facility, Big Canyon, is located on the Clearwater River at Peck at the confluence of Big Canyon Creek and the Clearwater River. The Capt. John Rapids facility is a single pond while the Pittsburg Landing and Big Canyon sites consist of portable fish rearing tanks assembled and disassembled each year. Acclimation of 450,000 yearling smolts (150,000 each facility) begins in March and ends 6 weeks later. When available, an additional 2,400,000 fall chinook sub-yearlings may be acclimated for 6-weeks and released as subyearling smolts.

Pittsburg Landing satellite is located in the Hells Canyon National Recreation Area (HCNRA) near Whitebird, Idaho. The site is located on the Idaho side of the Snake River at River Mile (RM) 215, about 31 miles downstream of Hells Canyon Dam.

Captain John Rapids satellite is located on the Snake River between Asotin, Washington and the mouth of the Grand Ronde River at RM 164. The site is on the Washington side of the river, 20 miles upstream of Asotin, with vehicle access provided by the Snake River Road.

Big Canyon acclimation site is located on the lower Clearwater River adjacent to US Highway 12 near Peck, Idaho. The site is 4 miles below the confluence of the North Fork and Middle Fork of the Clearwater River at RM 35.

FCAP is a supplementation project; in that hatchery produced fish are acclimated and released into natural spawning habitat for the purpose of returning a greater number of natural spawners. Only Snake River stock is used; juvenile production occurs at Lyons Ferry Hatchery. This long-term project is intended to ultimately work towards ESA-delisting of Snake River fall chinook by NOAA Fisheries. Complete adult returns for all three facilities occurred in the year 2002. The progeny from these fish become ESA-listed fish, as will those from all future adult returns. Hence, this production contributes to the ESA-delisting cycle and represents the first full generation of spawners.

The immediate goal of the project is a concerted effort to ensure that the Snake River fall chinook salmon above Lower Granite Dam do not go extinct. Long-term goals of the project are:

1. Increase the natural populations of Snake River fall chinook spawning above Lower Granite Dam.
2. Sustain long-term preservation and genetic integrity of this population.
3. Keep the ecological and genetic impacts of non-target fish populations within acceptable limits.
4. Assist with the recovery of Snake River fall chinook to remove from ESA-listing.
5. Provide harvest opportunities for both tribal and non-tribal anglers.

Idaho Power Company

Idaho Power Company is obligated to provide mitigation for lost fish and fishing opportunity resulting from construction of the Hells Canyon Hydroelectric Complex. Under a 1980 FERC settlement agreement, IPC is obligated to produce 400,000 pounds (about 1.8 million fish at 4.5 fish per pound) of steelhead smolts, 4 million spring/summer chinook smolts and 1 million fall chinook smolts. Because of poor access and limited remaining habitat in the Snake Hells Canyon subbasin, most of the mitigation releases have been relocated to the Salmon River subbasin. Annually IPC releases about 300,000 spring chinook smolts and 500,000 steelhead smolts at Hells Canyon Dam. Starting with broodyear 2000, IPC has produced and released a few hundred thousand fall chinook smolts at Hells Canyon Dam. The fall chinook smolt release is expected to reach 1 million smolts within the next few years, pending development of facilities and adequate broodstock, and an ongoing negotiation among the management entities for a long term fall chinook management plan (Herb Pollard, NOAA Fisheries, personal communication, December 2003).

3.2.2 Terrestrial Species

Ten nonnative terrestrial vertebrate species are thought to occur within the subbasin. The majority of these species are native to Asia or Europe and were not introduced directly to the Snake Hells Canyon subbasin but colonized from surrounding areas (Table 21). Five species of introduced game birds inhabit the subbasin. Although these game birds are economically important because they provide hunting opportunities, they may compete with native birds for food and nest sites (Table 21) (Johnson and O'Neil 2000). The remaining introduced species are generally considered undesirable and may have negative impacts on native wildlife. For instance, starlings have been documented to usurp nest sites from many species of native birds, and bullfrogs have been shown to outcompete and prey on native amphibian species. Introduced wildlife species are not currently considered to be a significant factor limiting native wildlife populations in the subbasin. However, if bullfrog populations on Craig Mountain continue to increase, they may begin to have an impact on the diverse amphibian populations that the area supports (Llewellyn and Peterson 1998).

Table 21. Introduced wildlife species of the Snake Hells Canyon subbasin (Johnson and O'Neil 2001).

Common Name	Scientific Name	Origin	Reason for Original Introduction*
Chukar	*Alectoris chukar*	Eurasia	game
Gray partridge	*Perdix perdix*	Eurasia	game
Ring-necked pheasant	*Phasianus colchicus*	Eurasia	game
California quail	*Callipepla californica*	Southwestern United States	game
Rock dove	*Columba livia*	Eurasia	aesthetics, racing, messengers
European starling	*Sturnus vulgaris*	Eurasia	aesthetics
House sparrow	*Passer domesticus*	Eurasia	aesthetics, insect control
Bullfrog	*Rana catesbeiana*	Eastern and central United States	Insect control, aesthetics, hunting, food
Norway rat	*Rattus norvegicus*	Asia	stowaway
House mouse	*Mus musculus*	Europe	stowaway

* not all species were directly introduced to the Snake Hells Canyon subbasin, most colonized from other areas

3.3 Focal Species Identification

Eight fish species and 12 wildlife species were selected as focal species for this assessment. Aquatic species selection was based on their listing status (e.g., threatened) and their ecological, social, cultural, and/or local significance (Table 22). In addition to the above criteria, wildlife focal wildlife species were selected as representatives of the wildlife habitat types in the subbasin. More focal species were selected to represent widely distributed or disproportionately important habitat types, compared with habitats that are only a minor component of the landscape. Species were selected that represent structural conditions or habitat elements particularly important to a variety of wildlife species in the subbasin and that are thought to be less common now than they were historically. Susceptibility to current and historical management, data availability, and monitoring potential were also factors considered during the selection process. The list of focal species used for the neighboring Imnaha subbasin was used as a starting place in selecting focal species for the Snake Hells Canyon subbasin to promote province-level consistency.

The focal species were selected by a technical team made up of resource professionals who represented a variety of management entities (Nez Perce Tribe, USFWS, USFS, Oregon Department of Fish and Wildlife [ODFW], IDFG). Focal species were selected during a discussion, which took into account the various planning guidance documents available.

Table 22. Aquatic and terrestrial focal species selected for use in this assessment.

Aquatic	
Type	**Focal Species**
Anadromous	Spring chinook salmon Fall chinook salmon Steelhead trout Sockeye salmon Pacific lamprey
Resident	Bull trout Rainbow/redband trout White sturgeon
Terrestrial	
Wildlife Habitat Type	**Focal Species**
Eastside and montane mixed conifer forest	American marten Boreal owl Rocky Mountain elk
Ponderosa pine forests and woodlands	Flammulated owl White-headed woodpecker
Lodgepole pine forests and woodlands	Black-backed woodpecker
Alpine grasslands and shrublands	Mountain goat
Eastside grasslands	Rocky Mountain bighorn sheep Grasshopper sparrow
Agriculture, pastures, and mixed environs	Mule deer
Open water	Bald eagle
Wetland and riparian areas	Mountain quail Columbia spotted frog
Caves	Townsend's western big-eared bat

3.4 Aquatic Focal Species Population Delineation and Characterization

3.4.1 Spring Chinook Salmon

Distribution

Stream-type chinook were historically widely distributed, occupying an estimated 46% of the Columbia Basin and occurring as far up the Snake River as Shoshone Falls (RM 615; Haas 1965). Spring chinook spawning does not occur in the mainstem Snake River within the Snake Hells Canyon subbasin. Below the confluence with the Salmon River, Asotin Creek (not contained within the Snake Hells Canyon subbasin) is the only tributary stream used by chinook salmon for spawning, while a limited amount of rearing may occur in lower reaches of some of the other larger tributaries (i.e., Captain John Creek; Figure 33) (WDFW et al. 1990, BLM 2000b). Above the Salmon confluence, Granite and Sheep creeks are the only tributaries used for spawning, although they are used very minimally (BLM 2000a). Limited juvenile rearing may occur in lower tributaries when stream conditions are suitable.

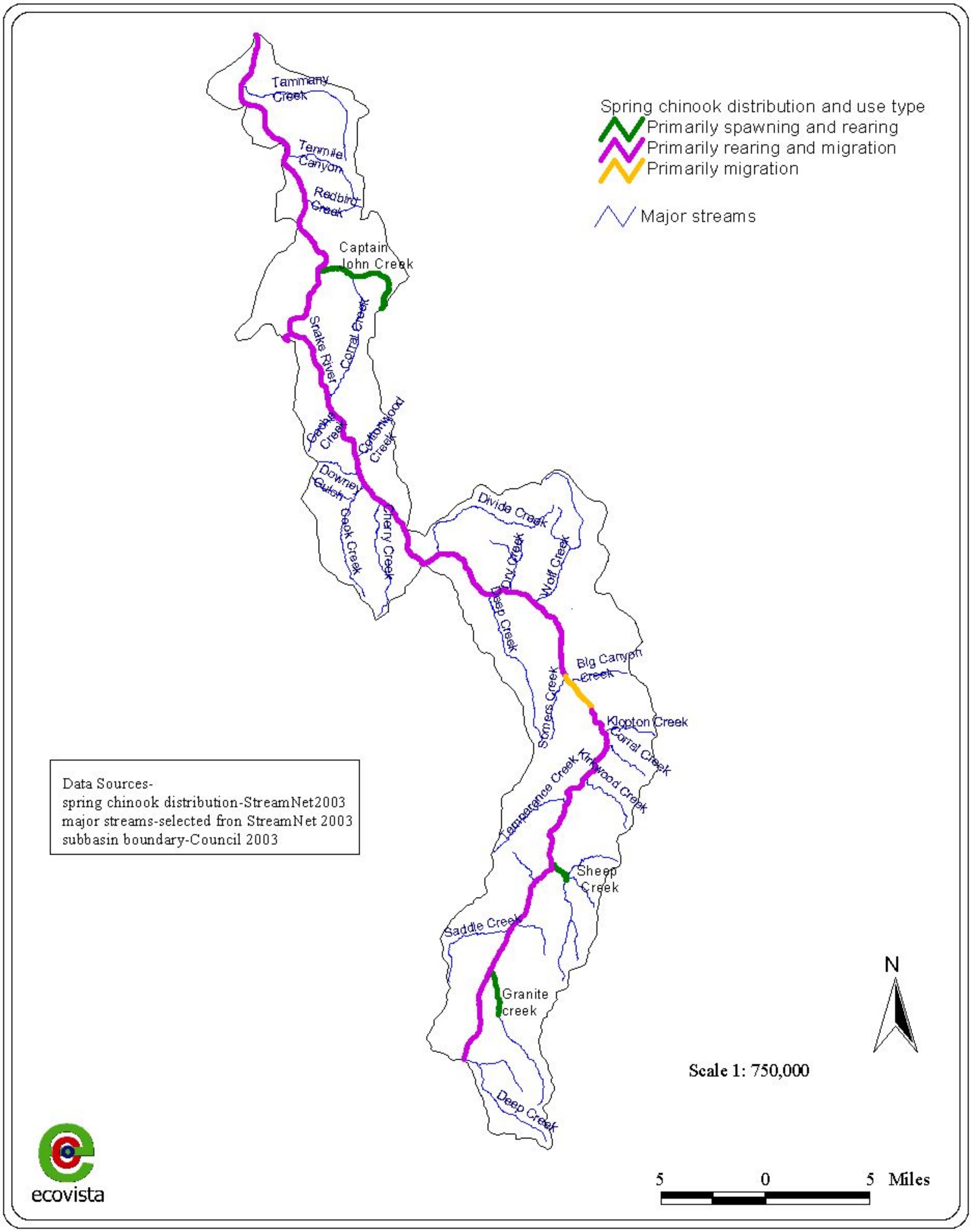

Figure 33. Spring chinook distribution in the Snake Hells Canyon subbasin.

Population Data and Status

Abundance and Trends

Historically, Snake River spring and summer chinook spawned in virtually all accessible and suitable habitat in the Snake River system (Fulton 1968). A substantial proportion of Columbia Basin spring/summer chinook were estimated to have originated in the Snake River basin in the late 1800s, with total production probably exceeding 1.5 million in some years (NMFS 2000a). By the mid-1900s, however, the abundance of adult spring/summer chinook salmon had declined considerably. Fulton (1968) estimated that an average of 125,000 adults per year entered the Snake River tributaries from 1950 through 1960. Adult counts at dams show that this value has continued to decline since the 1960s.

Until recently increased returns in 2001 and 2002, the number of naturally spawning spring/summer chinook salmon in the Snake River basin had been at all-time lows with an overall downward trend (Figure 34). Spring chinook salmon abundance within the Snake Hells Canyon subbasin has likely followed similar long-term trends, although recent increases in overall returns to the Snake River may have been less pronounced within the subbasin due to limited habitat availability. Most chinook salmon stocks in the remaining accessible habitat are severely depressed and at risk (BLM 2000a,b). Detailed information on biology and trends of Snake River spring and summer chinook can be found in Matthews and Waples 1991, Healy 1991 and ODFW and WDFW 1998.

Productivity

No productivity information is available relating directly to spring chinook salmon within the Snake Hells Canyon subbasin.

Life History Diversity

The highly variable life histories of stream-type chinook allow the species to adapt to a wide range of environmental conditions. Adult spring chinook salmon destined for the Snake River and its tributaries enter the Columbia River in early spring, pass Bonneville Dam from March through May, and reach the Snake River by late April (BLM 2000b). They arrive at staging areas from late May to early July and spawn from August to mid-September (IDFG 1992, cited in BLM 2000b). Spawning adults are typically four to five year olds (spending 2–3 years in the ocean), although they may return to the subbasin as three to six year olds. Fry emerge from February to April, rear through the summer in the natal stream, and then migrate downstream into the mainstem or larger tributary (i.e., Captain John or Asotin Creek) where they overwinter. Spring chinook outmigrate as age 1+ juveniles, passing Lower Granite Dam from late April through June.

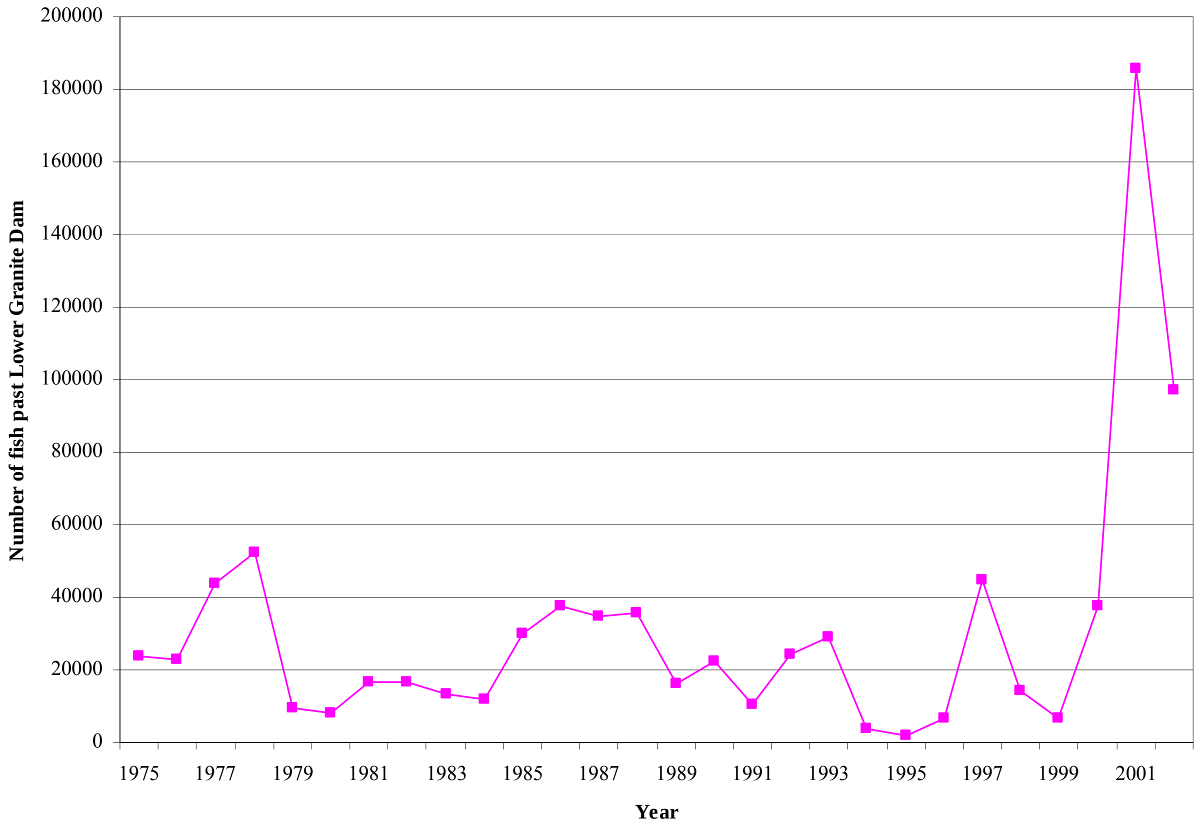

Figure 34. Adult returns of spring/summer chinook past Lower Granite Dam annually since 1975 (StreamNet 2003).

Carrying Capacity

Limited information is available related to carrying capacity of spring chinook and other focal species in the subbasin. That which is available relates only to carrying capacity of the smolt life history stage and, in some cases, inaccurately reflects known distribution of use areas (either through addition or omission of currently recognized use areas). The information is presented as a relative picture of potential smolt carrying capacity throughout major areas of the subbasin (e.g., upriver versus downriver tributary or mainstem habitats) only.

Estimates of spring chinook salmon smolt carrying capacity are available for select stream reaches in which spawning and rearing is known or suspected to occur (Table 23). Estimates are based on data downloaded from the StreamNet website (PSMFC 2004), which was originally produced using the smolt density model developed in 1989 as part of the Northwest Power Planning Council's presence/absence database. Detailed overview of methods used to estimate smolt carrying capacity are presented in Northwest Power Planning Council (1989). In short, the smolt density model estimates potential smolt capacity, accounting for both the amount of available habitat and relative quality of that habitat within a given stream reach. Estimates are considered very rough, but they likely provide a reasonable picture of the relative distribution of carrying capacity throughout the subbasin.

Table 23. Smolt capacity of spring chinook in various areas of the Snake Hells Canyon subbasin (PSMFC 2004).

Subbasin Area	Smolt Capacity
Upriver Tributaries–Above Salmon River Confluence	
Granite Creek	3,593
Sheep Creek	5,663
Downriver Tributaries–Below Salmon River Confluence	
N/A	0
Upriver Mainstem–Above Salmon River Confluence	
Snake River	620,417
Downriver Mainstem–Below Salmon River Confluence	
Snake River	90,649

Unique Population Units

Based on preliminary designations, no unique population units of spring chinook have been defined within, or encompassing any portion of, the Snake Hells Canyon subbasin (McClure et al. 2003).

Genetic Integrity

Information regarding genetic makeup and integrity of spring chinook salmon within the Snake River basin (including the Snake Hells Canyon subbasin) is presented in McClure et al. 2003. Much of the existing genetic information is unavailable for public distribution due to proprietary or other reasons; therefore, it is not included in this document. Readers are referred to McClure et al. 2003 for an overview of existing genetic information.

Harvest

No information is available regarding tribal or sport harvest of spring chinook salmon within the subbasin.

Habitat Condition

The Snake Hells Canyon subbasin provides designated critical habitat for spring/summer chinook salmon, as designated on December 28, 1993 (Federal Register 58:68543) and effective on January 27, 1994.

Spring/summer chinook habitat in the Snake Hells Canyon subbasin has been severely degraded over the past century. Even before mainstem dams were built, habitat was lost or severely damaged in the high-elevation streams used for chinook spawning and rearing (Fulton 1968). Construction and operation of irrigation dams and diversions; inundation of spawning areas by impoundments; and siltation and pollution from sewage, farming, logging, and mining all contributed to reductions in habitat quantity and quality (Fulton 1968). Habitat loss following completion of the Columbia/Snake hydropower/water storage system further contributed to habitat losses, as many primary spawning and rearing areas were no longer accessible (NMFS 2000a).

Chinook habitat in the Snake Hells Canyon subbasin consists of the mainstem Snake River, primarily used for migration, and its associated tributaries, some of which support limited spawning and rearing. In addition to a migration route, the mainstem Snake River provides rearing and staging habitat for spring chinook produced in tributary subbasins. The amount of rearing is unknown (WDFW et al. 1990).

Excluding the four primary tributaries (Clearwater, Grande Ronde, Imnaha, and Salmon rivers), the only tributaries known to contain habitat that supports spawning and rearing life history phases of spring/summer chinook are Granite and Sheep creeks (IDEQ 1998; BLM 2000a,b). Accessible tributary streams may be used by juvenile spring/summer chinook for rearing when conditions are suitable or when conditions in the mainstem become unsuitable (BLM 2000a,b).

3.4.2 Fall Chinook Salmon

Distribution

Snake River fall chinook were historically distributed from the mouth of the Snake River to a natural barrier at Shoshone Falls, Idaho, at RM 615 (Haas 1965). Swan Falls Dam was the first impoundment to inundate spawning and rearing habitat in 1901, eliminating 385 miles of habitat in the upper river (Tiffan et al. 1999). Following construction of Swan Falls Dam, most production occurred in the 30-mile reach from the dam to Marsing, Idaho (Connor et al. 2002). From the late 1950s through the mid-1970s, development and completion of the Snake River hydropower system further reduced available fall chinook spawning and rearing areas in the free-flowing river reach to approximately 100 miles between the backwaters of Lower Granite Reservoir and Hells Canyon Dam (Figure 35) (Tiffan et al. 1999).

Although the remaining free-flowing section represents about 17 percent of the historically available river miles, the Hells Canyon reach has never been considered to be the best spawning and rearing habitat. The historically most important spawning and rearing areas were located upstream of Hells Canyon where the river temperatures are regulated by the Thousand Springs inflow and the river is spread in broad gravel riffles compared to the relatively narrow and rocky river section remaining. However, the remaining habitat in Hells Canyon and in the lower reaches of the larger tributaries of this section are now the only areas that this ESU persists (Herb Pollard, NOAA Fisheries, personal communication, December 2003).

Snake River fall chinook currently spawn from Asotin (RM 148.5) to Hells Canyon Dam (RM 247), utilizing both shallow- (<3.0 m) and deep-water (≥3.0 m) habitats for redd construction (Groves 2001). The distribution of redds throughout this area is highly variable from year to year, and data collected from 1991 to 2000 suggest that, although "shifts" in spawning distribution may occur, such shifts do not appear to maintain themselves for extended periods. Redd surveys between 1988 and 1993 located greater percentages of redds in areas farther downstream (below the Grande Ronde River) relative to surveys in 1994 and 1995, suggesting an upstream shift in spawning distribution (Rondorf and Tiffan 1997). However, subsequent data have shown an increased number of redds reported from these same downstream areas (Groves 2001).

Population Data and Status

Abundance and Trends

Detailed information on biology and trends of Snake River fall chinook can be found in Waples *et al.* 1991a, Healy 1991 and ODFW and WDFW 1998. Throughout the early 1900s, populations of Snake River fall chinook salmon remained stable at high levels of abundance (NMFS 2000a). Although historical abundance of Snake River fall chinook is speculative, adult escapement estimates suggest a decline in abundance by as many as three orders of magnitude since the 1940s and by perhaps another order of magnitude from pristine levels (NMFS 2000a). During the period 1938–1949, wild runs of Snake River fall chinook averaged 72,000 fish. During the 1950s, runs averaged 29,000 fish (Irving and Bjornn 1981). Construction of the Hells Canyon Complex (1958–1967) and lower Snake River dams (1961–1975) eliminated or severely degraded 530 miles of spawning habitat.

Fall chinook populations in the Snake Hells Canyon subbasin are depressed (Quigley and Arbelbide 1997) but showing considerable improvement following restoration efforts. Returning wild fall chinook salmon counts from 1975 through 1980 averaged 600 fish per year (Waples et al. 1991a). From 1981 to 1990 and 1991 to 1999, respectively, wild fall chinook counts over Lower Granite Dam averaged 369 and 557 fish per year (Figure 36).

The number of redds observed within the mainstem Snake River (shallow-water and deep-water inclusive) has increased over recent years, from 46 in 1991 to 1,113 in 2002 (Table 24). Redd counts in 2002 were the highest recorded since annual searches began in 1986. The increase in returns since 1998 may be attributable to supplemental releases of juvenile fish in previous years (G. Mendel, personal communication, May 2001). Evidence presented by Groves (2001) suggests that carrying capacity in terms of spawning has not been attained at even the highest levels of escapement in recent years (since 1991).

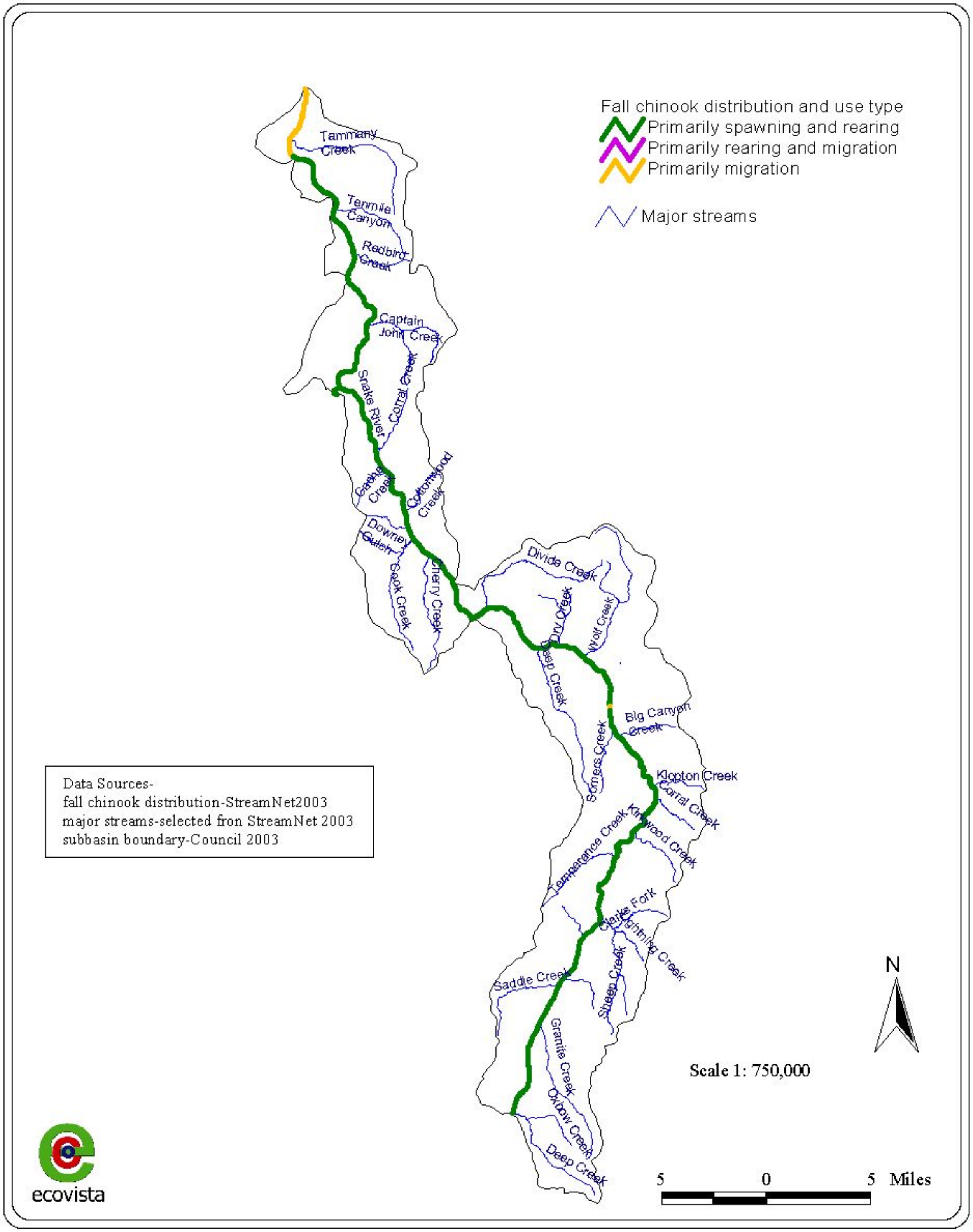

Figure 35. Fall chinook distribution in the Snake Hells Canyon subbasin.

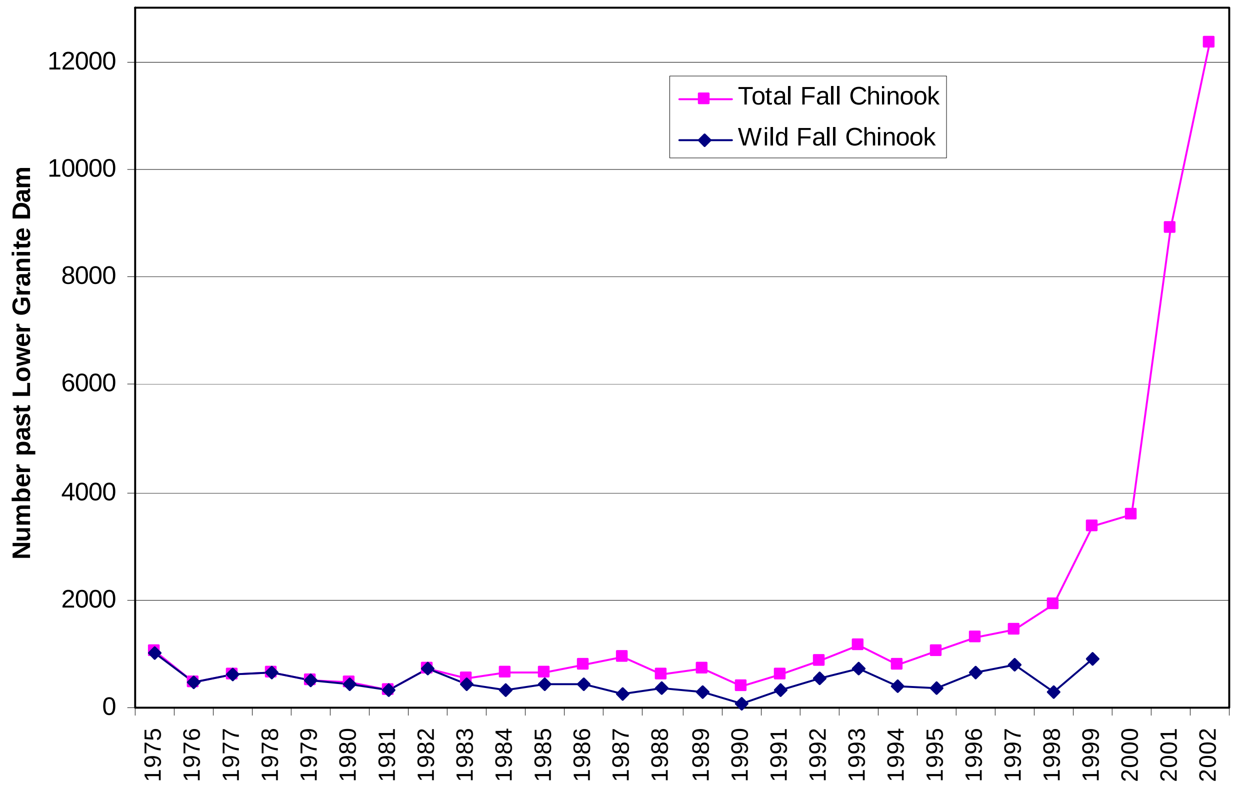

Figure 36. Total (StreamNet 2003) and wild (BLM 2000a) returns of fall chinook salmon past Lower Granite Dam annually since 1975.

Productivity

The Hells Canyon Snake subbasin supports the bulk of fall chinook spawners in the Snake River ESU, typically accounting for 55 to 65% of all fall chinook redds surveyed upriver from Lower Granite Dam (Table 24).

Life History Diversity

Because of their ESA listing, little applied research has been conducted regarding the incubation life history stage of fall chinook in the Snake Hells Canyon subbasin. Methods used to define habitat and water quality criteria relative to incubation life history stages generally require unnecessary and unacceptable levels of direct “take” (in the form of mortality) and are prohibited under the ESA. It is therefore reasonable to use surrogate measures such as laboratory experiments or sedimentation indices to define criteria for incubation life history stages of fall chinook. Empirical data suggest that fine sediments (<6.4 mm) that comprise 20 to 25% of the redd substrate will have a deleterious effect on incubation success (Eaton and Bennett 1996), including a reduction in the porosity of the redd. The less porous redd will consequently have a reduced intragravel water velocity, which will in turn affect oxygen delivery to developing embryos and removal of metabolic wastes. Eaton and Bennett (1996) found that Snake River fall chinook survival to emergence (STE) was not significantly impaired by low water velocity and that successful STE occurred when velocities were at least 0.3 cm/s. Early or premature emergence has been documented when oxygen concentrations within the redd are unsuitable

(Alderice et al. 1958) or water temperatures become warm. Connor et al. (2002) found fry emergence of Snake Hells Canyon fall chinook to occur earliest in the upper reach (above the Salmon River confluence) where water temperatures were warmest. Connor's research also establishes that the historical spawning/incubation areas (those occurring near or within the Marsing reach of the Snake River) likely had warmer water temperatures than contemporary reaches and that, because of this difference, fall chinook salmon juvenile life histories likely progressed on an earlier time schedule than they do currently.

Upon emergence in early May to early June, fall chinook juveniles inhabit the sandy littoral areas (Tiffan et al. 1999, BLM 2000a) for up to two months or until water temperatures are no longer suitable. The movement away from the littoral zone signifies the progression from parr to smolt stages, which for fall chinook occurs earlier in life than it does for other anadromous salmonids. The downstream migration of subyearling fall chinook from the Snake River in Hells Canyon is protracted, occurring from late spring (June) through midsummer (August; Rondorf and Miller 1993, Connor et al. 2002). Late emigration of hatchery fish to Lower Granite Dam may be affected by a number of factors including fall chinook salmon size at time of release, river flow, and water temperature at time of release (Rondorf and Miller 1993, 1994, 1995). Connor et al. (1998 and 2002) found late emigration timing to be detrimental to production: smolt survival to Lower Granite Dam decreased with reduced summer flows and higher water temperatures.

Hells Canyon fall chinook smolts range between 2.7 and 3.9 inches in length. Studies have shown that outmigrating fall chinook juveniles are capable of moving substantial distances during the day as well as at night, swimming actively only at low water velocities and rarely drifting passively (Rondorf and Miller 1993, 1994, 1995). During their migration, subyearlings have a biological requirement for food and may consume terrestrial insects and zooplankton in reservoir reaches and aquatic insects in the free-flowing reaches.

Based on annual redd searches from 1991 to 1999, redd construction timing in the Hells Canyon Snake initiates by mid-October, peaks in early to mid-November, and is essentially completed by late November or early December (Rondorf and Miller 1993, 1994, 1995; Groves 2001; Connor et al. 2002). Spawning was determined to initiate when water temperatures dropped below 16 °C and terminated when temperatures approached 5 °C (Table 25). Groves (2001) found the relationship between spawn timing and temperature to be less predictable, however, since fish were observed initiating spawning activities when temperatures were as high as 17 °C or delaying activities at temperatures around 12 °C. Based on survey data from 1991 to 2000, Groves (2001) proposes that fall chinook spawn timing between Asotin and Hells Canyon Dam is equally influenced by the total number of fish within the population and how clumped their distribution is on arrival upstream of Lower Granite Dam. Groves (2001) concludes that, as the escapement past Lower Granite Dam increases, spawning tends to begin earlier, peak within a short time, and end earlier than when escapement is depressed. Groves and Chandler (1999) determined that redd depths for Snake River fall chinook salmon ranged from 0.2 to 6.5 m and mean water column velocity during spawning ranged from 0.6 to 1.7 m/s (Table 25). Substrate sizes used for spawning ranged from 1.0 to 5.9 inches (Groves and Chandler 1999). Groves and Chandler (2001) determined that the mean area required for a female fall chinook salmon to successfully build a redd was 45.8 m^2 (n = 8, standard error = 3.87).

Carrying Capacity

Groves and Chandler (2001) presented the most recent assessment of the redd capacity of the Snake Hells Canyon subbasin. Spatially, Groves and Chandler (2001) concluded that the most suitable area for redds (~ greatest adult carrying capacity) existed in the upper Hells Canyon reach (above the mouth of the Salmon River). The authors determined that habitat availability for redd construction increases moderately at discharges from Hells Canyon Dam of 8,000 to 13,000 cfs, remains stable at discharges of 13,000 to 15,000 cfs, and decreases rapidly at discharges greater than 15,000 cfs. The greatest estimated redd capacity occurred with a discharge of 13,000 cfs from Hells Canyon Dam. Within a discharge range (from Hells Canyon Dam) of 8,000 to 13,000 cfs, redd capacity of the Snake River within the Snake Hells Canyon subbasin was between 3,450 and 3,750 redds (±1,217). At 9,500 cfs, a discharge level normally associated with IPC's protective flow program, modeled results predicted a redd capacity of 3,587 redds (±1,222).

No numerical estimates of juvenile fall chinook rearing capacity are available. However, Chandler et al. (2001) found availability of fall chinook rearing habitat in the Snake River to be most abundant (~ greatest juvenile carrying capacity) below the mouth of the Salmon River, with maximum modeled availability about six times higher than that above the mouth of the Salmon River.

Unique Population Units

Based on preliminary designations, a single population unit has been defined encompassing all fall chinook spawning within the Snake River drainage, including fall chinook salmon within the Snake Hells Canyon subbasin (McClure et al. 2003).

Genetic Integrity

Information regarding genetic makeup and integrity of fall chinook salmon within the Snake River basin (including the Snake Hells Canyon subbasin) is presented in McClure et al. 2003. Much of the existing genetic information is unavailable for public distribution due to proprietary or other reasons; therefore, it is not included in this document. Readers are referred to McClure et al. 2003 for an overview of existing genetic information.

Table 24. Number of fall chinook redds counted upriver from Lower Granite Dam, 1986–2002. An empty cell indicates that no searches were conducted in the corresponding river or method for that year (A.P. Garcia, USFWS, Ahsahka, Idaho, unpublished data; data from the Clearwater subbasin and Salmon River provided by the Nez Perce Tribe).

River	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Snake River within the Snake Hells Canyon subbasin																	
Snake (aerial)[1]	7	66	64	58	37	41	47	60	53	41	71	49	135	273	255	535	878
Snake (camera)[2]						5	0	67	14	30	42	9	50	100	91	175	235
Subtotal—Hells Canyon	**7**	**66**	**64**	**58**	**37**	**46**	**47**	**127**	**67**	**71**	**113**	**58**	**185**	**373**	**346**	**710**	**1,113**
Other Areas within the Snake River Fall Chinook ESU																	
Clearwater (RM 0-41)			21	10	4	4	25	36	30	20	66	58	78	179	164	290	520
Clearwater (RM 41-74)							1	0	0	0	0	0	0	2	7	16	4
Middle Fork Clearwater (RM 74-98)									0	0	0	0	0	0	0	0	0
North Fork Clearwater							0	0	7	0	2	14	0	1	0	0	0
South Fork Clearwater							0	0	0	0	1	0	0	2	0	1	0
Grande Ronde	0	7	1	0	1	0	5	49	15	18	20	55	24	13	1	5	0
Imnaha		0	1	1	3	4	3	4	0	4	3	3	13	9	8	197	111
Salmon							1	3	1	2	1	1	3	0	9	38	72
Selway									0	0	0	0	0	0	0	22	31
Subtotal—Other Areas	**0**	**7**	**23**	**11**	**8**	**8**	**35**	**92**	**53**	**44**	**93**	**131**	**118**	**206**	**189**	**593**	**738**
Total—Snake River ESU	**7**	**73**	**87**	**69**	**45**	**54**	**82**	**219**	**120**	**115**	**206**	**189**	**303**	**579**	**535**	**1,303**	**1,851**

[1] The targeted search area was the entire reach from the head of Lower Granite Reservoir to Hells Canyon Dam.
[2] The targeted search areas were discrete sites composed mainly of 1- to 6-inch bottom substrates. The number of sites searched varied each year.

Table 25. Physical habitat and water quality criteria for various life history stages of fall chinook salmon occurring within the Snake Hells Canyon subbasin (from Groves and Chandler 2001).

Life History Stage	Parameter	Life History Criteria	
		Suitable Range	Optimal Range
Adult migration	temperature	1–8 °C *as well as* 15–21 °C	8–15 °C
Spawning	temperature	5–10 °C *as well as* 15–16 °C	10–15 °C
Spawning	depth	between 0.2 and 6.5 m	
Spawning	velocity	water column velocities between 0.6 and 1.7 m/s	
Spawning	substrate	between 2.6 and 15.0 cm long-axis length	
Rearing	temperature	1–10 °C *as well as* 15–21 °C	10–15 °C
Rearing	depth	littoral depths up to 1.5 m	
Rearing	substrate	littoral substrates measuring <22.5 cm long-axis lengths	
Rearing	velocity	mean water column velocities <0.4 m/s	
Rearing	morphometry	lateral shoreline slopes <40%	
Juvenile migration	temperature	1–8 °C *as well as* 15–21 °C	8–15 °C
All stages	DO	40–76% saturation @ ≤16 °C	≥76% saturation @ ≤16 °C

Harvest

No consumptive (catch-and-keep) sport fishery exists for fall chinook salmon within the Snake Hells Canyon subbasin. No information is available regarding tribal or incidental harvest of fall chinook within the subbasin.

Habitat Condition

Critical habitat was designated for Snake River fall chinook salmon on December 28, 1993 (Federal Register 58:68543) and effective on January 27, 1994. The Snake Hells Canyon subbasin provides designated critical habitat for fall chinook salmon.

Between 1991 and 2000, no single spawning site was utilized every year, and only 4% of sites where redds had been observed were used in 8 of those 10 years; 18% of sites where redds had been observed were used in 6 of those 10 years (Groves 2001). The continued use of new spawning sites and lack of consistent re-use of spawning sites suggest that the available spawning habitat for fall chinook salmon within the Snake Hells Canyon subbasin is not fully seeded under current escapement levels (Groves 2001). Connor et al. (2001) estimated that the Snake River within the Snake Hells Canyon subbasin is currently capable of supporting a total of approximately 2,500 redds. Since 1986, fall chinook redd surveys within the Snake River have not located more than 373 redds (1999) in any single year.

Prior to impoundment, the mainstem Snake River and the lower reaches of several tributaries provided key spawning and rearing habitat for fall chinook (Rondorf and Tiffan 1997). The upper reaches of the mainstem Snake River, particularly near the town of Marsing, Idaho (RM 390, approximately 144 miles upstream of Hells Canyon Dam; Haas 1965), were the primary areas used by fall chinook salmon, with only limited spawning activity reported downstream of RM 272 (NMFS 2000a). Access to spawning areas upstream of Hells Canyon Dam was blocked starting in 1955 by the three-dam complex. After construction of the dams, the areas available for spawning included 104 miles of free-flowing Snake River downstream of Hells Canyon Dam, in the tailraces below the four Snake River dams, and in associated major tributaries including the Imnaha, Salmon, Grande Ronde and Clearwater (Rondorf and Tiffan 1997). The fact that Snake River fall chinook spawn in the lower reaches of the primary tributaries may, however, be due to the overall reduction in available habitat, as historical evidence documenting tributary spawning is inconclusive (Connor et al. 2002). An estimated 80% of the Snake River drainage formerly used by fall chinook salmon for spawning and rearing has been eliminated due to habitat changes or lack of access (USFS 1999).

The timing of fall chinook salmon life history events and growth are largely regulated by water temperature and differ both within and between subbasins. Connor et al. (2002) found two distinct temperature regimes occurring within the Snake Hells Canyon subbasin: the warmer upper Snake River reach (from the confluence of the Imnaha River upstream to Hells Canyon Dam) and the slightly cooler, lower Snake River reach (from the head of Lower Granite Reservoir to the confluence of the Salmon River). Within the two reaches, Connor et al. (2002) determined that fall chinook from the upper reach grew faster and smolted earlier than those from the lower reach. Similarly, when compared against results of beach seine hauls from the Hanford reach (Columbia River) in April and McNary Reservoir (Columbia River) in May, subyearling chinook salmon seined from the Hells Canyon reach of the Snake River in June had attained a larger size more quickly than Columbia River subyearlings, due in large part to intrasubbasin temperature differences (Rondorf and Tiffan 1995).

Based on a total effective area model, in 1993, the predicted suitable spawning habitat (that which successfully met slope, depth, velocity, substrate, and scour criteria) in the Snake Hells Canyon subbasin) was determined to be 9% of shallow-water transitional, 0% of shallow-water-lateral, and 6% of deep-water transitional (Rondorf and Tiffan 1994). The estimates, when compared to fall chinook production, suggest that known spawning sites are probably underseeded (Rondorf and Tiffan 1994). Through hydraulic and habitat modeling (RHABSIM), Groves and Chandler (2001) estimated the quantity, quality, and availability of fall chinook spawning habitat downriver of Hells Canyon Dam and found that habitat availability increases moderately as discharge from Hells Canyon Dam increases from 8,000 to 13,000 cfs, remains stable from 13,000 to 15,000 cfs, and decreases rapidly at discharges greater than 15,000 cfs. They found that the morphometry of the Snake River through Hells Canyon is such that a given increase in discharge may increase the weighted usable habitat area in downstream reaches (below the Salmon confluence) due to the reduced gradient and shoreline slope, while effectively reducing habitat quantity and quality in upstream reaches characterized by steeper gradients and shoreline slopes. Groves and Chandler (2001) found that the change in measured and predicted stage at the various discharge levels (8,000 to 15,000 cfs) varied by only about 0.9 m and that this change would influence about 9% of all measured redds that had been observed at that depth.

The quality of fall chinook spawning substrate, measured at index reaches throughout the Snake Hells Canyon subbasin, is generally high, although some studies have documented gravel too large for spawning (Rondorf and Tiffan 1996). Percent fines in the substrate, fines by depth, and surface fines vary by year and site, but overall they are not considered to inhibit cobble utilization or incubation success (Rondorf and Tiffan 1994, 1996; BLM 2000a). Groves and Chandler (2001) determined that the percentage of fines (<1 mm) increased in a downstream progression, although percentages were determined to be within an acceptable range (<11%). Similarly, Groves and Chandler (2001) found permeability values (i.e., hydraulic conductivity) to be lowest at RM 152 (0.009 cm/s), increasing as distance upstream increased (ranging from 0.07 to 0.21 cm/s), with the highest values occurring at the most upstream sample locations. Results from all sites fell within the normal range of values determined for alluvium and are typical for fluvial sediments comprising a riverbed. Using sedimentation evaluation statistics (i.e., geometric mean particle size [dg], degree of sorting [sg], and Fredle index [Fi]), Groves and Chandler (2001) estimated that STE for fall chinook occurring within the Hells Canyon reach fell within an acceptable range (61 to 90% at sites in the upper canyon and 58 to 87% in the lower canyon) and, as data indicate, that STE was highest in the uppermost reaches.

Using the RHABSIM model, Groves and Chandler (2001) estimated the redd capacity of the Snake River downstream of Hells Canyon Dam to be between approximately 3,450 and 3,750 redds (±1,217), given a discharge range of 8,000 to 13,000 cfs. This estimate falls within the recovery goals for Snake River fall chinook that require sufficient suitable habitat upstream of Lower Granite Reservoir to support a minimum of 1,250 redds.

3.4.3 Steelhead Trout

Distribution

Steelhead trout are the most widespread of the selected aquatic focal species in the Snake Hells Canyon subbasin. In Idaho, some of the larger tributaries above the Salmon River confluence with known spawning and rearing populations of summer steelhead include Divide, Wolf, Getta, Kirkwood, Sheep, and Granite creeks (see Figure 1) (BLM 2000a). Due to their use by steelhead and other focal species, Granite Creek and Sheep Creek are considered to be priority watersheds by the Cottonwood Field Office (BLM 2000b). Larger tributaries utilized for spawning and rearing in Oregon include Somers, Temperance and Saddle creeks. Other Idaho and Oregon tributaries used by steelhead include Dry, Highrange, Big Canyon, West, Kurry, Klopton, Corral, Kirby, Kirkwood, Sheep, Bernard, Three, Granite, Deep creeks (all in Idaho), Deep, Cougar, Salt, Sand, Rush, Sluice, Battle, Stud, and Hells Canyon creeks (all in Oregon).

Juveniles utilize a wide array of habitats throughout the Snake River in Hells Canyon and are generally ubiquitous where other salmonids occur, including areas adjacent to hatchery smolt-release locations (ODFW 2001). Captain John Creek is the primary area below the Salmon River confluence (and within the Snake Hells Canyon subbasin boundary) in which both spawning and rearing of steelhead occurs (Figure 37) (BLM 2000b). Other tributaries (below the Salmon River confluence) with limited use (often rearing only) include Tammany, Tenmile, Corral, Cache, Cottonwood, and Cherry creeks (BLM 2000b).

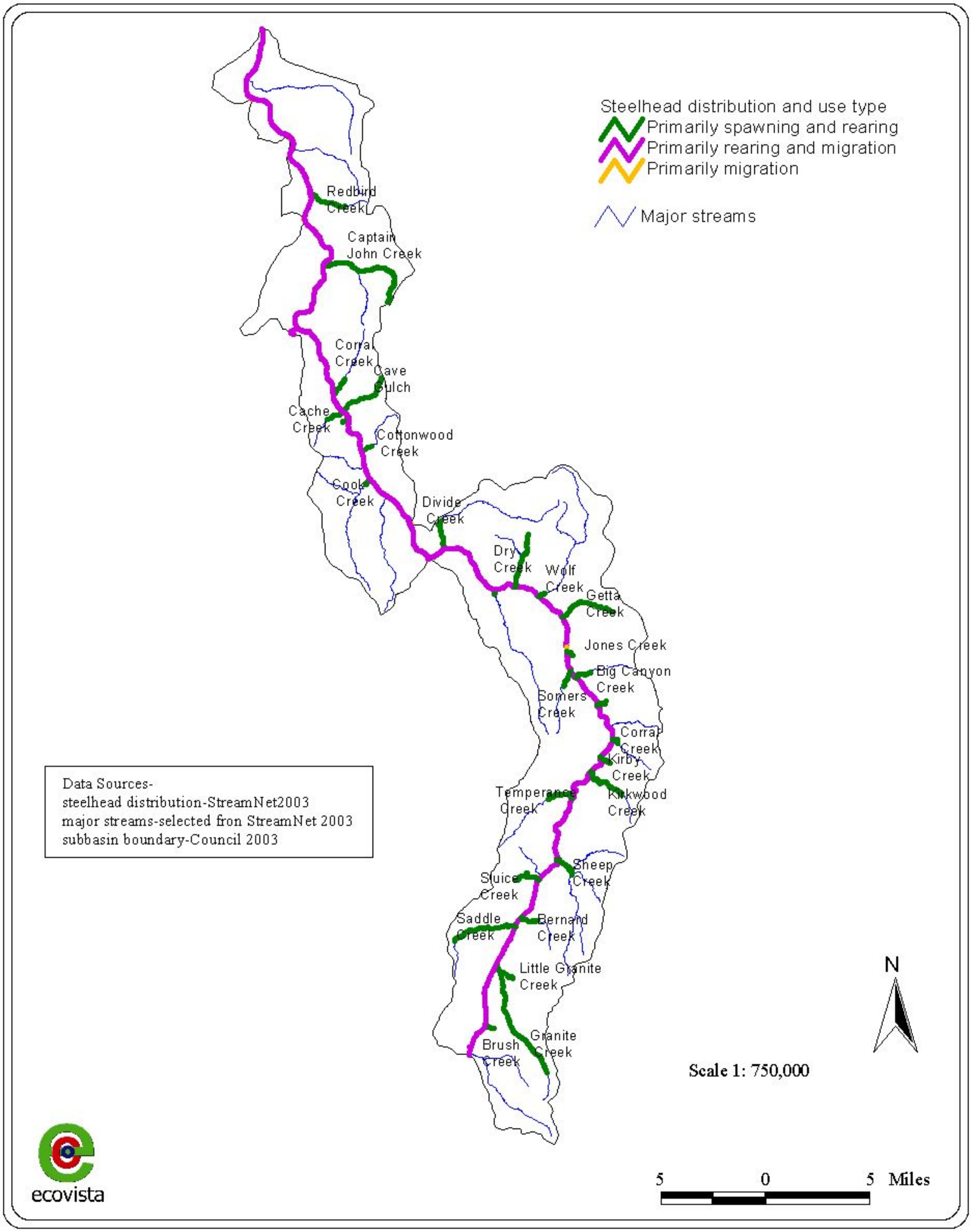

Figure 37. Steelhead distribution within the Snake Hells Canyon subbasin.

Population Data and Status

Abundance and Trends

Detailed information on biology and trends of Snake River summer steelhead can be found in Busby *et al*. 1996 and ODFW and WDFW 1998. No subbasin-specific information is available regarding abundance or trends for steelhead in the Snake Hells Canyon subbasin. Mallett (1974) estimated that 55% of all Columbia River steelhead trout historically originated from the Snake River basin. The following excerpts from Busby et al. (1996) summarize trends in Snake River steelhead population(s) at the time of that publication:

> …there has been a severe recent decline in natural run size. The majority of natural stocks for which we have data within this ESU have been declining. Parr densities in natural production areas have been substantially below estimated capacity in recent years. The aggregate trend in abundance for this ESU (indexed at Lower Granite Dam) has been upward since 1975, although natural escapement has been declining during the same period. However, the aggregate trend has been downward (with wide fluctuations) over the past 10 years, recently reaching levels below those observed at Ice Harbor Dam in the early 1960s. Naturally produced escapement has declined sharply in the last 10 years.

Although steelhead stocks are still considered depressed, recent trends in Snake River steelhead counts have shown substantially increased numbers since 1999 for both natural and composite (hatchery and natural) runs (Figure 38). Recent run sizes, although much improved relative to the past 20 years, are still considered far depressed from historical numbers, and much of the available habitat in the Snake River system remains underseeded.

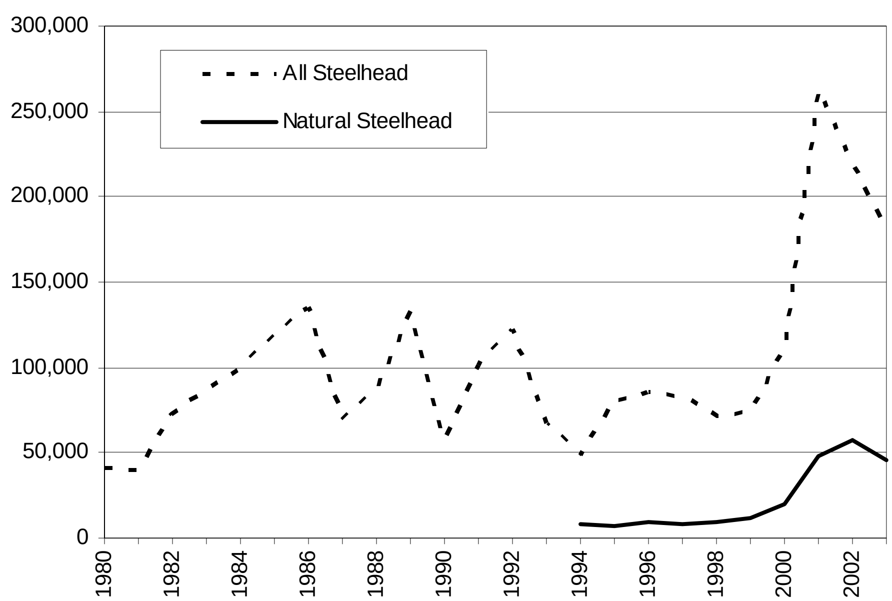

Figure 38. Annual total and natural steelhead counts over Lower Granite Dam since 1980 (Columbia Basin Research 2004).

Productivity

No productivity information is available for steelhead within the Snake Hells Canyon subbasin.

Life History Diversity

Steelhead occurring in the Snake Hells Canyon subbasin are typical A-run steelhead from the mid-Columbia and Snake basins. Most adults (60%) return from the ocean after one year of marine rearing (ODFW 2001). Two-salt and occasionally three-salt fish comprise the remainder of returns to the Snake River. Females generally predominate, with a 3:2 sex ratio on average (ODFW 2001). Returning adults range in size from 45 to 91 cm in length and average 1.4 to 6.8 kg.

Adults generally enter the Columbia River from May through August, reaching their natal streams from September through April (ODFW 2001). Adults use accessible and suitable habitat throughout the subbasin for spawning. Spawning is initiated in March in lower elevation habitat and continues through early June in higher elevation, snowmelt-dominated habitat.

Most naturally produced smolts migrate after rearing for two years (ODFW 2001). A much lower percentage migrates after one or three years. Smolt outmigration from the basins extends from late winter until late spring. Peak smolt movement is associated with increases in flow, generally occurring between mid-April and mid-May.

Carrying Capacity

No information is available regarding carrying capacity of steelhead within the Snake Hells Canyon subbasin.

Unique Population Units

Based on preliminary designations, the Snake Hells Canyon subbasin contains all or portions of three steelhead population areas. The "Snake River Hells Canyon tributaries" steelhead population area includes all mainstem and tributary habitats above the mouth of the Salmon River. The "Little Salmon and Rapid River" population area includes mainstem Snake River tributaries in Hells Canyon below the mouth of the Salmon River but above the mouth of the Grande Ronde River. The "Grand Ronde River lower mainstem tributaries" population area includes mainstem Snake River tributaries in Hells Canyon below the mouth of the Grande Ronde River (Michelle McClure, Northwest Fisheries Science Center's Interior Columbia Technical Recovery Team, personal communication, January 13, 2003).

Genetic Integrity

Information regarding genetic makeup and integrity of steelhead within the Snake River basin (including the Snake Hells Canyon subbasin) is presented in McClure et al. 2003. Much of the existing genetic information is unavailable for public distribution due to proprietary or other reasons; therefore, it is not included in this document. Readers are referred to McClure et al. 2003 for an overview of existing genetic information.

Harvest

Steelhead harvest in the Snake Hells Canyon subbasin has been restricted to hatchery fish only since 1979 (ODFW 2001). Consumptive fisheries for wild steelhead are unlikely to be reinstated in the foreseeable future (ODFW 2001). Adult hatchery steelhead returns of fish produced from the LSRCP and IPC hatchery programs have allowed harvest opportunities since 1986. Oregon punch card estimates of hatchery fish harvest ranged from 1,116 to 2,444 fish for the 1991–92 through 1993–94 fishing seasons. Angler effort has tended to follow the availability of hatchery fish with effort, being high in high return years and low in low return years (ODFW 2001).

Habitat Condition

Critical habitat for Snake River summer steelhead trout was originally established in February 2000 (Federal Register 65:7764). This critical habitat is under redesignation following withdrawal of previous critical habitat designations for this and 18 other ESUs, in accordance with a NOAA Fisheries consent decree (NMFS 2002).

Below the confluence of the Salmon River, the quality of steelhead habitat in the Snake Hells Canyon subbasin is highest in those limited areas afforded protection by the HCNRA (e.g., Cook Creek). Above the confluence with the Salmon River, most tributary watersheds are contained within either the HCNRA or Hells Canyon Wilderness (exceptions include Divide, Dry, Wolf, and Getta creeks). Steelhead habitat quality above the Salmon River confluence is highest in Granite and Sheep creeks. These are generally larger tributaries and provide access to suitable spawning and rearing habitat.

Habitat in the mainstem Snake River is primarily used for upstream and downstream migration, but this habitat may also facilitate rearing life history forms of steelhead. Adult steelhead also winter in the mainstem Snake River (BLM 2000b).

Although steelhead are considered to occupy the widest array of habitat types of any anadromous salmonid in the Interior Columbia Basin, an estimated 7,737 river miles of historically occupied habitat have been eliminated or are no longer accessible (Northwest Power Planning Council 1986). Within the Snake Hells Canyon subbasin, habitat is restricted to that occurring between Hells Canyon Dam and Clarkston, Washington, much of which has been modified to some degree by various land-use activities. Coarse-scale assessments conducted for the Northwest Power Planning Council (1990) identified low flow levels (dewatering), high temperatures, lack of high-quality pools, passage impediments, and streambank degradation as negatively affecting steelhead habitat in various tributaries to the Snake River within the Snake Hells Canyon subbasin.

3.4.4 Sockeye Salmon

Distribution

Snake River sockeye salmon (*Oncorhynchus nerka*), the rarest of federally listed Snake River salmonids (Federal Register 58:68543), use the lower reaches of the Snake River within the Snake Hells Canyon subbasin as a migration corridor (Figure 39) for accessing the Salmon River drainage en route to spawning grounds in the Stanley Basin (see Huntington et al. 2001).

Population Data and Status

Abundance and Trends

Detailed information on biology and trends of Snake River sockeye salmon can be found in Waples *et al.* 1991b, Burgner 1991, and ODFW and WDFW 1998. Subbasin specific information does not exist since the species uses the Snake Hells Canyon subbasin only as a migration corridor.

Adult sockeye runs at the mouth of the Columbia River may have numbered more than two million before the beginning of the twentieth century. From 1910 through 1934, although some passage may have occurred, adult sockeye salmon were largely prevented from returning to the Sawtooth Valley in Idaho by the presence of the Sunbeam Dam (McClure et al. 2003). Between 1954 and 1968, adult returns to Redfish Lake in the Salmon subbasin ranged from 11 to 4,361 fish (Bjornn et al. 1968, cited in McClure et al. 2003). Since 1990, the number of Snake River sockeye adults crossing Lower Granite Dam (Figure 40) en route to Redfish Lake has ranged from zero (1990) to 282 fish (2000). An intensive, captive broodstock program has been initiated to conserve the remaining population.

Based on critically low population numbers and the risk of extinction, IDFG, in cooperation with NMFS, Shoshone-Bannock Tribes, BPA, University of Idaho, and others, initiated a species conservation program in 1991. At the center of this effort is a captive broodstock program that produces fish for reintroduction back to the habitat and for meeting future broodstock needs. Reintroduction efforts have been ongoing in Redfish Lake since 1993 (see Huntington et al. 2001 for additional details regarding the species conservation program).

Productivity

The Snake Hells Canyon subbasin provides a migration corridor for sockeye salmon migrating to or from the Salmon subbasin in Idaho. No spawning or rearing of sockeye occurs within the Snake Hells Canyon subbasin, making productivity information for that species irrelevant within this subbasin assessment.

Life History Diversity

Information on life history diversity of Snake River sockeye salmon will not be provided in this assessment since the species only uses the Snake Hells Canyon subbasin as a migration corridor. Readers are referred to Waples et al. (1991b) and Huntington et al. (2001) for details regarding life history characteristics of Snake River sockeye salmon.

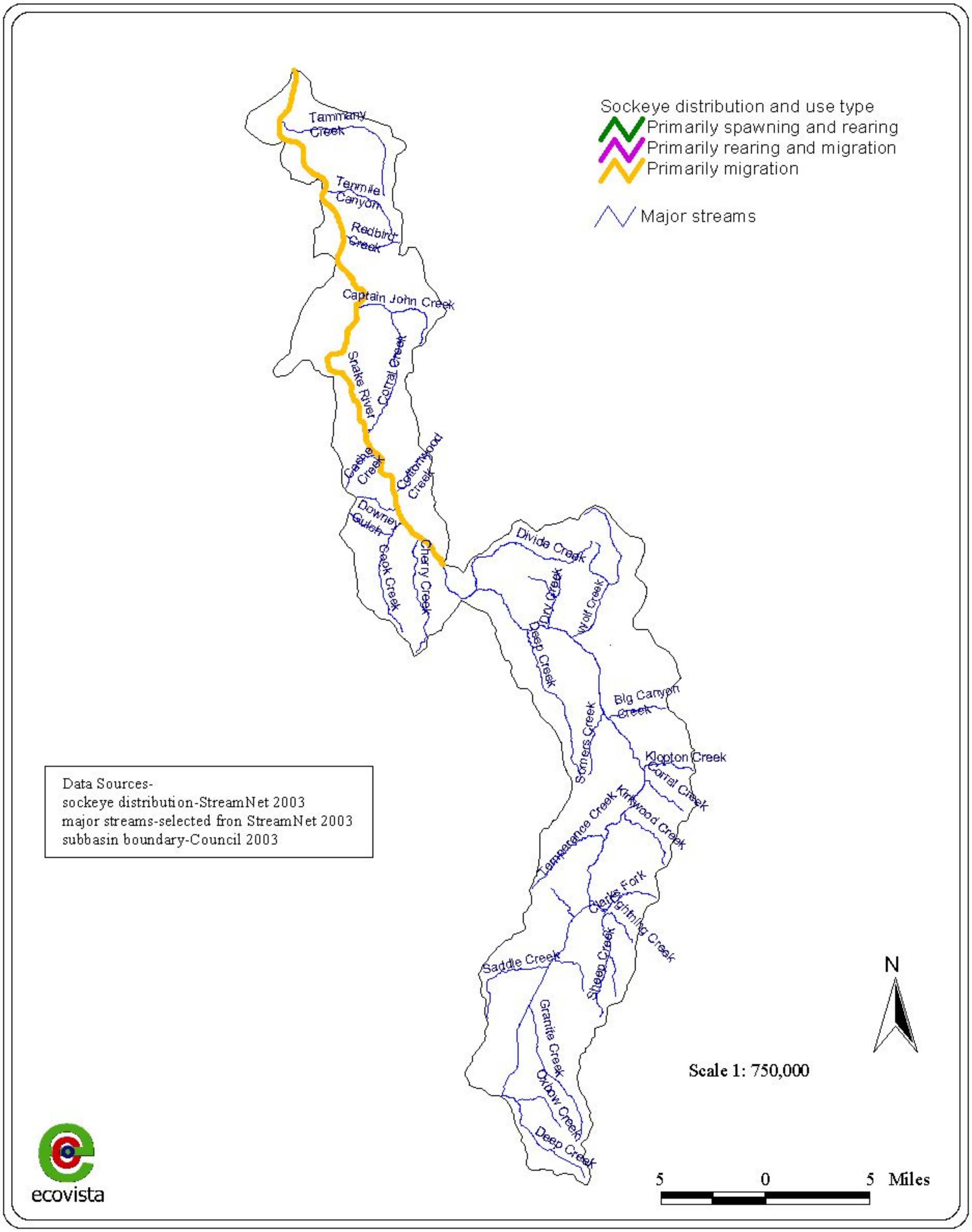

Figure 39. Sockeye salmon distribution in the Snake Hells Canyon subbasin.

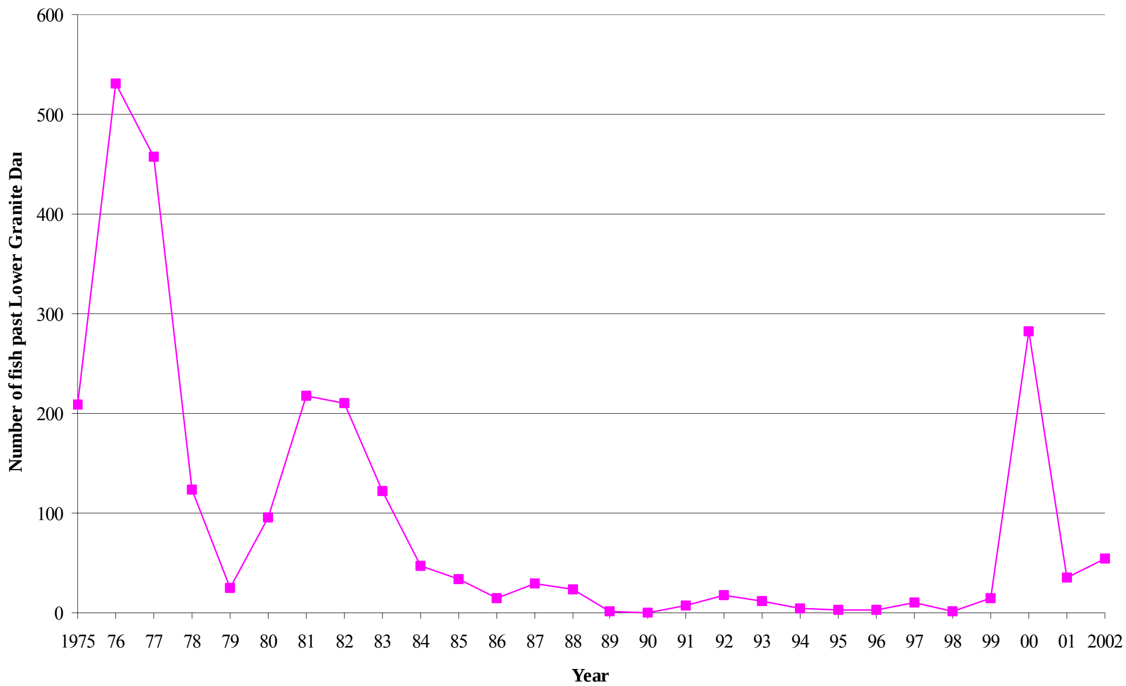

Figure 40. Numbers of Snake River sockeye passing Lower Granite Dam annually since 1975 (StreamNet 2003).

Carrying Capacity

Sockeye salmon were not known to spawn historically within the Snake Hells Canyon subbasin; the current capacity of the migratory corridor within the subbasin as it relates to recovery of the listed Snake River stock is unknown.

Unique Population Units

Sockeye salmon migrating through the Snake Hells Canyon subbasin are part of the Snake River sockeye salmon ESU although the subbasin itself does not lie within the ESU boundary.

Genetic Integrity

Information on the genetic integrity of Snake River sockeye salmon is not provided in this assessment since the species only uses the Snake Hells Canyon subbasin as a migration corridor. Readers are referred to Brannon et al. (1992, 1994), Robison (1996), Winans et al. (1996), Waples et al. (1997), and Powell and Faler (2000) (all cited in Huntington et al. 2001) for details regarding genetic characteristics of Snake River sockeye salmon.

Harvest

No information on historical harvest of sockeye salmon that may have occurred within the Snake Hells Canyon subbasin is available. Harvest of/fishing for sockeye salmon in Idaho closed in 1965. The current chance of Idaho sockeye entering the downriver salmon harvest is considered remote due to extremely low numbers at the mouth of the Columbia River since 1989 (IDFG 1998).

Habitat Condition

The Snake Hells Canyon subbasin provides a migratory corridor for adult and juvenile sockeye salmon during the periods from July to August and April to June, respectively. The portion of the Snake River within the Snake Hells Canyon subbasin and below the mouth of the Salmon River is designated critical habitat for fish en route to the upper Salmon subbasin (see Huntington et al. 2001).

3.4.5 Pacific Lamprey

Distribution

The Pacific lamprey (*Lampetra tridentata*) is an anadromous and parasitic lamprey widely distributed along the Pacific coast of North America and Asia. It was recently thought that Pacific lamprey still occurred in all areas that remain accessible to salmon and steelhead (Simpson and Wallace 1982). However, Pacific lamprey are believed to have been extirpated from some accessible areas within the Snake River drainage (e.g., Imnaha River and Asotin Creek subbasins; see Rabe et al. 2001 and Stoval et al. 2001, respectively). Various large tributaries to the Snake Hells Canyon subbasin are known (e.g., Clearwater and Salmon subbasins; see Cichosz et al. 2001 and Huntington et al. 2001, respectively) or suspected (Grande Ronde subbasin; see Nowak 2001) to still have Pacific lamprey present.

Although Pacific lamprey are found in the Snake River drainage, distribution data specific to the Snake Hells Canyon subbasin are unavailable. Most likely, potential use is limited to the mainstem Snake River for migration and larger accessible tributaries for spawning and rearing (BLM 2002). Groves et al. (2001) support this assertion, stating that there is no evidence that Pacific lamprey used or use the mainstem Snake River for spawning or rearing. According to the BLM (2002), no tributaries between Captain John Creek and the mouth of the Salmon River are known to be used by Pacific lamprey for spawning and rearing.

Population Data and Status

Abundance and Trends

Similar to other anadromous fishes, the distribution and abundance of Pacific lamprey has been reduced due to construction of dams and water diversions, as well as by degradation of spawning and rearing habitats. Historical runs of Pacific lamprey were large, with as many as 400,000 individuals migrating past Bonneville Dam on the lower Columbia River (Harrison 1995). Counts of lamprey passing Ice Harbor Dam on the Snake River were 40 and 399 in 1993 and 1994, respectively, in contrast to the 1960s when roughly 50,000 were counted annually at the same location (Harrison 1995). Currently, an estimated 3% of the lamprey that pass Bonneville Dam are counted at Lower Granite Dam (Close 2000).

Productivity

No productivity information is available for Pacific lamprey within the Snake Hells Canyon subbasin.

Life History Diversity

No Pacific lamprey life history information specific to the Snake Hells Canyon subbasin or surrounding areas is available, although life history studies are currently underway in the nearby Clearwater subbasin (see Cochnauer and Claire 2001). Pacific lamprey adults generally enter fresh water between July and September, but they do not mature until the following March. Spawning occurs from April through July in sandy gravel immediately upstream of riffles. Eggs hatch in two to three weeks, and the ammocoetes spend up to the next six years in soft substrate as filter feeders before emigrating to the ocean (Simpson and Wallace 1982). Kan (1975, cited in Groves et al. 2001) estimated that lamprey off the Oregon coast may spend 20 to 40 months in the ocean before returning to fresh water to spawn. Readers are referred to Close et al. (1995) for additional details regarding generic life history characteristics of Pacific lamprey in the Columbia River basin.

Carrying Capacity

The carrying capacity of lamprey habitat in the Snake Hells Canyon subbasin has not been defined. It is agreed, however, that habitat availability in the subbasin is not a factor limiting production and that underseeding is likely the primary cause for concern.

Unique Population Units

Population delineation for Pacific lamprey in the Snake River basin has not been conducted. It is therefore unknown whether lamprey within the Snake Hells Canyon subbasin constitute all or part of a unique population unit.

Genetic Integrity

No information is available regarding genetic integrity of Pacific lamprey within the Snake Hells Canyon subbasin.

Harvest

Native Americans harvested lamprey for consumption or trade and either roasted or dried the meat before eating it. Fishermen in the Snake, Columbia, and Fraser rivers commonly use lamprey as bait for white sturgeon (Groves et al. 2001). Commercial harvest of lamprey for medicinal anticoagulants, teaching specimens, and food continues today (Close et al. 1995). In 2001, the state of Oregon permitted commercial and personal-use harvest of the lamprey population in the Willamette River but restricted commercial harvest to 14,400 pounds (ODFW 2001). It is unclear to what degree, if any, downriver commercial and/or localized harvest for bait impacts Pacific lamprey populations within the Snake Hells Canyon subbasin.

3.4.6 Bull Trout

Distribution

The Snake Hells Canyon subbasin lies within the historic native range of bull trout, although no clear documentation of the historical distribution of bull trout within the subbasin exists. Surveys for bull trout have been conducted throughout the subbasin, with current distribution of bull trout defined in the mainstem Snake River and portions of Granite and Sheep creeks (Figure 41).

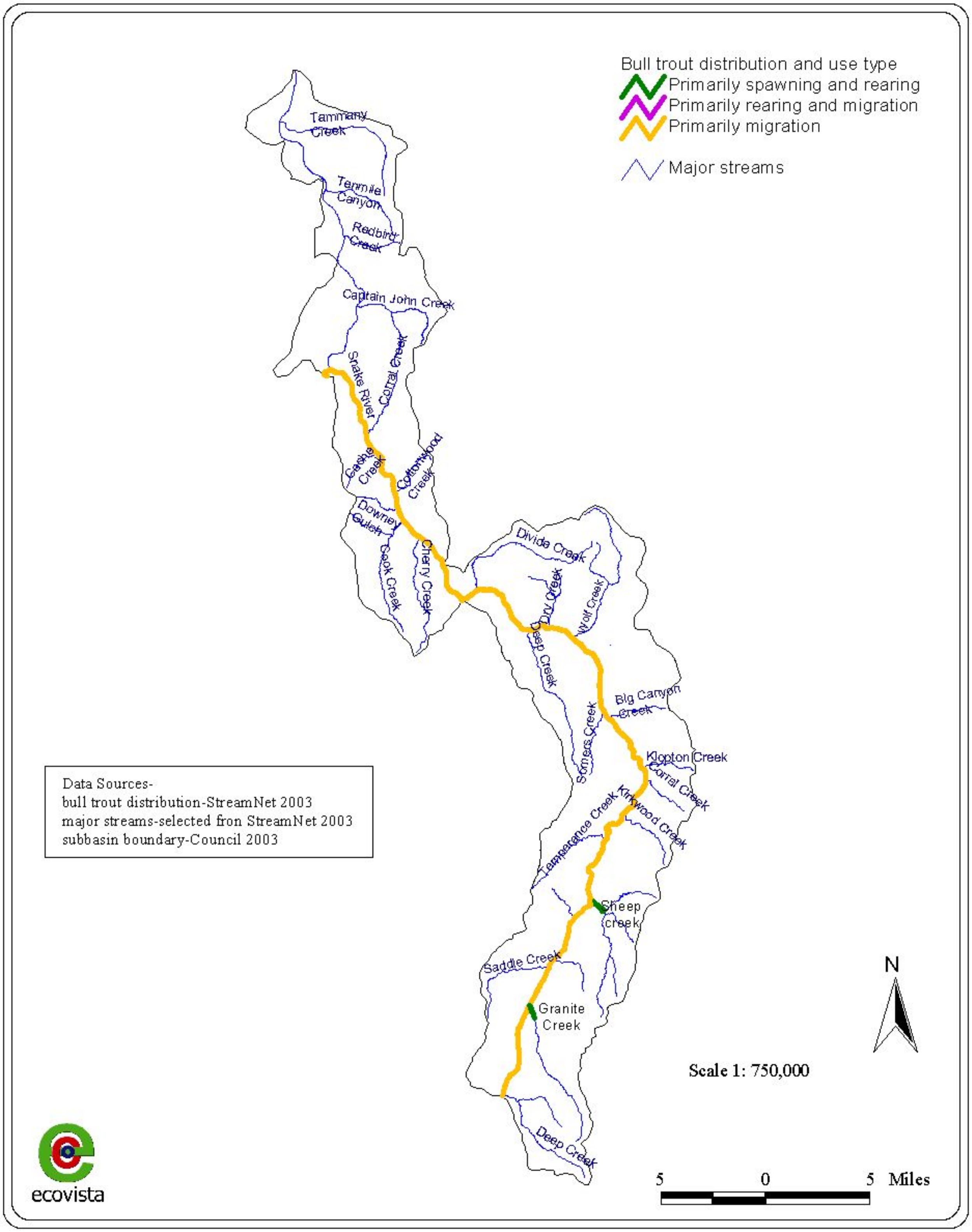

Figure 41. Bull trout distribution in the Snake Hells Canyon subbasin.

Population Data and Status

Abundance and Trends

Historical abundance and trend data are scarce because bull trout were considered a nuisance fish (IDEQ 1998). Bull trout are also difficult to detect during surveys because they hide and tend to be nocturnal. Therefore, they are often missed or underestimated during electrofishing and daytime snorkel surveys (IDEQ 1998). That fluvial bull trout may occupy a portion of a stream for only a limited amount of time further limits survey and abundance measures.

The lack of information regarding migratory phases of bull trout has led to the misidentification of fluvial fish as resident fish (Hemmingsen et al. 2001a). Management implications resulting from this confusion may underestimate the importance of maintaining migratory habitat crucial for connectivity among various populations. To address these management issues, new efforts are currently underway. The ODFW has initiated studies to determine the distribution of juvenile and adult bull trout and their respective habitats; the agency is also studying fluvial and resident life history patterns. While results are still preliminary, ODFW has documented radio-tagged Grande Ronde fish in the Snake River as far downstream as RM 146, just upstream of Asotin, Washington (e.g., Hemmingsen et al. 2001a,b), although documenting the extent and duration of their residence in the mainstem currently represents a research need (M. Hanson, ODFW, personal communication, April 19, 2001). In the lower reaches of the Imnaha River, large migrant-sized bull trout are incidentally caught by steelhead anglers each year, and ODFW believes that these fish are migrants that use the Snake River seasonally (B. Knox, ODFW, personal communication, 2000). Fluvial bull trout are occasionally captured at the IDFG smolt trap near Lewiston, but the catch rates have been no more than one bull trout annually. Bull trout are also often caught in the steelhead fishery during the winter from the mouth of the Grande Ronde River to Asotin (G. Mendel, WDFW, personal communication, May 2001), as well as in upriver reaches (Tim Johnson, fishing guide, personal communication, February 2004).

Above the Salmon River confluence, the only known tributaries containing spawning and rearing bull trout are Sheep and Granite creeks (Buchanan et al. 1997, IDEQ 1998, BLM 2000a). Data are lacking for population size, movement, and/or life histories of bull trout using this portion of the subbasin. Important watersheds that produce forage fish for bull trout (i.e., rainbow trout/steelhead) in the upper subbasin include Divide, Getta, and Kirkwood creeks (IDEQ 1998). Similar watersheds occurring in Oregon include Saddle and Temperance creeks (IDEQ 1998). Other Snake River tributaries also produce forage fish; however, small size, low flows, steep gradient, and fish passage barriers limit anadromous production.

Below the Salmon River confluence, the only known tributaries providing spawning and early rearing of bull trout are the Grande Ronde River and Asotin Creek in Washington (Figure 41) (IDEQ 1998, BLM 2000b; see also Johnson et al. 2001, Nowak 2001), neither of which lies within the Snake Hells Canyon subbasin. Various Snake River tributaries also produce forage fish for bull trout, but small size, low flows, steep gradient, and fish passage barriers often limit production. Captain John Creek in Idaho and Asotin Creek are considered the greatest tributary producers of forage fish in the lower subbasin (IDEQ 1998).

Productivity

No productivity information is available for bull trout in the Snake Hells Canyon subbasin.

Life History Diversity

Data specific to the Snake Hells Canyon subbasin on population size, movement, and/or life histories of bull trout are not available.

Carrying Capacity

No information is available regarding bull trout carrying capacity within the Snake Hells Canyon subbasin.

Unique Population Units

All bull trout found within the Snake Hells Canyon subbasin are considered part of Bull Trout Recovery Unit 11 (Imnaha–Snake River basins), as defined by the USFWS (2002c). Several subpopulations of bull trout occur upstream of the reservoir influence of Lower Granite Dam, and migrants from these groups can move freely to and from Lower Granite Reservoir. These groups include fish from Asotin Creek and the Grande Ronde, Imnaha, and Salmon rivers. The USFWS (2002c) has found little evidence to suggest that these populations use habitat associated with the federal Columbia River hydropower system in the Lower Snake River.

Genetic Integrity

No information is available regarding genetic integrity of bull trout within the Snake Hells Canyon subbasin.

Harvest

No consumptive (catch-and-keep) sport fishery exists for bull trout within the Snake Hells Canyon subbasin. Nor is information available regarding tribal or incidental harvest of bull trout within the subbasin.

Habitat Condition

The quality of available bull trout habitat in the Snake Hells Canyon subbasin is variable. Bull trout use mainstem Snake River habitat for migration and subadult foraging and rearing life history phases (year-long). The water quality of the mainstem Snake River within the subbasin is generally excellent and fully supports all beneficial uses identified for the river (recreation, primary and secondary contact recreation, salmonid spawning, domestic water supply, agricultural water supply, and cold water biota; IDEQ 1998). Elevated summer water temperatures are not optimum for salmonid rearing, and high sediment concentrations occur during high-flow events (IDEQ 1998). The potential exists for fluvial bull trout populations from the Grande Ronde, Imnaha, and Salmon rivers to use the mainstem Snake River.

Habitat quality for bull trout in tributaries feeding the Snake River below the Salmon River confluence is considered marginal (BLM 2000b). Low flows, elevated levels of deposited sediment, high summer water temperatures, poor instream cover, and low numbers of high-quality pools limit potentially usable bull trout habitat (BLM 2000b). The only tributary containing habitat that supports bull trout spawning and early rearing in the lower Hells Canyon Snake is Asotin Creek (see Johnson et al. 2001).

Granite and Sheep creeks are the only tributary streams occurring above the Salmon River that provide spawning and early rearing habitat for bull trout (BLM 2000a). Both tributaries are proposed as critical habitat in the USFWS bull trout recovery plan (USFWS 2000b). Because both are fourth-order drainages that occur within the Hells Canyon Wilderness, they have a proportionate amount of undisturbed habitat. Granite Creek flows into the Snake River at RM 239.7, while Sheep Creek enters the Snake River at RM 229.4. Granite Creek contains approximately 7 miles of stream used by fluvial bull trout, while Sheep Creek contains approximately 6 miles (IDEQ 1998). No documentation of a resident bull trout population exists for either creek. Habitat in the two streams supports spring/summer chinook salmon, rainbow/steelhead trout, cutthroat trout, and bull trout. No brook trout occur in either drainage. Past monitoring efforts by IDFG have documented relatively low bull trout numbers within the monitored stream segments. During 1998, no bull trout were observed at the trend monitoring stations (IDEQ 1998).

3.4.7 Redband Trout

Distribution

Although redband trout likely existed historically throughout the Snake Hells Canyon subbasin (Quigley and Arbelbide 1997), little is known about the current distribution or status of redband trout populations in the subbasin. One reason for the lack of information is the inability to differentiate juvenile steelhead and resident redband trout phenotypically. In addition, coexistence of the two subspecies throughout much of the occupied habitat in the Snake Hells Canyon subbasin complicates efforts to gather information on redband trout population(s).

Currently, redband trout likely inhabit all of the tributary systems inhabited by steelhead (see Figure 37 and the accompanying textual description of steelhead distribution). Redband trout are commonly more widely distributed than steelhead are within tributary habitats, often occurring in reaches upstream of current steelhead passage barriers.

Population Data and Status

Abundance and Trends

Redband trout are considered a species of special concern by the American Fisheries Society and the state of Idaho and classified as a sensitive species by the USFS and BLM (Quigley and Arbelbide 1997), suggesting their potentially limited or declining abundance. However, no information is available regarding the numerical abundance or trends of redband trout within the Snake Hells Canyon subbasin.

Productivity

No information is available regarding productivity of redband trout within the Snake Hells Canyon subbasin.

Life History Diversity

Redband trout are thought to represent the resident form of steelhead trout in areas where they coexist (or coexisted historically), although the subspecies also exists in areas outside the historic range of steelhead trout (Behnke 1992). Sympatric fish with resident and anadromous life histories form different breeding populations due to assortative mating (they prefer mates with a life history similar to their own), but the populations are not completely reproductively isolated from each other (Currens 1987).

Long-standing natural barriers do exist in some Hells Canyon tributaries (e.g., waterfalls in Cherry, Cook, and McGraw creeks) above which redband trout populations exist in isolation from steelhead populations (ODFW 1995). However, throughout much of the Snake Hells Canyon subbasin, redband trout likely coexisted with steelhead at some point. Current steelhead migration barriers in many tributaries are often "temporary" in nature, being deposited, removed, and/or redeposited by major flood events on a semiregular interval (e.g.,10–20 years; Ed Schriever, IDFG, personal communication, December 2003).

Carrying Capacity

No information is available regarding carrying capacity of redband trout within the Snake Hells Canyon subbasin.

Unique Population Units

Descriptions of population units for redband trout were located only for those areas of the subbasin within Oregon (ODFW 1995). It is unclear whether any other unique population units do or may exist within the portions of the subbasin contained in Idaho or Washington. The ODFW (1995) indicates the presence of at least two unique population units of redband trout contained wholly or partially within the Snake Hells Canyon subbasin:

> **Lower Snake River from Hells Canyon Dam to the Oregon–Washington Border:** This group includes summer steelhead and redband trout in the Snake, Grande Ronde, and Imnaha rivers. Systematic comparisons between this group and other Oregon populations outside the study area have not been made. Allozyme data indicate that the populations in these basins differ from those in the Yakima River and above the Hells Canyon Complex (Waples et al. 1991; Currens 1988, 1990, 1991, 1992, all cited in ODFW 1995). The groups are definitely reproductively isolated from Columbia River populations in Oregon, although intermediate populations extend down the Snake River in Washington.
>
> **McGraw Creek:** This group consists of a unique redband trout population isolated above a high waterfall on lower McGraw Creek. This creek is a direct tributary of the Snake River to the Hells Canyon Reservoir. The population does not appear to be closely related to any other Snake River *O. mykiss*. It is unique in both allozyme and meristic characteristics and may comprise its own subspecies (Currens 1991, cited in ODFW 1995).

Genetic Integrity

Hybridization of redband trout and stocked rainbow trout is common (Quigley and Arbelbide 1997) and often leads to questions over the genetic integrity of existing redband trout population(s). However, with the exception of limited information regarding genetics of redband trout in the Oregon portions of the subbasin (see prior information on unique population units), no information is available regarding the genetic makeup or integrity of redband trout within the Snake Hells Canyon subbasin.

Harvest

No information is available regarding current or historic harvest of redband trout within the Snake Hells Canyon subbasin.

Habitat Condition

No information regarding habitat conditions specific to redband trout was located for areas within the Snake Hells Canyon subbasin. According to ODFW (1995), habitat problems affecting most redband trout populations include irrigation diversions and cattle grazing. These activities modify river channels; remove riparian vegetation; block migration corridors; decrease summer flows, occasionally to complete dewatering; and increase summer water temperatures. Many populations have retreated to headwater areas as a result of these activities, causing extensive population fragmentation and declines in numbers. Other general habitat conditions and constraints are probably most similar to those previously described for steelhead (see section 3.4.3).

3.4.8 White Sturgeon

Distribution

White sturgeon were once widely distributed in the Columbia River basin. Habitat degradation, loss of prey resources, and loss of connectivity between populations has reduced the Columbia River basin population to a fraction of historical estimates. Within the Snake Hells Canyon subbasin, white sturgeon are currently found only in the mainstem Snake River, a distribution likely unchanged from historical conditions despite their reduced abundance.

Population Data and Status

Abundance and Trends

Snake River white sturgeon are listed as sensitive species by the BLM and USFS and as a species of special concern by the state of Idaho. Currently, Snake River white sturgeon are not listed or proposed for listing under the ESA. However, the USFWS lists the Kootenai River (Idaho, Montana, and British Columbia) white sturgeon population as endangered.

Population status information has been collected in various segments of the Snake River between Lower Granite and Hells Canyon dams since 1970 (Table 26). Currently, white sturgeon populations in the subbasin are considered viable (USFS 1999). Population estimates were 10,000 fish in 1977 (Coon et al. 1977), 4,000 fish in 1985 (Lukens 1985), 3,800 fish in 2000 (Tuell and Everett 2001), and 3,625 fish in 2002 (IDFG 2003c).

Table 26. Population abundance estimates reported for white sturgeon between Lower Granite Dam (Rkm 108) and Hells Canyon Dam (Rkm 398).

Location	Abundance (estimator)	Sample Year(s)	Author
Lower Granite Dam site to Hells Canyon Dam (Rkm 174–398)	8,000–12,000 (Schnabel)	1972–1975	Coon et al. 1977
Clearwater River to Hells Canyon Dam (Rkm 224–398)	3,955 (Schnabel)	1982–1984	Lukens 1985
Lower Granite Reservoir (Rkm 174–240)	1,372 (Jolly-Seber) 1,524 (Schnabel)	1990–1991	Lepla 1994
Lower Granite Reservoir (Rkm 174–240)	1,804 (Schnabel)	1992	Bennett et al. 1993
Salmon River to below Hells Canyon Dam (Rkm 303–383)	1,312 (Schnabel) 1,600 (Jolly-Seber)	1997–2000	Lepla et al. 2001
Lower Granite Dam to Salmon River (Rkm 174–303)	2,544 (Schnabel) 1,823 (Jolly-Seber)	1997–1999	Heofs 1997, 1998 Tuell and Everett 2000, 2001

White sturgeon less than 92 cm total length comprised 86% of the population between 1972 and 1975and 80% of the population between 1982 and 1984. In addition, the proportion of white sturgeon between 92 and 183 cm, which were heavily harvested until 1970, comprised 4 and 18% of the populations sampled in the 1970s and 1980s, respectively (Figure 42) (Coon et al. 1977, Lukens 1985). In contrast, of the white sturgeon collected during the 1997–1999 period, only 57% were less than 92 cm, while 30% ranged between 92 and 183 cm (Tuell and Everett 2001).

The Hells Canyon reach along the Oregon–Idaho border contains the highest densities of Snake River white sturgeon (BLM 2000b). Key habitats are generally associated with the deep holes occurring between Hells Canyon and Lower Granite dams. Relative distribution of fish from Lower Granite Dam to the mouth of the Salmon River is shown in Figure 43 (Tuell and Everett 2001).

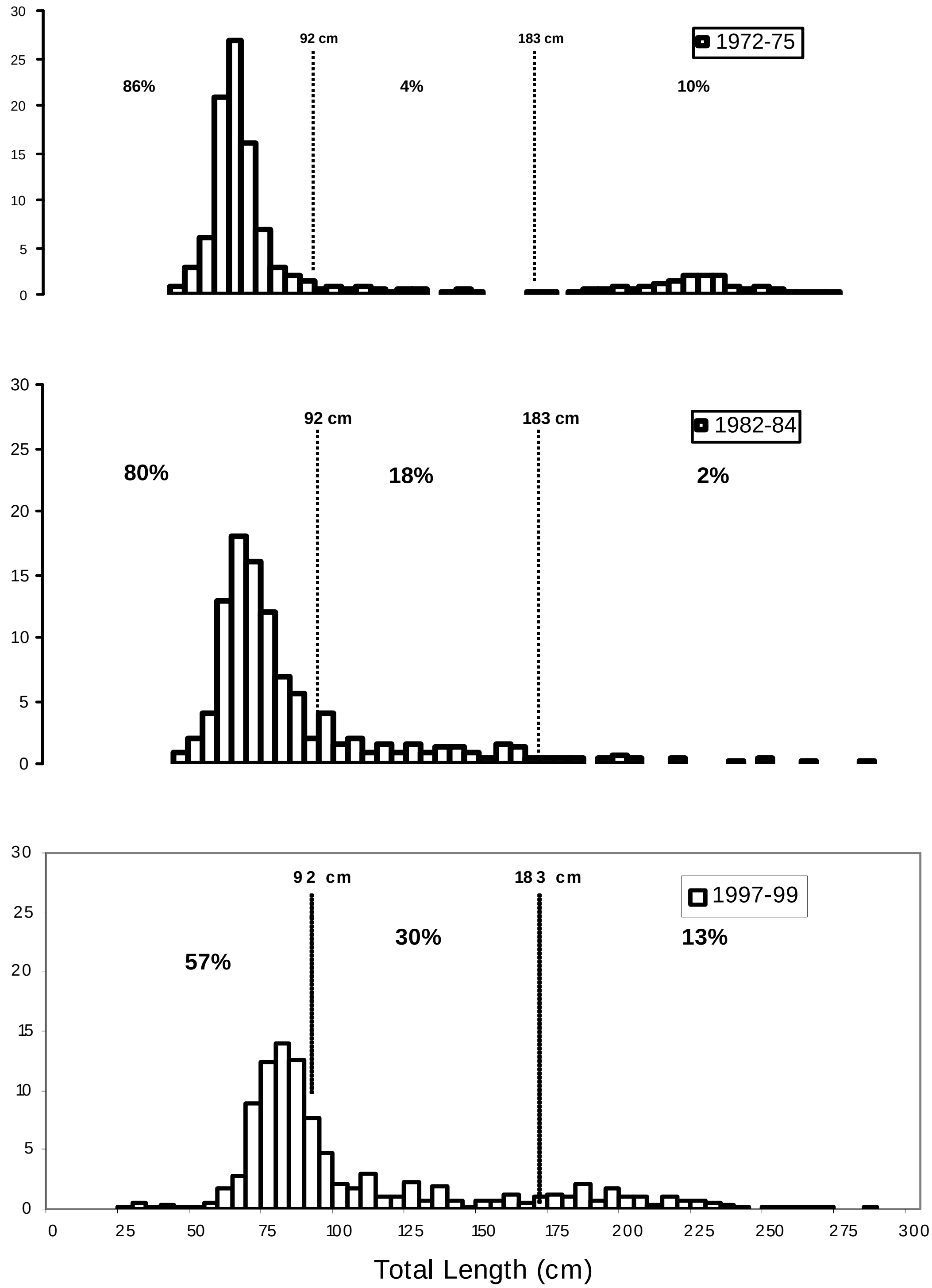

Figure 42. The length (total length) frequency distributions of sturgeon sampled from the Hells Canyon reaches of the Snake River, 1997–1999 (Tuell and Everett 2001), 1982–1984 (Lukens 1985), and 1972–1975 (Coon et al. 1977) and the percentage of the populations less than 92 cm, between 92 and 183 cm, and greater than 183 cm.

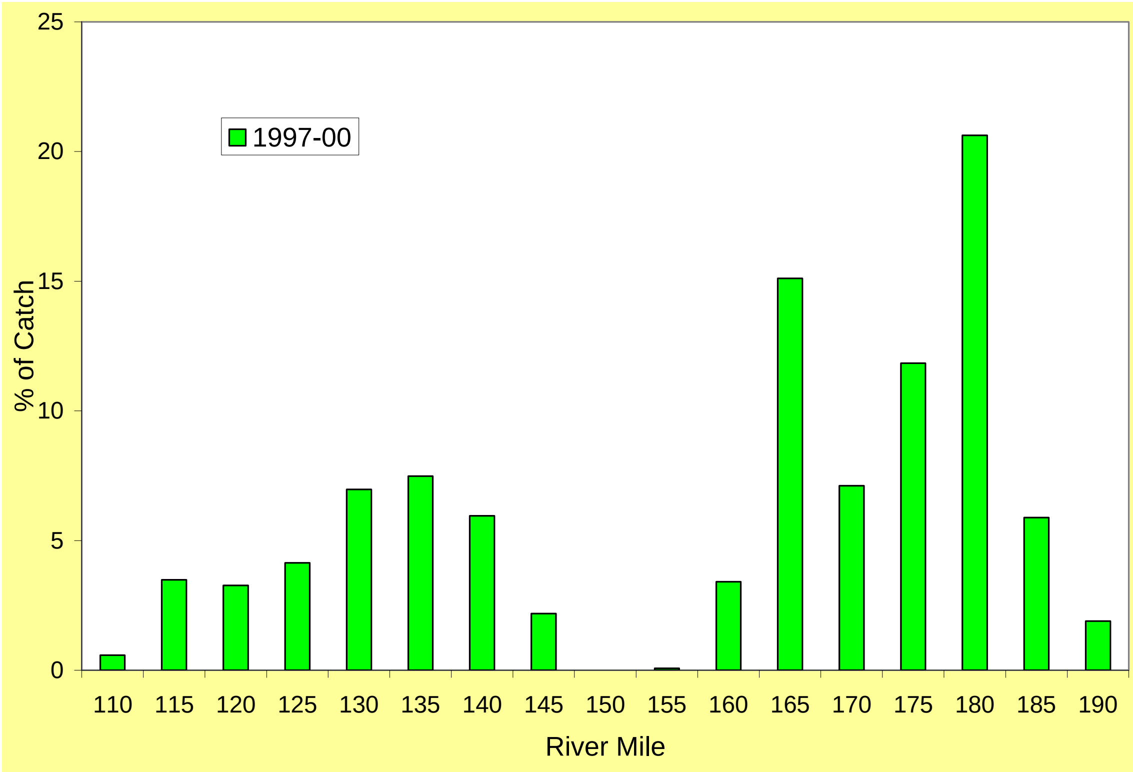

Figure 43. Relative distribution of white sturgeon between Lower Granite Dam and the confluence of the Salmon River (1997–2000) (J. Hesse, Nez Perce Tribe, personal communication, May 2001).

Productivity

No information is available regarding productivity of white sturgeon within the Snake Hells Canyon subbasin.

Life History Diversity

The following information is summarized from the Interior Columbia Basin aquatic component report (Quigley and Arbelbide 1997). The white sturgeon becomes sexually mature at 10 to 15 years, and spawning intervals may be 4 to 11 years. The fish spawns during May and June in rocky bottoms near rapids and lays up to two million eggs. A fish at one year is 9 inches in length; at 5 years, 20 inches in length; at 15 years, 40 inches in length (15 to 20 pounds); and at 25 to 60 years, 6 to 9 feet in length. Females grow faster than males, particularly in weight, after 14 years. The Idaho record for a white sturgeon is 1,500 pounds, caught on a set line in the Snake River in 1898. The rod-and-reel record is 394 pounds, caught in the Snake River in 1956.

The white sturgeon is a bottom feeder that feeds on almost anything, dead or alive. Young feed largely on larval forms of aquatic insects, crustaceans, and mollusks. Fish form a high percentage of the diet of larger sturgeon. The sturgeon spends a large percentage of time in deep pools with poor light. “Sturgeon holes” often range from 30 to 100 feet in depth. Because of poor light conditions, the sturgeon utilizes four barbels on the snout for touching and smelling.

Substrate size and water velocity influence selection of spawning areas by white sturgeon. Spawning generally occurs in water over 3 m in depth and over cobble substrate. In the Columbia River system, reproduction has been greater during years of high flows than in years of low flow (Hanson et al. 1992). Adults and juveniles prefer deep pool habitat with a fine bottom substrate. Adults tend to move downstream in the summer and fall months and upstream in the winter and spring months. Fish tend to stay in shallower water during the spring and summer and move to deeper waters during the winter.

Carrying Capacity

No information is available regarding the carrying capacity of white sturgeon within the Snake Hells Canyon subbasin.

Unique Population Units

Brannon et al. (1988) and Setter and Brannon (1992) compiled information on genetic similarity of white sturgeon throughout the Columbia River system, including the Snake River. Reports by those authors concluded that some differences exist between white sturgeon of the Columbia, Snake, and Kootenai rivers, but there is not enough genetic distance to base a strong argument for consideration as separate stocks.

However, white sturgeon between Hells Canyon and Lower Granite dams are isolated from other population areas due to lack of adequate passage at both upstream and downstream dams. Although there has been documentation of downstream movement past dams, there are no suitable fish passage structures on Snake River dams to allow upstream passage. Movement downstream can be hazardous: white sturgeon must either move past a dam over a spillway during high flows or through the turbine units. The inability of white sturgeon to move freely past dams has created unbalanced population structures in most areas where they exist within the Snake River basin (IDFG 2003c).

Genetic Integrity

No information is available specifically regarding the genetic makeup or integrity of white sturgeon within the Snake Hells Canyon subbasin. Data gathered by Brannon et al. (1988) and Setter and Brannon (1992), although adequate for general comparison of areas throughout the Columbia River basin, are not adequate to characterize the genetic integrity of white sturgeon within the Snake Hells Canyon subbasin.

Harvest

Traditionally, the Nez Perce people harvested white sturgeon in the Snake River for subsistence purposes, although numerical characterization of that harvest is unavailable. The Nez Perce Tribe practices subsistence and ceremonial take of white sturgeon in the Snake River below Hells Canyon Dam, removing an unknown number of spawning-sized individual sturgeon annually (IDFG 2003c).

Sport harvest occurred prior to 1970, but a catch-and-release fishery has been implemented since then. Limited catch statistics indicate variability in numbers and size of white sturgeon collected by both year and river reach (Table 27).

Table 27. White sturgeon catch from the Snake Hells Canyon subbasin by reach and length code for 1989–1991 from sturgeon permit data (IDFG unpublished data).

	<3 feet in length			3–6 feet in length			>6 feet in length			Total—all lengths		
	'89	'90	'91	'89	'90	'91	'89	'90	'91	'89	'90	'91
Below Salmon R. Confluence	81	33	165	26	48	98	15	41	57	122	122	320
Above Salmon R. Confluence	30	48	86	76	138	183	92	138	133	198	324	402

Although the current fishery is catch-and-release only for white sturgeon, harvest impacts may still influence the population. IDFG (2003c) provides the following characterization of the potential impacts of the existing catch-and-release fishery on white sturgeon

> Even with sport catch and release regulations, the biological aspects of repeated catch-and-release angling is largely unknown for white sturgeon. Booth et al. (1995) indicates that angling can be one of the most severe forms of exhaustive exercise that fish experiences. Several studies on different species of fish have shown that exhaustive exercise, including angling results in a variety of severe physiological disturbances that altered reproductive performance and delayed mortality (Nelson 1998, Lambert and Dutil 2000, Schreer et al. 2001). IPC (Ken Lepla, IPC, personal communication) documented hooking mortality on white sturgeon below C.J. Strike Dam in July 2001. Necropsy of two white sturgeon revealed the presence of 3- 20 angler hooks in the digestive tract, several of which punctured the esophagus and intestinal tracts. Delayed hooking mortality and illegal harvest are two unknown but potential sources of mortality on white sturgeon populations. The increasing demand placed on white sturgeon population can only exacerbate impacts on stability or restoration of populations in all sections of the Snake River. Future investigations on white sturgeon populations in the Idaho's Snake River must include the extent of sport angler usage as well as an assessment of hooking mortality.

Habitat Condition

Development of the Columbia River basin hydropower system has created impoundments that have altered the habitat and movement of white sturgeon and their principal food resources in the lower Snake River between Hells Canyon and Lower Granite dams. The upstream and downstream dams have considerable influence over the nature of sturgeon habitat. The upstream reservoirs have shifted the timing, natural flow patterns, and temperature regimes of the Snake River below the Hells Canyon Complex (Coon 1978). Flows have been increased through the fall, winter, and early spring to meet power demands, effectively emptying the reservoirs prior to spring runoff. Spring peaks have been reduced and spread out over a longer duration. These changes may decrease quality spawning and incubation habitat (BLM 2000b). Bedload, suspended solids, and nutrients are trapped behind upstream impoundments, creating a deficit to downstream reaches. Overall, however, the condition of sturgeon spawning and rearing habitat is considered to be good (Saul et al. 2001).

3.5 Terrestrial Focal Species Population Delineation and Characterization

As discussed in section 0, terrestrial focal species were selected for the Snake Hells Canyon subbasin primarily because they were good indicators of broader habitat conditions. For this reason, the following information is organized by the WHT for which the species was selected to represent. The descriptions of terrestrial focal species biology, habitat use, and population trends are intended to be illustrative of the importance of the habitat type for wildlife in the subbasin and the factors that may be influencing the quality of that habitat for the native wildlife of the subbasin.

3.5.1 Alpine Grasslands and Shrublands

Mountain Goat

Mountain goats (*Oreamnos americanus*) inhabit subalpine or alpine mountain zones (Christensen 2001). Good goat habitat is dominated by cliffs or extremely steep rocky slopes. The cliffs and rock outcrops provide security, cover, and shelter from extreme weather. Interspersed with the rocks are areas of high-quality forage (ODFW 2003d). Adept at surviving on a variety of plants, mountain goats have been documented eating grasses, forbs, sedges, mosses, lichens, shrubs, and conifer trees (Christensen 2001). Food preferences and forage areas tend to shift seasonally. Grasses are preferred in most areas and used year-round if available. Shrubs and conifers become more prominent in the mountain goat diet in the winter when grasses are less available. South- to west-facing slopes limit snow depth and provide the greatest food availability during winter, while north- and east-facing slopes often have greater snow accumulations that lead to better summer forage (ODFW 2003d). Reasons for the selection of mountain goats as a focal species for this assessment include economic and cultural importance, potential vulnerability to human influenced changes in vegetative community, vulnerability to human disturbance, and a demonstrated vulnerability to extirpation.

IPC contracted with the Rocky Mountain Elk Foundation to conduct an assessment of big game habitat in the company's area of operations. One of the subareas included in the study, the "Hells Canyon subarea," roughly corresponds with the boundaries of the Snake Hells Canyon subbasin. However, it includes the area around Brownlee Reservoir but excludes the lower subbasin downstream of the Washington state line. As part of this effort, panels of local big game experts identified areas of important big game habitat. More than 49,000 acres of currently utilized mountain goat habitat and almost 99,000 acres of potential mountain goat habitat were delineated in the Hells Canyon subarea. Habitat succession and maturation and dispersed recreation were the factors identified as most limiting the effectiveness of habitat in the area to support mountain goats (Christensen 2001).

The historical distribution of mountain goats in Oregon is debated. Some documents indicate that mountain goats are not native to Oregon and result from introductions (Verts and Carraway 1998, Johnson and O'Neil 2001). However, a review of literature documenting archaeological evidence of the species' presence, accounts of observations in the journals of Oregon's early explorers, and early scientific accounts and descriptions of the species led the ODFW to conclude that mountain goats were part of Oregon's native wild fauna until or just prior to the time of European settlement (ODFW 2003d).

Mountain goats are native to Idaho, and published archaeological investigations document their historical presence on the Idaho side of Hells Canyon (Verts and Carraway 1998). Unregulated hunting in the late 1800s and early 1900s resulted in major population declines. By the mid-1900s, it is estimated that there were less than 3,000 mountain goats in Idaho. Remnant populations were centered in the mountains of central Idaho. Mountain goats were extirpated from the Hells Canyon area by the 1930s (Edelmann and Rocklage 2001).

Two distinct populations of mountain goats currently occupy the subbasin: one in the Seven Devils Mountains of Idaho and the other near Sluice Creek in Oregon. The Idaho population was formed through translocation in 1962 and supplemented in 1964. The Oregon population was formed through translocation in 2000 (Edelmann and Rocklage 2001).

In April 1996, IPC and the IDFG conducted a helicopter census of the Seven Devils mountain goat population. At this time of year, goats are often observed at lower elevations where green forage becomes available earliest. Observers counted 117 goats in April 1996. Nine of these goats were goats observed above Hells Canyon Dam in the Middle Snake subbasin. Goats observed in the subbasin occurred at an average elevation of 1,410 feet above the Snake River (Edelmann and Rocklage 2001).

Population trends were difficult to assess because previous surveys were conducted over slightly different areas or during different seasons of the year. However, the comparisons that could be made indicate a 15% population decline between 1993 and 1996 and a decline in the kid:adult ratios. Due to the low initial population size and low reproductive potential of mountain goat, this population decline is of significant concern, but additional surveys are needed to verify the decline. The current management goal of the IDFG is to maintain the Seven Devils population above 90 goats (Edelmann and Rocklage 2001).

Possible reasons for the declines in population of the Seven Devils herd include natural environmental stochasticity, changes in vegetation from the 1994 Granite Creek fire, and increased predator populations. The Seven Devils mountain goat population has been hunted each year since 1983, with harvest levels averaging between three and four goats a year. This level of harvest is unlikely to have played a causal role in reducing the mountain goat population. However, little is known about the effects of harvest on mountain goat population stability, and Hayden (1990) considered that investigating population responses to harvest is the most important research topic regarding mountain goats (Edelmann and Rocklage 2001).

In 2000, 3 male and 13 female mountain goats were released into the Oregon portion of the Snake Hells Canyon subbasin near Sluice Creek. Ongoing monitoring of the population indicates that reproduction has been good and the 2002 population estimate was 30 animals. Hells Canyon could potentially support a population of 200 goats (ODFW 2003d).

3.5.2 Eastside Grasslands

Rocky Mountain Bighorn Sheep (Ovis canadensis canadensis)

Introduction

The Rocky Mountain bighorn sheep (*Ovis canadensis*), classified as a game animal in Idaho, Oregon, and Washington, is under the administrative management of the IDFG, ODFW, and WDFW, respectively. Sportsmen consider it a premier game species, but hunting opportunities are limited due to low population numbers. Once common in many parts of the basin, bighorn sheep were extirpated throughout the Northwest earlier in the twentieth century due to overharvest, disease, and habitat loss. Reintroduction efforts have brought bighorns back to the Columbia Basin, but many populations remain small and isolated. The Rocky Mountain Bighorn sheep was selected as a focal species for this assessment due to its sensitivity to changes in grassland habitat composition and structure, its cultural and economic importance and the management challenges associated with protecting bighorn sheep populations from disease.

Diet

Bighorn sheep are opportunistic foragers that utilize whatever plant species are available to them (Todd 1972). The primary component of bighorn sheep diet is grasses, although forbs and shrubs may contribute significantly to the diet in some regions or seasons (Shackleton et al. 1999). Bluebunch wheatgrass (*Pseudoregneria spicatum*), Idaho fescue (*Festuca ovina* var. *ingrata*), basin wild rye (*Elymus cinereus*), and various bluegrass (*Poa* spp.) and brome (*Bromus* spp.) species comprise the majority of grasses consumed by bighorns in the Columbia Basin.

Diet varies seasonally (Shackleton et al. 1999 and references therein) and among individuals (Hickey 1975) and sex classes (Shank 1982). Shank (1982) attributed the variation in diets between ewes/lambs and adult males to the different availability of plant species on the geographically segregated ranges of the two groups.

Reproduction

Female bighorn sheep reach sexual maturity at approximately 2.5 years of age although, in some cases, females can mate as young as 1.5 years and give birth as two year olds (Van Dyke 1978). Females are iteroparous, usually producing a single lamb (sometimes twins) yearly until they die or become too old to breed. Males do not reach sexual maturity until about seven or eight years old (Geist 1971). Once rams reach sexual maturity, they may actively breed ewes for only a few years. During that time, they may sire many offspring (Shackleton et al. 1999). Bighorns are polygamous, with a few dominant rams performing most of the breeding (ODFW 2003d).

Mating occurs during the fall rut, which typically lasts from two to three weeks. Timing of the rut varies geographically. The gestation period for Rocky Mountain bighorns has been estimated at 173 to 176 days (Geist 1971, Blunt et al. 1972, Whitehead and McEwan 1980). Birth occurs in the spring during periods of high forage availability and, as a result, varies considerably across the geographic range of the species. In Oregon, lambing generally occurs during April and May (ODFW 2003d) in steep, rocky terrain where ewes can give birth in seclusion. Shackleton et al. (1999:122) attribute three primary functions to the isolation and ruggedness of lambing sites: 1) a relatively predator-proof habitat, 2) shelter from inclement weather, and 3) isolation required for the development of the mother–young bond.

Mortality

Mortality factors vary by life stage. Young sheep may experience high rates of mortality during their first year of life. Date of birth and birth weight both contribute indirectly to early mortality rates (Geist 1971, Hass 1989). Lambs with low birth weight may be more susceptible to disease, predation, or hypothermia during severe weather events. A study by Festa-Bianchet (1988) found that lambs born late in the season may miss the period of peak forage nutrition for lactating females and therefore be more likely to die from inadequate nutrition.

Disease is a significant mortality factor for young bighorn sheep. Pneumonia caused by *Pasteurella* has been a contributing factor in low lamb survival in several local populations throughout Oregon, Washington, and Idaho (Coggins 1988, Akeson and Akeson 1992, Cassirer et al. 1996). Lungworms (*Protostrongylus*) have also been implicated in lamb mortalities at Hart Mountain, Oregon (Cottam 1985).

Predation by coyote, cougar, and bobcat and incidentally by wolverine and black bear can all contribute to lamb mortality (Shackleton 1985). Coyotes in particular have been shown to have significant impacts to lamb survival in some populations (Hebert and Harrison 1988, Hass 1989). The susceptibility of lambs to predators may be related to the availability and quality of escape/security cover (Shackleton et al. 1999).

The primary adult mortality factors are disease and predation. Recurrent infestations of lungworm, scabes (*Psoroptes ovis*), and *Pasteurella* can have significant impacts to small, localized herds. Cassirer et al. (1996) documented the loss of 50 to 75% of the bighorns in four of ten herds in the Hells Canyon ecosystem of Oregon and Washington following a *Pasteurella* outbreak in 1995. A more thorough discussion of the role of *Pasteurella* in bighorn sheep recovery is provided in the section about disease below.

Cougar and humans appear to be the principal large predator of adult bighorns. In small populations or those being newly established through transplants, predation can be a significant factor in success and establishment of populations. In one case, four transplants into Hells Canyon involving 53 sheep experienced a loss of 11% of the transplanted individuals from cougar kills and human-caused mortalities, including an animal attempting to cross a highway (Coggins et al. 2000). Since sheep were reintroduced to Hells Canyon, harvest has been strictly targeted on rams. Human hunters (both legal and poachers) disproportionately select for mature, breeding-age rams.

Habitat Requirements

Bighorn sheep habitat consists of steep, rocky, open terrain with abundant bunchgrasses. Vegetative structure is important to bighorns since they require long sight distances to detect and avoid predators. As a result, bighorn tend to avoid dense forests (USDA 2003a). Gregarious and extremely loyal to their home range, bighorns typically inhabit river canyons, talus slopes, cliffs, open meadows, and clearcut or burned forests. The use of each habitat type varies seasonally and with requirements such as breeding, lambing, and thermal cover (Valdez and Krausman 1999).

Habitat use also varies by sex, with mature males occupying separate ranges from females, lambs, and immature rams. Males tend to inhabit areas of higher forage quality but greater predation risk, while maternal groups select habitat with greater security cover, even if this choice results in poorer forage quality or availability (Shackleton et al. 1999).

Elevational migrations are common, and bighorns will follow the wave of new vegetation upward in the spring. Preferred climate is relatively warm and arid with cold, dry winters. Low annual snowfall is important for lamb survival. Bighorn sheep require 4 to 5% of their body weight in water each day, but they may be able to get sufficient water from succulent plants in the spring and snow in the winter so as not to be limited by standing water sources (Valdez and Krausman 1999).

Bighorn Sheep Population and Distribution

Historic Population

Humans and mountain sheep have coexisted in North America for more than 30,000 years. Bighorn sheep were historically widespread throughout the drier, nonforested regions of western North America. Nowak (1991) estimated that 1.5 to 2 million individual *Ovis canadensis* may have inhabited North America prior to their decline in the nineteenth century. Bighorns were an important historical resource for Native Americans. Horns and bones were used to make tools and ornaments, hides were used for clothing, and the meat was an important protein source (Valdez and Krausman 1999). Reports by early explorers, trappers, and settlers suggest that, at one time, bighorn sheep were one of the most abundant large animals in Idaho. They were also especially abundant in Hells Canyon and the Wallowa Mountains of Oregon (ODFW 2003d).

Overgrazing by cattle and sheep, disease, and uncontrolled hunting greatly reduced and often extirpated populations. Bighorn populations have increased since the 1900s due to a series of reintroductions, but much of their previous range is still unoccupied (Wisdom et al. 2000). Transplanting is necessary to stimulate new populations in unoccupied habitats because bighorn are extremely loyal to their territories and will not readily move into new ranges (Parker 1985).

Current Population

There are currently four extant Rocky Mountain bighorn sheep herds within the Blue Mountains of southeast Washington: Asotin Creek, Black Butte, Wenaha, and Mountain View (Fowler 1999). An additional 11 herds occur in northeastern Oregon, and four herds are found within the Idaho portion of Hells Canyon (Table 28). All of these herds comprise and contribute to bighorn populations of the Snake Hells Canyon subbasin.

Table 28. Bighorn sheep population status within or adjacent to the Snake Hells Canyon subbasin in Idaho, Oregon, and adjacent southeastern Washington (IDFG 2002, ODFW 2003d, WDFW 2003c, Hells Canyon Initiative 2004).

Herd	# Releases (# animals)	2002-3 Pop. Estimate	Current Status
Asotin Creek, WA	3 (25)	45[a]	Increasing
Bear-Minam, OR	4 (48)	35	Static

Herd	# Releases (# animals)	2002-3 Pop. Estimate	Current Status
Big Canyon, ID	2 (22)	21	Declining
Black Butte, WA	No Data	80	Unknown
Lostine, OR	1 (20)	80	Increasing
Lower Hells Canyon, OR	3 (45)	35	Increasing
Lower Imnaha, OR	3 (36)	165	Increasing
Mountain View, OR/WA	No Data	20	Static
Muir Creek, OR	2 (27)	25	Declining
Myers Creek, ID	1 (?)	16	Unknown
Redbird, ID	1 (17)	150	Increasing
Saddle Creek, OR	None	12	Increasing
Sheep Mountain, OR	4 (42)	35	Static
Upper Hells Canyon, OR	2 (54)	45	Static
Upper Hells Canyon, ID	4 (78)	25	Increasing
Upper Joseph Creek, OR	None	40	Increasing
Wenaha, OR/WA	2 (430)	65	Static

[a] P. Fowler, WDFW, personal communication, 2004
[b] Established by natural dispersal from other herds

Much of the current success of Rocky Mountain bighorn sheep populations is the direct result of reintroduction efforts. As recently as February 2002, 20 sheep from Montana were released along the Snake River above Kirkwood Creek (IDFG 2002). Potential future release sites have been identified in Sheep Creek and Big Canyon in Idaho and Saddle Creek in Oregon (Hells Canyon Initiative 2004).

Historic Distribution

The geographic range of the species is quite large and extends from southeastern British Columbia and southwestern Alberta south along the Cascade and Sierra Nevada mountains into Baja California, eastward through Montana to western North Dakota, South Dakota, and Nebraska, as well as into central Colorado and New Mexico, western Texas, and eastern Coahuila, Mexico (Verts and Carraway 1998).

In Oregon, Rocky Mountain bighorn sheep occupied suitable habitat from the John Day–Burnt River divide north and east to the Snake River and the Oregon–Washington state line. Bighorn sheep were considered abundant throughout the Idaho portion of the Hells Canyon ecosystem. Historical distribution of bighorns in Washington in not entirely clear (WDFW 1995), but there is general agreement that Rocky Mountain bighorns inhabited the Blue Mountains region where they occupied all suitable habitat within the rugged river canyons of the area.

Current Distribution

Current distribution is restricted to four geographic areas within the Blue Mountains: Asotin Creek, Black Butte, Wenaha, and Mountain View (Fowler 1999). An additional 11 populations occur within northeastern Oregon (ODFW 2003d), and four herds are found in Idaho within Hells Canyon.

The current distribution of Rocky Mountain bighorn sheep is the result of transplants that targeted areas with suitable habitat and lacked conflicts with domestic sheep. The last Oregon population estimate in 2003 was 637 Rocky Mountain bighorns in 12 herds (ODFW 2003d). Washington estimates from 2002 were 239 Rocky Mountain bighorns within five herds (WDFW 2003c). Idaho populations within the Clearwater region contain an estimated 223 animals (Hells Canyon Initiative 2004).

Factors Affecting Bighorn Sheep Population Status

Currently there are three key factors threatening the successful reestablishment of a population of Rocky Mountain bighorn sheep in the Snake Hells Canyon subbasin: 1) the continuing threat of disease transmission from domestic sheep and goats, 2) a large portion of the bighorn sheep habitat not being in protected status and vulnerable to land management changes negative to bighorn sheep, and 3) the continued threat of noxious weed invasion on core Rocky Mountain bighorn sheep habitat in the Snake Hells Canyon subbasin.

Habitat Loss

Within the Snake Hells Canyon subbasin, only a small proportion of bighorn sheep habitat has been lost due to land conversion for agricultural production and urban development. A high percentage of public landownership and the steep, rugged nature of bighorn sheep habitat has afforded some level of protection from some of the more destructive land uses.

Habitat Degradation

Aggressive nonnative plants and other noxious weeds are the primary factor negatively impacting habitat quality. Across their range in Washington, Idaho, and Oregon, bighorn habitat has suffered encroachment from yellow starthistle (*Centaurea solstitialis*), knapweed (*Centaurea* spp.), common crupina (*Crupina vulgaris*), rush skeletonweed (*Chondrilla juncea*), leafy spurge (*Euphorbia esula*), and other plants. Such encroachment reduces forage quality and vigor. In the Snake Hells Canyon subbasin, habitat conditions are generally good, but yellow starthistle and diffuse knapweed (*Centaurea diffusa*) are threats to the continued quality of Rocky Mountain bighorn sheep range (see section 4.1.2). Due to fir exclusion, fire-adapted grasses and shrubs have become more decadent. Bighorn sheep use their vision to detect predators. Fire suppression is one of the major factors that have reduced the quality of habitat for this species (BLM 2002).

Livestock Grazing

Historical overgrazing of Rocky Mountain bighorn sheep habitat by domestic livestock has reduced range quality and increased competition for resources. Periods of historical overgrazing by livestock have contributed to the degradation of range quality and the susceptibility of native communities to introduced invasive plant species. Many of the range areas within the Snake Hells Canyon subbasin are still recovering from historical overgrazing.

Domestic sheep and goat grazing presents a unique constraint on Rocky Mountain bighorn sheep recovery within the Snake Hells Canyon subbasin due to the transmission of disease pathogens. In fact, an outbreak of *Pasteurella* was just documented within the Big Canyon herd as of April 8, 2004 (Barker 2004). This issue is covered in more detail below.

Disease

Disease transmission from domestic sheep and goats has proven to be the largest threat to wild bighorn sheep populations in the tri-state region of Oregon, Washington, and Idaho. With the exception of lungworm and scabies, most diseases negatively affecting bighorns commonly occur in domestic sheep, and disease prevalence in bighorns generally increases with contact between bighorns domestic sheep. The Oregon bighorn sheep and Rocky Mountain goat plans provide an explanation of the hazards of disease transmission in bighorn sheep (2003d). The following is quoted directly from that document:

> When bighorn sheep come in contact with infected domestic sheep, bighorns usually die of pneumonia within 3–7 days of contact (Martin et al. 1996, Schommer and Woolever 2001). Because exposed bighorns do not die immediately infected individuals may return to their herd and infect other individuals, which can cause 70–100% of the herd to die (ODFW 2003d). The significant Hells Canyon die-off of 1995–96 was believed to have started when a feral goat interacted with wild bighorns in the Tenmile drainage south of Asotin (Cassirer et al. 1996). During the 1995–96 die-off, the Black Butte, Mtn. View, and Wenaha herds experienced 75, 65, and 50 percent mortality, respectively (Cassirer et al. 1996). The die off did not affect the Asotin Creek herd (Fowler 1999).

Field treatment of pasteurellosis with antibiotics has had some success, but prevention needs to be emphasized. The most effective prevention is separation between bighorns and domestic sheep or goats (ODFW 2003d). The amount of separation necessary to protect bighorn sheep from interaction with domestic sheep is variable based on each location's specific circumstances. After a *Pasteurella* die-off in 1993 in an Aldrich Mountain, California, bighorn herd, trailing practices of a domestic sheep band were modified to provide 5 miles of separation in the spring and 20 miles of separation in the fall. This approach has protected that population of bighorns from any recurrence of *Pasteurella* (ODFW 2003d). In Hells Canyon, a 25-mile separation between Rocky Mountain bighorn sheep and domestic sheep has proven ineffective at insulating bighorns from *Pasteurella* transmission (Schommer and Woolever 2001).

A single public land grazing allotment on the Payette National Forest allows domestic sheep grazing. All sheep allotments on the Wallowa-Whitman National Forest have been discontinued (USFS 2003a). There are a few commercial sheep and goat grazing operations within or adjacent to the Snake Hells Canyon subbasin that continue to provide disease transmission opportunities to wild bighorns. Most notably are a sheep herd in lower Joseph Creek and a herd of goats based in the White Bird, Idaho, area that are used in weed-control efforts. Domestic sheep and goats are also kept sporadically in small quantities as hobby animals in the river bottoms of the Snake River system and adjacent subwatersheds.

Grasshopper Sparrow

This section draws heavily from the species description prepared by Paul Ashley and Stacy Stoval (2004). See http://www.nwcouncil.org/fw/subbasinplanning/ for additional information on grasshopper sparrow biology.

The grasshopper sparrow (*Ammodramus savannarum*) is a small migratory bird that breeds throughout most of the lower 48 states, but it is often locally distributed and even uncommon to rare in parts of its range (Vickery 1996). Grasshopper sparrows arrive on the breeding grounds in mid-April and depart for the wintering grounds in mid-September (Vickery 1996). They winter across the southern tier of states south into Central America. The grasshopper sparrow was selected as a focal species for this assessment based on their reliance on large areas of bunchgrass dominated grasslands, a habitat type that as declined significantly in abundance in the subbasin and the Columbia Basin as a whole.

In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69% across the United States since the late 1960s. In Washington, the grasshopper sparrow is considered a Watch species and a candidate for listing by the state (Table 14). In Oregon, it has a state Natural Heritage Program status of imperiled, while in Washington and Idaho, it has a state Natural Heritage Program rank of vulnerable (2003). Breeding Bird Survey data show long-term declines in populations of grasshopper sparrow in all three of the states partially contained by the Snake Hells Canyon subbasin (Sauer et al. 2003).

Table 29. Trends for grasshopper sparrow from Breeding Bird Survey data, 1980–2002 (Sauer et al. 2003).

State	1996–2002 Trend	1980–2002 Trend
Washington	–4.9	–3.0
Idaho	–7.4	–10.7
Oregon	–4.4	–1.6

The diet of the grasshopper sparrow varies by season. In the spring and summer, grasshopper sparrows rely on invertebrates for 60% of their diet and seeds for the remainder. In the fall, seeds become a greater component of the diet, making up 71% of the total while invertebrates make up the remainder. No data were available on the composition of the winter diet (Martin et al. 1951, cited in Vickery 1996).

Grasshopper sparrows are monogamous throughout the breeding season and nest in semicolonial groups of 3 to 12 pairs (Ehrlich 1988). The female incubates the eggs alone (Ehrlich 1988), while the male defends the pair's territory (Smith 1963). The incubation period lasts from 11 to 13 days (Smith 1963, Harrison 1975, Ehrlich 1988), with a nestling period of 6 to 9 days after hatching (Harrison 1975, Hill 1976, Kaspari and O'Leary 1988). Hatchlings are blind and covered with grayish-brown down (Smith 1968). After the young hatch, both parents share the responsibilities of tending the hatchlings (Smith 1963). Brood parasitism by brown-headed cowbirds has been documented, but rates are generally low (Vickery 1996).

Throughout most of their range, grasshopper sparrows can produce two broods, one in late May and a second in early July (Smith 1968, Vickery 1996). However, in northern portions of its range, such as the Snake Hells Canyon subbasin, one brood is probably most common (Wiens 1969, Vickery et al. 1992).

Predators of the grasshopper sparrow include hawks, loggerhead shrikes, mammals, and snakes (Vickery 1996). Nest predators cited include raccoons (*Procyon lotor*), red fox (*Vulpes vulpes*), northern black racers (*Coluber constrictor constrictor*), blue jays (*Cyanocitta cristata*), and common crows (*Corvus brachyrhynchos*) (Wray et al. 1982, Johnson and Temple 1990).

Grasshopper sparrows prefer grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground (Bent 1968, Blankespoor 1980, Vickery 1996). Vickery (1996) states that exposed bare ground is the critical microhabitat type for effective foraging. Other habitat requirements include moderately deep litter and sparse coverage of woody vegetation (Smith 1963; Bent 1968; Wiens 1969, 1970; Kahl et al. 1985; Arnold and Higgins 1986). In east-central Oregon, grasshopper sparrows occupied relatively undisturbed native bunchgrass communities dominated by *Agropyron spicatum* and/or *Festuca idahoensis* (Holmes and Geupel 1998). Vander Haegen et al. (2000) found no significant relationship with vegetation type (i.e., shrubs, perennial grasses, or annual grasses), but they did find one with the percent cover of perennial grass. Grasshopper sparrows are area sensitive, preferring large grassland areas over small areas (Herkert 1994a,b; Vickery et al. 1994). Key habitat features of grasshopper sparrow habitat are displayed in Table 30.

Grasshopper sparrows occasionally inhabit cropland but at lower densities than are found in grassland habitats (Smith 1963, Smith 1968, Ducey and Miller 1980, Basore et al. 1986, Faanes and Lingle 1995, Best et al. 1997). Early season mowing of hayfields causes major nest failures in grassland nesting species (Knapton 1994). Areas where hayfields are adjacent to bunchgrass grasslands may serve as population sinks for grasshopper sparrows (Wisdom et al. 2000). Grasshopper sparrows are also included as members of shrub-steppe communities that exhibit the features described in Table 30 (Altman and Holmes 2000).

Table 30. Key habitat relationships required for breeding grasshopper sparrows (Altman and Holmes 2000).

Conservation Focus	Key Habitat Features			
	Vegetative Composition	Vegetation Structure	Landscape/Patch Size	Special Considerations
native bunchgrass cover	native bunchgrasses	bunchgrass cover >15% and >60% total grass cover; bunchgrass >25 cm tall; shrub cover <10%	>40 ha (100 ac)	larger tracts better; exotic grass detrimental; vulnerable in agricultural habitats from mowing, spraying, etc.

In the Snake Hells Canyon subbasin, the best habitats for grasshopper sparrow historically occurred in the northernmost portions of the subbasin (Wisdom et al. 2001). Much of this area has been converted to agricultural or urban land uses. Wisdom et al. (2001) found that some of the subwatersheds in this area historically contained between 75 and 100% source habitats for grasshopper sparrows. Source habitat for grasshopper sparrows still exists in the subbasin but has become less dense. Currently, the subwatersheds with the greatest density of grasshopper sparrow source habitat contain between 25 and 50% source habitat. The Breeding Bird Survey Route Was-023 Asotin is partially contained in the lower Snake Hells Canyon subbasin. The majority of the route lies in the lower portions of the neighboring Asotin subbasin but enters the subbasin for 4.7 miles near the confluence of the Snake River and Asotin Creek. Grasshopper sparrows have been observed along the route every year since 1983, with the exception of 1992. Counts of grasshopper sparrows along the route have been variable, ranging from a high of 12 in 1998 to a low of 0 in 1992. The average over the 20-year period was 6.65 grasshopper sparrows per year (Sauer et al. 2003). Variability has been commonly observed in grasshopper sparrow populations as they are known to move from year to year, depending on the location of suitable habitat (Csuti et al. 2001). It is impossible to determine grasshopper sparrow population trends in the Snake Hells Canyon subbasin from available data.

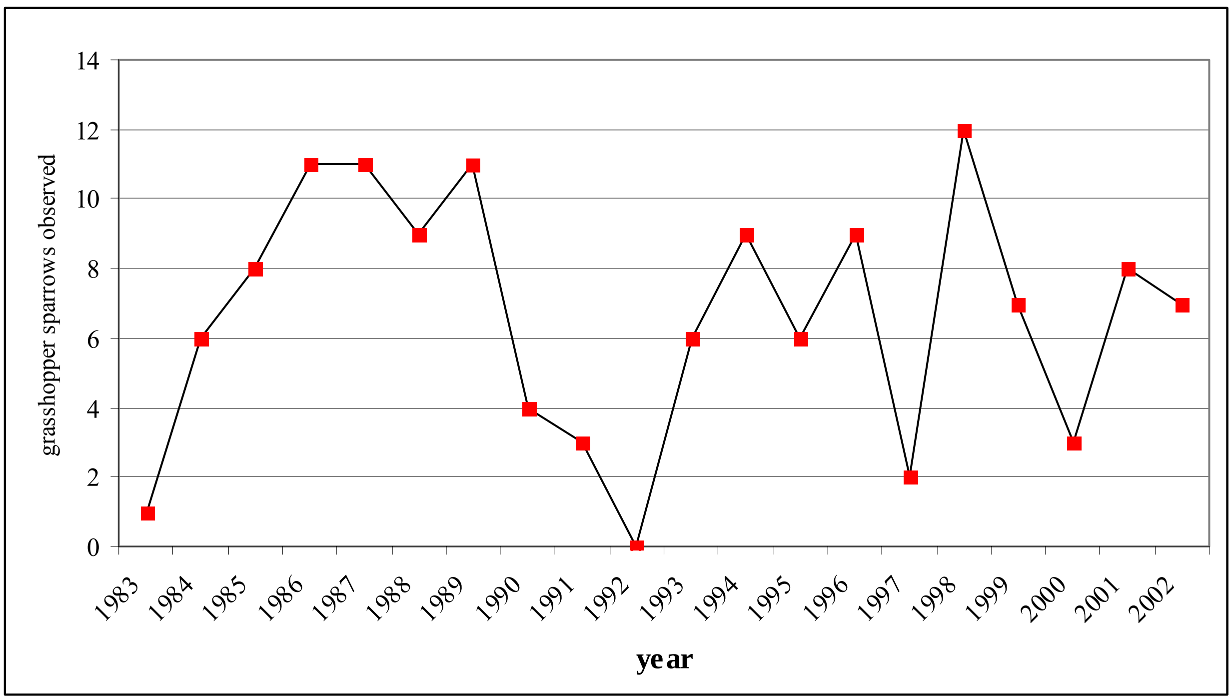

Figure 44. Grasshopper sparrow counts along the Breeding Bird Survey Route Was-023 Asotin, 1983–2002 (Sauer et al. 2003)

Primary threats to the species have been identified as loss, degradation, and incompatible management of grassland habitat (NatureServe 2003). Maintaining the quality, size and connectivity of the remaining bunchgrass habitat in the subbasin should be a priority for maintaining grasshopper sparrows. See section 0 for more discussion of the loss and degradation of grassland habitats as a limiting factor to wildlife species; see also the *Snake Hells Canyon Management Plan* for strategies for addressing this limiting factor.

3.5.3 Montane Mixed Conifer Forest

American Marten

The American marten *(Martes americ*ana) is a medium-sized carnivorous mammal that inhabits boreal forests of North America. In the western United States, marten ranges include Oregon, Idaho, Washington, Montana, Wyoming, Colorado, Utah, New Mexico, Nevada, and California (Strickland et al. 1982). It is globally distributed throughout Canada and Alaska and south through the Rockies, Sierra Nevada, northern Great Lakes region, and northern New England. Total population size is unknown but is probably at least several hundred thousand. Martin populations are considered secure in Idaho but vulnerable in Oregon (NatureServe 2003). The species was assigned Oregon state sensitive status due to declining habitat quantity and quality caused by the harvest of mature and old-growth timber (Turley and Holthuijzen 2002).

The American marten breeds in summer, and delayed implantation results in an average litter of three or four in spring. The young are usually born in hollow trees but sometimes in rock dens. Young are weaned in six weeks, and males are sexually mature in one year, while females mature in one to two years (NatureServe 2003).

The diet of the American marten consists mainly of small mammals, birds, insects, and carrion. When in season, berries and other vegetative matter contribute to their diet. American marten forage both on the ground and in trees and are expert at exploiting subnivean prey (voles, red squirrels, etc.) (NatureServe 2003).

American marten prefer structurally complex habitats with multiple canopy layers and abundant down woody debris and understory shrubs (Koehler and Hornocker 1977). They are associated with old-growth forest, particularly in winter, and were selected as a focal species due to their established status as an indicator of mature forest conditions (BLM 2002). Home range size is variable but usually averages less than 10 km^2, although it may be larger when food sources are scarce (Slough 1989).

In the Snake Hells Canyon subbasin, American marten inhabit mesic coniferous forests typically above 4,500 feet (BLM 2002). The marten is considered a valuable furbearing species, and historic overharvest caused marten population declines in many areas. Today loss of habitat and fragmentation are the primary factors impacting American marten populations (NatureServe 2003).

American martens have been historically documented in the subbasin, but two recent sampling efforts have failed to detect their presence. Martens were not observed by Eshelman (1998) during mammal live-trap studies conducted during the spring and summer of 1996 in areas surrounding Kirkwood, Bernard, Sheep, and Granite creeks. Remote-camera surveys conducted by Edelman and Pope (2001) at the confluence of perennial streams with the Snake River between Hells Canyon Dam and the Salmon River also failed to detect presence of American martens. Due to the secretive nature of the species, these results may not indicate a declining population trend but may warrant closer monitoring of martens in the subbasin. Two potential sightings of marten tracks were reported during wildlife surveys conducted at Craig Mountain in 1995 (Cassirer). Adequate information is not currently available to assess population status or distribution in and adjacent to the Snake Hells Canyon subbasin (Turley and Holthuijzen 2002).

Boreal Owl

The boreal owl (*Aegolius funereus*) breeds in North America, from the treeline in central Alaska east to Newfoundland; south-central Oregon in the Cascade and Blue mountains, and in the Rocky Mountains south through Washington, Idaho, Montana, Wyoming, and Colorado to northern New Mexico; then east through central Saskatchewan, southern Manitoba, northern Minnesota, southern Quebec, and Ontario. It breeds in Eurasia, from the treeline in northern Scandinavia, Russia, and Siberia, south in the mountains to southern Europe, the western Himalayas, and western China (AOU 1983, Hayward and Hayward 1993). The boreal owl winters mainly in the breeding range; however, it may move south in the eastern United States and Europe during eruption years (AOU 1983, Hayward and Hayward 1993, NatureServe 2003).

Reliable populations number are unavailable, and obtaining them is complicated by nomadism caused by fluctuating prey density (Hayward and Hayward 1993). Boreal owls are listed as a species of concern by the state of Idaho, a monitor species by the state of Washington, and as sensitive-status undetermined by the state of Oregon (Table 12).

Boreal owls nest in abandoned woodpecker holes or natural cavities in standing snags, usually in older forests with complex physical structures. Some success has been achieved in getting them to use artificial nest boxes (Harrison 1978). Females typically occupy the nest cavity one to three weeks prior to egg laying. In Idaho, nesting was initiated between mid-April and late May. After the female incubates the eggs for between 25 and 36 days, a clutch of 4 to 6 young hatches. The young owls fledge at about 4 to 5 weeks and are independent after 5 to 6 weeks. Boreal owls are sexually mature by one year (NatureServe 2003).

Boreal owls hunt from a perch and capture prey on the ground (DAI 2004). They eat primarily small mammals but sometimes birds and insects. They forage mostly at night. The best foraging habitat for boreal owls is in spruce–fir stands (DAI 2004).

In Idaho, the annual home range averaged 3,774 acres (1,289–10,174 acres), with a larger range in winter than in summer (Hayward et al. 1987). Boreal owl home ranges overlapped extensively, and they were found to defend the nest site only (NatureServe 2003).

In the Rockies, boreal owls generally inhabit mature, multilayered spruce–fir forest. They are usually found in remote subalpine habitats, and their early breeding season is usually associated with deep snow. Consequently, very few surveys have occurred. They are known to occur on a limited basis in northeastern Oregon and western Idaho. No population estimates have been made (USFS 2003c).

Large stand-replacement fires can destroy the structure of stands that serve as boreal owl habitat. Such fires are thought to be a major adverse impact to the species. Returning to a more natural fire regime through prescribed burning would reduce the threat of large stand-replacement fires to boreal owl habitat in the subbasin (USFS 2003c). Timber harvest may also be a threat to boreal owls since it affects their habitat by removing nest trees and forest structure and it can reduce prey populations. However, harvest has been very limited in the subalpine habitats of the HCNRA (USFS 2003c).

Rocky Mountain Elk

Relative to other wildlife species, elk (*Cervus elaphus nelsoni*) are considered habitat generalists. They favor a mix of grassland/shrub landscapes and forested landscapes that provide important security cover. Considered grazing animals, elk feed on grasses, sedges, and forbs all year. They shift to more shrubs in the winter as nonwoody plants become less available and less nutritious Christensen 2001). Elk were chosen as a focal species for this assessment due to their economic and cultural importance, their sensitivity to security issues and the importance of the subbasin for providing winter range habitat, they were selected as a representative of the coniferous WHTs because of the importance of these areas in providing cover. Thermal cover may be limited within the winter ranges of the subbasin (BLM 2002).

Optimum elk habitat consists of a forage cover ratio of 60% forage area and 40% cover (Thomas *et al.* 1979 cited in Ashley and Stoval 2004). Cover quality is defined in two ways; satisfactory and marginal. Satisfactory cover consists stands of coniferous trees that are > 40 feet tall, with a canopy closure of > 70%. Marginal cover is defined as coniferous trees > 10 feet tall with a canopy closure of > 40%. Cover provides protection from weather and predators. Forage areas are all areas that do not fall into the definition of cover. Proper spacing of forage and cover areas is very important in order to maximize use of these areas by elk (Thomas *et al.* 1979 cited in Ashley and Stoval 2004).

Idaho Power Company contracted with the Rocky Mountain Elk Foundation to conduct an assessment of big game habitat in the company's area of operations. One of the subareas included in the study, the "Hells Canyon subarea," roughly corresponds with the boundaries of the Snake Hells Canyon subbasin. However, it includes the area around Brownlee Reservoir but excludes the lower subbasin downstream of the Washington state line. As part of this effort, panels of local big game experts identified areas of important big game habitat. This effort recognized the subbasin as having some of the most crucial big game winter habitat in the region. Deer and elk persist throughout much of the surrounding area based on the capacity of the Snake River canyon to provide winter range and support these populations (Christensen 2001).

Elk in the Snake Hells Canyon subbasin are managed by the state wildlife departments Idaho, Oregon and Washington and contains portions of nine of the management units used by these agencies, six of these unit contain the majority of the subbasin and are listed below. The Washington Unit 186 contains most of the Washington portion of the subbasin. The Oregon units 58-Chesnimus and 59-Snake River are partially contained within the subbasin. The subbasin contains portions of Idaho Game Management Units 11, 13, and 18. IDFG collectively refers to these units as the Hells Canyon Zone.

The resident elk population in Washington GMU 186 varies between 50 and 150 elk. Elk from Oregon move into GMU 186 during the winter months, increasing the elk population by 250 to 550 elk, depending on the severity of winter conditions (Ashley and Stoval 2004). Elk are maintained at relatively low population levels in this unit due to concerns of agricultural damage (Ashley and Stoval 2004). Elk have caused damage to grain, legumes, hay, and rangeland forage in the subbasin. Cultivated crops are the main concern in the northern part of the subbasin, while livestock forage is the primary concern in the rest (IDFG 2003e).

Management objectives for the Hells Canyon zone (Idaho portion of the subbasin) are to establish a population of 1,950 cows and 525 bulls. Historically, elk herds were scattered, and numbers were low in this area. Elk populations increased in the area as a result of large fires that occurred in the beginning of the 20th century, that created fast brushfields that provided abundant forage areas for elk. Elk herds began to decline again in the 1970s, as a result of the maturation of these brush fields, logging and road building activity which reduced security, and loss of some major winter ranges (IDFG 2003e). Elk populations in all the Idaho game units in the subbasin meet management objective except for, adult bull numbers in Unit 11 (Table 31).

Table 31. Winter status and objectives for Elk in the Hells Canyon Elk Zone (number below objective in bold)

Unit	Current Status				Objective		
	Survey Year	Cows	Bulls	Adult Bulls	Cows	Bulls	Adult Bulls
11 Lower subbasin	2002	646	184	**66**	600-900	150-250	100-150
13 Craig Mountain Area	2001	890	185	117	500-700	100-150	50-100
18 HCRNA Area	2000	558	253	161	500-700	150-225	100-150
Zone Total		2094	622	344	1600-2300	400-645	250-400

Primary threats to elk in the Snake Hells Canyon subbasin include fragmentation of late successional forests and invasion by weeds and nonnative grasses, particularly cheatgrass and yellow starthistle. Security is a moderate concern, road densities are moderate, and access is restriction during many seasons. Big game in the subbasin exhibit medium to low vulnerability to hunters (IDFG 2003e).

3.5.4 Lodgepole Pine Forests and Woodlands

Black-backed Woodpecker

The black-backed woodpecker *(Picoides arcticus*) ranges from Alaska and Canada, south into northeastern Oregon along the Cascade Range and the Blue Mountains. The species prefers high-elevation forests, inhabiting forest dominate by lodgepole pine and ponderosa pine mixed with other conifers (Marshall et al. 1996, Csuti et al. 1997). The species is locally common in Oregon, with a spotty distribution. The black-backed woodpecker breeds throughout Idaho in suitable habitat (Turley and Holthuijzen 2002). The black-backed woodpecker was selected as a focal species for the lodgepole pine habitat type because of its association with fire killed, and mature trees, two elements that have been reduced by management practices in some areas.

Population trends are poorly understood, but the species has probably undergone declines over the twentieth century due to suppression of fire, cutting of snags, and loss of mature and old-growth forests. Documenting population trends is complicated by irregular population irruptions, and population extensions outside resident ranges occur in response to fires and insect outbreaks, temporarily boosting local populations (Bock and Bock 1974, Yunick 1985). The species is rarely detected on the North American Breeding Bird Survey, in part because there are relatively few survey routes in montane and northern boreal forests (NatureServe 2003).

The black-backed woodpecker has been designated a species of special concern by the state of Idaho, a sensitive species in the state of Oregon, and a candidate species by the state of Washington. Black-backed woodpeckers are a sensitive species for Region 1 of the USFS and the BLM.

The species' diet contains large numbers of bark beetles and wood-boring beetle adults and larvae (Marshall et al. 1996, USFS 1998). The species occasionally eats fruits, nuts, sap, and cambium (Terres 1980). Woodpeckers may be attracted by the clearly audible chewings of wood-boring insects in recent burns (Taylor and Barmore 1980). In a study in northeastern Oregon, 97% of foraging occurred on ridges. The birds preferred to forage in lodgepole pine and ponderosa pine and fed almost equally on live and dead trees. The species used trees averaging 31 cm diameter at breast height (dbh) and 18 m tall, with more than 40% of their needles intact. This finding suggests that they preferred live or recently dead trees (Bull et al. 1986).

Nests are located in the body of dead or dying pine snags that have pronounced decay and are infested with beetles and beetle larvae (Bock and Bock 1974, Wisdom et al. 2000). The male does most of the excavation, and a new cavity is excavated every year. The nest cavity is usually 0.6 to 4.6 m above the ground (NatureServe 2003). In Idaho, used nest trees average 32.3 cm dbh ($N = 15$; Saab and Dudley 1998). Both sexes incubate 2 to 6 eggs (usually 4) for 14 days. Young are tended by both parents (DAI 2004). Females feed young more often than males, but they carry less food in each visit. Although males visit less often, they come with more food and perhaps supply 50 to 75% of the food to nestlings (Kilham 1983). Usurpation of nesting cavities by hairy woodpeckers and Lewis' woodpeckers causes stress and excessive energy costs in territorial competition (Wisdom et al. 2000).

Stands inhabited by black-backed woodpeckers are typically old-growth lodgepole pine or recently burned forests with standing dead trees (USFS 1998, BLM 2002). In Montana, Hutto found that the species is almost exclusively associated with early successional burned forests, although it is occasionally observed in mixed conifer, lodgepole pine, Douglas-fir, and spruce–fir forests (1995a,b). The number of small trees present in a burn served as the best correlate of species abundance (Hutto 1995b). Hutto (1995b) suggests that a mosaic of recently burned forests may represent source habitat where local reproduction exceeds mortality. The low densities of woodpeckers in unburned forests may be sink populations that are maintained by birds that move into these areas as conditions on post-fire habitats become less suitable over time (NatureServe 2003).

Black-backed woodpeckers have been documented frequently in the HCNRA, although no systematic surveys have been conducted. Habitat conditions are thought to be excellent in many parts of the HCNRA because of the low emphasis on timber harvest, abundance of dead wood and insects, and overstocked stands. These conditions probably allow the HCNRA to act as source habitats for black-backed woodpeckers migrating to new areas (USFS 2003c). Recent fires have contributed to improved habitat conditions for the black-backed woodpecker in the Craig Mountain area (BLM 2002).

Suppression of fires and post-fire logging, as well as the threat of large, severe wildfires that reduce numbers of decaying snags, serve as limiting factors for the black-backed woodpecker (Dixon and Saab 2000). Goggans (1989) cites the above factors and the conversion of mature and old-growth forests to young stands with few decayed trees as significant threats to the species. Management should focus on maintenance of natural patterns of forest fire, wood-boring insects, disease, and decay. Heartrot in trees and snags is important for nests, diseased trees for roosts, and beetle-infested trees for foraging (Goggans et al. 1989, Rodrick and Milner 1991).

Better information is needed on demographics, population density, population irruptions, seasonal movements, breeding territory, home range sizes, productivity, survivorship, juvenile dispersal, and winter ecology of black-backed woodpeckers. More detailed information is also needed on habitat use, diet, and response to land management activities, particularly forest harvest patterns and changes in fire regimes. In addition, a better understanding is needed regarding the ecology and interactions with fire and insect infestations, including a comparison of densities and productivity between unburned forests and recent burns. (NatureServe 2003).

3.5.5 Ponderosa Pine Forests and Woodlands

Flammulated Owl

This Section draws heavily from the species description prepared by Paul Ashley and Stacy Stoval (2004). Please see http://www.nwcouncil.org/fw/subbasinplanning/ for additional information on flammulated owl biology.

The flammulated owl (*Otus flammeolus)* is a tiny owl with dark brown eyes, dark body, and small ear tuffs (USFS 2003c). These owls are one of the most migratory of all North American owls, going south of Mexico during most of the fall and winters. They are found in the Snake Hells Canyon subbasin from late-spring to early fall to breed. The flammulated owl is a species dependent on large diameter Ponderosa pine forests (Hillis *et al.* 2001). The mature and older forest stands that are used as breeding habitat by the flammulated owl have changed during the past century due to fire management and timber harvest. Concerns that the narrow habitat requirements of the flammulated owl make it susceptible to populations declines led the State of Oregon to designate the flammulated owl a state-sensitive critical species (Marshall *et al.* 1996). Partners of flight uses the flammulated owl as a focal species for the dry forest habitat type (see section 3.1.3). Flammulated owls were selected as a focal species for the ponderosa pine WHT due to their close association with this habitat type and due to concerns that the reduced abundance of mature ponderosa pine habitat types in the subbasin and across the region may be negatively impacting populations of flammulated owls.

Flammulated owls are entirely insectivores; nocturnal moths are especially important during spring and early summer (Reynolds and Linkhart 1987). As summer progresses and other prey become available, lepidopteron larvae, grasshoppers, spiders, crickets, and beetles are added to the diet (Goggans 1986). The flammulated owl is distinctively nocturnal although it is thought that the majority of foraging is done at dawn and dusk.

Flammulated owl predators include spotted and other larger owls, accipiters, long-tailed weasels (Zeiner et al. 1990), felids and bears (McCallum 1994).

Males arrive on the breeding grounds before females. In Oregon, they arrive at the breeding sites in early May and begin nesting in early June (Goggans 1986). They call to establish territories and to attract arriving females. Birds pair with their mates of the previous year, but if one does not return, they often pair with a bird from a neighboring territory. The male shows the female potential sites from which she selects the one that will be used, usually an old pileated woodpecker or northern flicker hole (Ashley and Stoval 2004).

The laying of eggs happens from about mid-April through the beginning of July. Generally 2 - 4 eggs are laid and incubation requires 21 to 24 days, by female and fed by male. The young fledge at 21 -25 days, staying within about 100 yards of the nest and being fed by the adults for the first week. In Oregon, young fledge in July and August (Goggans 1986). The young leave the nest around after about 25 days but stay nearby. In Colorado, owlets dispersed in late August and the adults in early October (Reynolds and Linkhart 1987).

The flammulated owl occurs mostly in mid-level conifer forests that have a significant Ponderosa pine component (McCallum 1994). In the northern Blue Mountains they typically occur at elevations above 700 meters and below 1,400 meters. Flammulated owls habitat in the subbasin consists primarily of mature to old, open canopy Ponderosa pine, Douglas-fir, and grand fir (Bull and Anderson 1978; Goggans 1986; Powers et al. 1996).   Reductions in mature ponderosa pine habitat have resulted in loss of habitat for this species in Oregon (Marshall et al. 1996, Csuti et al. 2001), Idaho (Engle and Harris 2001), and much of their range.

Flammulated owls are obligate secondary cavity nesters (McCallum 1994), requiring large snags in which to roost and nest. The owls nest primarily in cavities excavated by flickers (Colates spp.), hairy woodpeckers (Picoides villosus), pileated woodpeckers (Dryocopus pileatus), and sapsuckers (Sphyrapicus spp.) (Goggans 1986; McCallum 1994). For 33 nests studied in northeastern Oregon by Bull et al. (1990), 67 percent were created by pileated woodpeckers, 27 percent by northern flickers (Colaptes auratus), and 6 percent by decay. Flammulated owls used pileated woodpecker cavities significantly more than expected based on availability.

In northeastern Oregon, Bull and Anderson (1978) found that Ponderosa pine was an overstory species in 73 percent of flammulated owl nest sites. Powers et al. (1996) reported that Ponderosa pine was absent from their flammulated owl study site in Idaho and that Douglas-fir and quaking aspen (Populus tremuloides) accounted for all nest trees. Flammulated owls will nest only in snags with cavities that are deep enough to hold the birds, and far enough off the ground to be safe from terrestrial predators.

In studies from northeastern Oregon and south central Idaho, nest sites were located 16-52 feet high in dead wood of live trees, or in snags with an average diameter at breast height (DBH) of >20 in. (Goggans 1986; Bull et al. 1990; Powers et al. 1996). Bull et al. (1990) found that stands containing trees greater than 20 in. DBH were used more often than randomly selected stands. Reynolds and Linkhart (1987) suggested that stands with trees >20 in. were preferred because they provided better habitat for foraging due to the open nature of the stands, allowing the birds access to the ground and tree crowns. Some stands containing larger trees also allow more light to the ground that produces ground vegetation, serving as food for insects preyed upon by owls (Bull et al. 1990).

Both slope position and slope aspect have been found to be important indicators of flammulated owl nest sites (Goggans 1986, Bull et al. 1990). In general, ridges and the upper third of slopes were used more than lower slopes and draws (Bull et al. 1990). It has been speculated that ridges and upper slopes may be preferred because they provide gentle slopes, minimizing energy expenditure for carrying prey to nests. Prey may also be more abundant or at least more active on higher slopes because these areas are warmer than lower ones (Bull et al. 1990).

Flammulated owls prefer to forage in older stands because the open crowns and park-like spacing characteristic of these stands permits maneuverability during feeding (USFS 1994b). Grasslands in and adjacent to forest stands are thought to be important foraging sites (Goggans 1986). A pair of owls appears to require about 2-10 acres during the breeding season, and substantial patches of brush and understory to help maintain prey bases (Marcot and Hill 1980). Areas with edge habitat and grassy openings up to 5 acres in size are beneficial to flammulated owls (Howle and Ritcey, 1987) for foraging.

Flammulated owls are present throughout the northern Blue Mountains in appropriate habitat types. The abundance of ponderosa pine stringers adjacent to grasslands habitats in the subbasin indicate good breeding habitat for flammulated owls (USFS 2003c). Not much is known about historical population trends of flammulated owls. Nocturnal call surveys conducted in the early 1990s indicate a state population of less than 1,000 in Idaho. Eleven records of sightings or flammulated owl call backs in the subbasin have been reported to the Idaho Conservation Data Center. Nine of these observations occurred during the nocturnal call surveys conducted in 1991 in the upper portion of the subbasin (Moore and Frederick 1991).Data on flammulated owl populations in the subbasin is insufficient to determine population numbers or trends for the species. Population data are also inadequate for trend assessment at the scale of the western united states, but loss and fragmentation of mature forest habitat suggests that populations are declining (Sauer et al. 2003; NatureServe 2003).

Flammulated owls prefer late seral ponderosa pine forests, activities that alter or remove these habitats pose the greatest threat to the species. Several studies have shown a decline in flammulated owl numbers following timber harvesting (Marshall 1957; Howle and Ritcey 1987). Management practices that remove snags reduce the availability of cavities suitable for nesting and are also a threat (Reynolds et al. 1989). The suppression of wildfires has allowed many ponderosa pines to proceed to the more shade resistant fir forest types, which is less suitable habitat for these species (Marshall 1957; Reynolds et al. 1989; see section 4.2.2)

Aerial spraying of carbaryl insecticides to reduce populations of forest insect pests may affect the abundance of non-target insects important in the early spring diets of flammulated owls (Reynolds et al. 1989).

Flammulated owls come late to breeding grounds, and competition for nest sites may be a factor limiting breeding success (McCallum 1994). Saw-whet owls, screech owls, and American kestrels compete for nesting sites, but flammulated owls probably have more severe competition with non-raptors, such as woodpeckers, other passerines, and squirrels for nest cavities (Zeiner et al. 1990, McCallum 1994). Birds from the size of bluebirds upward are potential competitors. Owl nests containing bluebird eggs and flicker eggs suggest that flammulated owls evict some potential nest competitors (McCallum 1994). The introduced European starling also uses and competes with flammulated owls for flicker cavities. Encouraging the maintenance and growth of pileated woodpecker and northern flicker populations will help maintain high numbers of cavities, thereby minimizing this competition (Zeiner et al. 1990).

White-headed Woodpecker

The white-headed woodpecker (*Picoides albolarvatus*) is a nonmigratory bird that is a year-round resident of lower-elevation ponderosa pine habitats in the subbasin. White-headed woodpeckers have been designated a species of special concern by the state of Idaho, a candidate for listing by the state of Washington, and sensitive by the state of Oregon. They are considered sensitive by Regions 1 and 4 of the USFS and sensitive by the BLM. Partners in Flight uses the white-headed woodpecker as a focal species for ponderosa pine in the Blue Mountains (see section 3.1). White-headed woodpeckers are particularly vulnerable due to their highly specialized winter diet of ponderosa pine seeds (Ashley and Stoval 2004).

White-headed woodpeckers feed primarily on the seeds of large ponderosa pines. This diet makes the white-headed woodpecker quite different from other species of woodpeckers who feed primarily on wood-boring insects (Blood 1997; Cannings 1995). White-headed woodpeckers do use secondary food sources, including insects, mullein seeds, and suet feeders during the spring and summer (Blood 1997; Joy et al. 1995). By late summer, white-headed woodpeckers shift to their exclusive winter diet of ponderosa pine seeds. This dependence is likely the key limiting factor to the white-headed woodpecker's distribution and abundance (Ashley and Stoval 2004).

White-headed woodpeckers are monogamous and may remain associated with their mate throughout the year. They build their nests in old trees, snags, or fallen logs but always in dead wood. Every year, the pair bond constructs a new nest. This construction may take three to four weeks. The nests are, on average, 3 m off the ground. The old nests are used for overnight roosting by the birds (Ashley and Stoval 2004).

The woodpeckers fledge about 3 to 5 birds every year. During the breeding season (May to July), the male roosts in the cavity with the young until they are fledged. The incubation period usually lasts for 14 days, and the young leave the nest after about 26 days. White-headed woodpeckers have one brood per breeding season, and there is no replacement brood if the first brood is lost. The woodpeckers are not very territorial except during the breeding season. They are not especially social birds outside of family groups and pair bonds, and they generally do not have very dense populations (about 1 pair bond per 8 ha) (Ashley and Stoval 2004).

Chipmunks are known to prey on the eggs and nestlings of white-headed woodpeckers. There is also predation by the great horned owl on adult white-headed woodpeckers. However, predation does not appreciably affect the woodpecker population (Ashley and Stoval 2004).

White-headed woodpeckers live in montane, coniferous forests. Studies in Oregon show that abundance of the species is positively associated with increasing abundance of large-diameter ponderosa pines (Marshall et al. 1996) Although most abundant in uncut forest stands, it will utilize areas where forested vegetation treatments provide sufficient densities of ponderosa pine. Closed canopy stands with heavy shrub or young conifer regeneration are less likely to support the species than open stands with 50% or less canopy cover (USFS 2003c). Highest abundances of white-headed woodpeckers occur in old-growth stands (Ashley and Stoval 2004).

The bird excavates its nest cavities in moderately decayed wood, usually in large-diameter snags (USFS 2003c). Generally large ponderosa pine snags consisting of hard outer wood with soft heartwood are preferred by nesting white-headed woodpeckers. In British Columbia, 80% of reported nests have been in ponderosa pine snags, while the remaining 20% have been recorded in Douglas-fir snags. Excavation activities have also been recorded in trembling aspen, live ponderosa pine trees, and fence posts (Cannings et al. 1987, cited in Ashley and Stoval 2004). Breeding territories in Oregon were found to be 104 ha in continuous forest and 321 ha in fragmented forests (Dixon 1995).

Although systematic surveys for this species have not been conducted on the HCNRA, the species is occasionally observed. These observations indicate that white-headed woodpeckers densities are greatest in the southern portion of the subbasin (USFS 2003c). White-headed woodpeckers have also been observed on the Garden Creek Preserve (Neiman 1987, cited in Cassirer 1995). Declines in the availability of mature ponderosa pine have resulted in a severe decline in abundance of this species in the Blue Mountains. Many late/old-structure stands of ponderosa pine still exist in the HCNRA, and this area may provide source habitats for white-headed woodpeckers colonizing adjacent areas (USFS 2003c).

Nesting and foraging requirements are the two critical habitat attributes limiting the population growth of this species of woodpecker. Both of these limiting factors are very closely linked to the habitat attributes contained within mature open stands of ponderosa pine. Past land-use practices, including logging and fire suppression, have resulted in significant changes to the forest structure within the ponderosa pine ecosystem (Ashley and Stoval 2004).

3.5.6 Wetland and Riparian Areas

Mountain Quail

The mountain quail *(Oreortyx pictus*) is the largest North American quail north of Mexico. Rangewide mountain quail are distributed in five western states including California, Washington, Oregon, Nevada, and Idaho, as well as in Baja Norte, Mexico. They are also found in small disjunct populations as introduced birds on Vancouver Island, British Columbia, and the San Juan Islands, Washington (USFWS 2003b). Mountain quail are found in relatively high numbers throughout suitable habitat in the Coast and Cascade ranges and the Rouge Umpqua and Willamette valleys of western Oregon. However, population numbers in the eastern portion of their range, which includes the Snake Hells Canyon subbasin have declined dramatically since the 1930s. Due to these declines, the eastern population of mountain quail was considered for listing under the ESA. On July 2003, the USFWS found that this listing was not warranted, in large part due to concerns over the discreteness of the two populations (USFWS 2003b). The mountain quail is classified as a species of special concern by the IDFG and as a sensitive species by the BLM and Regions 1 and 4 of the USFS (section 3.1). The mountain quail was selected as a focal species for this assessment due to the importance of the subbasin in supporting some of the few remaining mountain quail populations in the region and the association of mountain quail with high quality riparian areas.

In Idaho, mountain quail populations are now confined to remnant populations along the mid- to lower Snake River corridor, the lower Salmon River drainage, and the Little Salmon River drainage (Brennan 1989, Cassirer 1995). In eastern Oregon, mountain quail were historically found primarily in Malheur, Baker, and Wallowa counties. They appear to be extirpated from areas adjacent to Brownlee and Oxbow reservoirs on the Snake River (Brennan 1989, cited in Rocklage and Edelmann 2001). Small numbers have persisted along several tributaries of the Imnaha River, and an additional population has recently been reintroduced to the Imnaha subbasin (Crawford and Pope 1999). Hunting of mountain quail has been banned since 1984 in Idaho and is limited in eastern Oregon (Rocklage and Edelmann 2001).

Mountain quail habitat in relatively arid areas such as the Snake Hells Canyon subbasin consists of tall dense shrubs close to water, usually in riparian areas (Heekin et al. 1993). Mountain quail are usually elevational migrants and winter in coveys below the snow line. In March, pairs start moving to nesting areas, often up in elevation to open forest (Cassirer 1995). Mountain quail nest in a concealed depression on the ground. The female typically lays two clutches of 7 to 10 eggs, one of which is incubated and raised by the male (Heekin et al. 1993). Nest sites in the Imnaha subbasin were most commonly located in Douglas-fir/common snowberry associations (Pope and Crawford 1999).

Mountain quail eat primarily plant material throughout the year, based at least partially on abundance. This plant material includes perennial seeds, fruits, flowers and leaves of annual forbs, legumes, and mushrooms. Invertebrate animal matter makes up only 0 to 5% of the adult diet but a larger percentage of the juvenile diet (USFWS 2003b). Mountain quail food-producing shrubs found in the subbasin and surrounding area are white alder, serviceberry, hackberry, black hawthorn, smooth sumac, poison ivy, currant, black locust, elderberry, and snowberry. Other shrub species such as chokecherry, ninebark, and syringa have not been identified as food sources but are important components of mountain quail habitat (see summary of food sources contained in Rocklage and Edelmann 2001).

Mountain quail are prey to numerous predators but are especially vulnerable to hawks. Other known predators include great horned owl (*Bubo virginianus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), and rattlesnake (*Crotalus* sp.) (USFWS 2003b). Results from predation studies conducted in the Imnaha subbasin indicate predation rates of more than 60% a year (Pope and Crawford 2002, cited in USFS 2003b).

The Snake Hells Canyon subbasin is one of the few areas where populations of mountain quail are thought to persist in the state of Idaho, but recent survey efforts seem to indicate a declining population trend, despite the persistence of apparently high-quality habitat. In 1995, Cassirer conducted a survey of mountain quail and their habitat on Craig Mountain. In the ten years previous to her study, mountain quail observations in Wapshilla, China, Eagle, Dough, and Captain John creeks had been reported to the Idaho Conservation Data Center. However, in 1995, calling surveys were only able to verify the presence of mountain quail in Eagle Creek. Lack of observations in other drainages does not necessarily mean that there are no mountain quail in these areas because calling surveys have low response rates. But response was low enough that it was interpreted to indicate a mountain quail population decline in the area (Cassirer 1995).

As part of the research effort to support the relicensing process for the Hells Canyon Complex, Reese and Smasne (1996) searched for mountain quail in areas studied by Ormiston (1966) in

1964 and 1965. In 1966, mountain quail were relatively abundant in the area, but despite significant effort and the help of Ormiston in relocating his old study areas, mountain quail were not detected. This led Reese and Smasne to conclude that mountain quail have been extirpated from Big Canyon Creek or are present in very low numbers (Reese and Smasne 1996.)

Despite declines, the mountain quail continues to inhabit the subbasin in low densities. The mountain quail was observed in the subbasin in 1996 by IPC personnel at Temperance Creek and at higher elevations above Pittsburg Landing (Turley and Edelmann 2001). In 1996, Craig Johnson of the BLM's Cottonwood Field Office observed 2 adults and 17 juveniles on a road about 0.9 mile above Getta Creek (IDCDC 2001). In 1998, a local chukar hunting guide observed two groups of more than 20 birds along the Snake River. The first was located just downstream of Cottonwood Creek, and the second was just downstream of Corral Creek (IDCDC 2001). The WDFW lists the mountain quail as a resident at the Chief Joseph Wildlife Area near the confluence of the Snake and Grande Ronde rivers (WDFW 2001).

A lack of suitable habitat does not appear to explain the decline of mountain quail numbers in the Hells Canyon area. A landscape-level assessment of mountain quail habitat in the subbasin indicate scattered but relatively widely distributed patches of high-quality habitat (Rocklage and Edelmann 2001). Vegetation structure and plant species composition suggested that good winter habitat was available in Wapshilla, Eagle, Dough, and Chimney creeks and Pruitt Draw and that suitable breeding habitat was found in Eagle, Dough, Chimney, and Corral creeks and Pruitt Draw. Deer, Birch, and China creeks also appeared to provide good wintering habitat (Cassirer 1995). It is thought that the problem may not be with the availability of habitat but that a lack of connectivity between habitat patches inhibits elevational movements up and down the riparian corridor (A. Sondenaa, Nez Perce Tribe, personal communication, 2003). The subbasin is considered a prime location for further research into the reasons for declining mountain quail populations, mountain quail habitat requirements, and the potential release of individuals for mountain quail reintroduction/augmentation (Cassirer 1995, Reese and Smasne 1996, Rocklage and Edelmann 2001).

Columbia Spotted Frog

The Columbia spotted frog (Rana luteiventris) is olive green to brown in color, with irregular black spots. They may have white, yellow, or salmon coloration on the underside of the belly and legs (Engle 2004). Tadpoles are black when small, changing to a dark and then light brown as they increase in size. Columbia spotted frogs are about 1 inch in body length at metamorphosis (Engle 2004). Females may grow to approximately 100 mm (4 inches) snout-to-vent length, while males may reach approximately 75 mm (3 inches) snout-vent length (Nussbaum et al. 1983, Stebbins 1985, Leonard et al. 1993). The Columbia spotted frog was selected as a focal species for this assessment as a representative or wetland habitats with high water quality.

Populations of Columbia spotted frog are found from Alaska and British Columbia to Washington east of the Cascades; eastern Oregon; Idaho; the Bighorn Mountains of Wyoming; the Mary's, Reese, and Owyhee river systems of Nevada; the Wasatch Mountains; and the western desert of Utah (Green et al. 1997). Genetic evidence (Green et al. 1996) indicates that

Columbia spotted frogs may be a single species with three subspecies or may be several weakly differentiated species.

The USFWS recognizes four distinct population segments (DPS) of Columbia spotted frog based on disjunct distribution: the Wasatch Front DPS (Utah), West Desert DPS (White Pine County, Nevada, and Toole County Utah), Great Basin DPS (southeast Oregon, southwest Idaho, and north-central/northeastern Nevada), and the Northern DPS (eastern Washington, central and northern parts of Idaho, western Montana, northwestern Wyoming, British Columbia, and Alaska) (J. Engle, personal communication, 2004). There is some uncertainty about whether the Columbia spotted frogs that inhabit the Snake Hells Canyon subbasin are part of the Great Basin or Northern population, and more genetic work will need to be done to clarify the issue.

The USFWS ruled on April 23, 1993, that the listing of the Great Basin population of spotted frog was warranted and designated it as a candidate for listing, but the species was precluded from listing due to higher priority species (Federal Register 58[87]:27260). The species remains a candidate for listing under the ESA. The Columbia spotted frog is listed as sensitive by the state of Oregon and as a candidate for state listing in Washington (see section 3.1.2 and Table 14).

The Columbia spotted frog eats a variety of food including arthropods (e.g., spiders and insects), earthworms, and other invertebrate prey (Whitaker et al. 1982). Adult Columbia spotted frogs are opportunistic feeders and feed primarily on invertebrates (Nussbaum et al. 1983). Larval frogs feed on aquatic algae and vascular plants and scavenged plant and animal materials (Morris and Tanner 1969).

The timing of breeding varies widely across the species range, owing to differences in weather and climate. But the first visible activity begins in late winter or spring shortly after areas of ice-free water appear at breeding sites (Turner 1958, Licht 1975, Leonard et al. 1996). Breeding typically occurs in late March or April, but at higher elevations, breeding may not occur until late May or early June (Amphibia Web 2004). Great Basin population Columbia spotted frogs emerge from wintering sites soon after breeding sites thaw (Engle 2001).

Adults exhibit a strong fidelity to breeding sites, with oviposition typically occurring in the same areas in successive years. Columbia spotted frogs have a strong tendency to lay their eggs communally, and it is not uncommon to find 25 or more egg masses piled atop one another in the shallows (Amphibia Web 2004). After a few weeks, thousands of small tadpoles emerge and cling to the remains of the gelatinous egg masses. Newly hatched larvae remain clustered for several days before moving throughout their natal site (USFWS 2002c). In the Columbia Basin, tadpoles may grow to 100 mm (4 inches) total length prior to metamorphosing into froglets in their first summer or fall. At high-elevation montane sites, however, tadpoles barely reach 45 mm (1.77 inches) in total length prior to the onset of metamorphosis in late fall (Amphibia Web 2004). As young-of-the-year transform, many leave their natal sites and can be found in nearby riparian corridors (USFWS 2002c). After breeding is completed, adults often disperse into adjacent wetland, riverine, and lacustrine habitats (Amphibia Web 2004).

Successful egg production and the viability and metamorphosis of Columbia spotted frogs are susceptible to habitat variables such as temperature, depth, pH of water, cover, and the presence/absence of predators (e.g., fishes and bullfrogs) (Morris and Tanner 1969, Munger et al. 1996). Mortality of eggs, tadpoles, and newly metamorphosed frogs is high, with approximately 5% surviving the first winter (D. Pilliod, personal communication, cited in Amphibia Web 2004).

This species is relatively aquatic and rarely found far from water. It occupies a variety of still-water habitats and can also be found in streams and creeks (Hallock and McAllister 2002). Columbia spotted frogs are found in aquatic sites with a variety of vegetation types, from grasslands to forests (Csuti 1997). A deep silt or muck substrate may be required for hibernation and torpor (Morris and Tanner 1969). Reproducing populations have been found in habitats characterized by springs, floating vegetation, and larger bodies of pooled water (e.g., oxbows, lakes, stock ponds, beaver-created ponds, seeps in wet meadows, backwaters) (IDFG et al. 1995, Reaser 1997). Vegetation in the breeding pools is generally dominated by herbaceous species such as grasses, sedges (*Cares* spp.) and rushes (*Juncus* spp.) (Amphibia Web 2004).

Populations of spotted frogs have declined in many areas of their range, and remaining populations tend to be smaller and more isolated than those found historically (see Paul 2004 for details). Population trends were unavailable for the species in the Snake Hells Canyon subbasin, but suitable habitat is well distributed and Columbia spotted frogs have been observed in numerous locations. During surveys of Craig Mountain conducted by Llewellyn and Peterson (1998), spotted frogs were the most commonly observed amphibian. In 1994, over 280 spotted frog adults and 23 pond breeding sites were found at upper-elevation sites in the Craig Mountain area. In July 1995, spotted frog tadpoles were located along the side channels of the Snake River near Craig Mountain. This use was unexpected and occurred at a lower elevation than where Columbia spotted frogs are typically thought to breed. Spotted frogs have also been found in the lower reaches of Deer, Eagle, Captain John, and Maloney creeks. It is hypothesized that frogs use these areas for foraging resting and dispersing but not breeding (Llewellyn and Peterson1998). Suitable habitat for Columbia spotted frog occurs in the Oregon portion of the HCNRA, but use has not yet been well documented (USFS 2003b).

Fragmentation of habitat is considered one of the most significant barriers to spotted frog recovery and population persistence. Recent studies in Idaho indicate that spotted frogs exhibit breeding site fidelity (Patla and Peterson 1996; Engle 2000; Engle and Munger 2000; J. Engle, IDFG, personal communication, 2001). Movement of frogs from hibernation ponds to breeding ponds may be impeded by zones of unsuitable habitat. As movement corridors become more fragmented due to loss of flows within riparian or meadow habitats, local populations will become more isolated (Engle 2000, 2001). Vegetation and surface water along movement corridors provide relief from high temperatures and arid environmental conditions, as well as protection from predators. Loss of vegetation and/or lowering of the water table can pose a significant threat to frogs moving from one area to another. Likewise, fragmentation and loss of habitat can prevent frogs from colonizing suitable sites elsewhere (USFWS 2002c).

Columbia spotted frog habitat fragmentation and degradation can result from land-use activities, including livestock grazing, spring development, agricultural development, urbanization, and mining activities. These activities eliminate vegetation necessary to protect frogs from predators and UV-B radiation; reduce soil moisture; create undesirable changes in water temperature, chemistry and water availability; and can cause restructuring of habitat zones through trampling, rechanneling, or degradation, which in turn can negatively affect the available invertebrate food source (IDFG et al. 1995, Munger et al. 1997, Reaser 1997, Engle and Munger 2000, Engle 2002).

The reduction of beaver populations has also been noted as an important feature in the reduction of suitable habitat for spotted frogs. Other threats to Columbia spotted frog include predation by fishes, bullfrogs, disease, and prolonged drought.

3.5.7 Open Water

Bald Eagle

This Section draws heavily from the species description prepared by Keith Paul (2004). Please see http://www.nwcouncil.org/fw/subbasinplanning/ for additional information on bald eagle biology.

The bald eagle (*Haliaeetus leucocephalus)* was first protected in the lower 48 states by the Bald Eagle Protection Act of 1940; it was federally listed as endangered in 1967. In 1995, the bald eagle was reclassified as threatened in all of the lower 48 States. No critical habitat has been designated for the bald eagle (USFWS 2003c). In 1963, a National Audubon Society survey reported only 417 active nests in the lower 48 states. In 1994, about 4,450 occupied breeding areas were reported (USFWS 2003c). Due to positive trends like this the bald eagle was proposed for delisting on July 6, 1999; a decision on whether to delist the bald eagle is pending (64 FR 36453). The bald eagle is listed as threatened by the states of Oregon and Washington; and are listed as endangered in Idaho (Table 12).

The bald eagle historically ranged throughout North America except extreme northern Alaska and Canada and southern Mexico. Bald eagles can be resident year-round where food is available; otherwise they will migrate or wander to find food. In Oregon, historic bald eagle nests have been documented in 32 of 36 counties. Those counties where historic breeding records did not occur include Sherman, Gilliam, Morrow, and Malheur counties (Isaacs and Anthony 2001). The current range in the lower 48 states has been divided into five recovery areas: Chesapeake Bay, Pacific, Southeastern, Northern States, and Southwestern (USFWS 2003c). The Snake Hells Canyon subbasin lies within the Pacific recovery area.

A recovery plan for the Pacific population of the bald eagle was completed in 1986. The plan identifies the following de-listing goals which are necessary to obtain a self-sustaining population of bald eagles: 1) a minimum of 800 nesting pairs with an average reproductive rate of one fledged young per pair and an average success rate per occupied site of not less than 65 percent over a five-year period, 2) attainment of breeding population goals should be met in at least 80 percent of the management zones, 3) wintering populations should be stable or increasing (USFWS 2003c).

The Pacific recovery area was divided into zones, and the Snake Hells Canyon subbasin is part of the Snake River zone. Recovery goals for the Snake River zone are to: 1) locate, monitor, and protect nesting, roosting, and feeding areas, 2) develop nest site plans for nesting and roost areas, 3) monitor productivity, 4) prevent significant habitat disturbance and direct human interference at nest sites and feeding areas, and 5) re-establish six breeding pairs (USWFS 2003c).

[Bald eagles consume a variety of prey that varies by location and season. Prey are taken alive, scavenged, and pirated (Frenzel 1985, Watson et al. 1991). Fish were the most frequent prey among 84 species identified at nest sites in south-central Oregon, and a tendency was observed for some individuals or pairs to specialize in certain species (Frenzel 1985). Wintering and migrant eagles in eastern Oregon fed on large mammal carrion, especially road-killed mule deer, domestic cattle that died of natural causes, and stillborn calves, as well as cow afterbirth, waterfowl, ground squirrels, other medium-sized and small rodents, and fish. Proportions varied by month and location. Food habitats are unknown for nesting eagles over much of the state (Isaacs and Anthony 2003a) (Paul 2004)]. Reductions in anadromous fish runs are considered a factor limiting the use of the Snake Hells Canyon subbasin by bald eagles (USFS 2003b).

Bald eagles are most abundant in the subbasin in late winter and early spring, because resident breeders (engaged in early nesting activities), winter residents, and spring transients are all present. Nest building and repair occur any time of year, but most often observed from February to June (Isaacs and Anthony unpublished data). Bald eagles are territorial when breeding but gregarious when not (Stalmaster 1987). The size and shape of a defended breeding territory varies widely (1.6 to 13 square miles) depending upon the terrain, vegetation, food availability, and population density of an area (USFWS 2003c). Bald eagles exhibit strong nest-site fidelity (Jenkins and Jackman 1993. Both sexes build the nest, incubate eggs, and brood and feed young (Stalmaster 1987). Egg laying (1-4 eggs) occurs mid-February to late April; hatching late March to late May (after about 35 days of incubation); and fledging late June to mid-Aug (Isaacs and Anthony 2003a). After a month of continued partial parental care the young eagles are on their own, mortality rates tend to be highest in young eagles and can be caused by disease, food shortages, bad weather, or human interference (USFWS 2003c). During the nest building, egg laying and incubating periods, eagles are extremely sensitive and will abandon a nesting attempt if there are excessive disturbances in the area during this time (USFWS 2003c).

Bald eagles nest in forested areas near the ocean, along rivers, and at estuaries, lakes, and reservoirs (Isaacs and Anthony 2001). Eighty-four percent of Oregon nests were within 1 mi (1.6 km) of water (Anthony and Isaacs 1989). Nest sites in forested areas show a strong preference to multi-layered, mature forest stands. Eagles usually nest in mature conifers with gnarled limbs that provide ideal platforms for nests. Ponderosa pine, Douglas fir, and black cottonwood are preferred nest trees in the Pacific recovery area (USFS 2003b).

Wintering eagles in the Pacific Northwest perch on a variety of substrates; proximity to a food source is probably the most important factor influencing perch selection by bald eagles. Favored perch trees are invariably located near feeding areas, and eagles consistently use preferred branches (Stalmaster 1976). Most tree perches selected by eagles provide a good view of the surrounding area (Servheen 1975, Stalmaster 1976), and eagles tend to use the highest perch sites available (Stalmaster 1976; USFWS 1986). Nearly all bald eagles observed in the Craig mountain area were perched in mature ponderosa pine trees along the Salmon and Snake rivers (Cassirer 1995). Dead trees are used by eagles in some areas because they provide unobstructed view and are often taller than surrounding vegetation (Stalmaster 1976). Isolation is also an important feature of bald eagle wintering habitat. In Washington, 98% of wintering bald eagles tolerated human activities at a distance of 300 m (328 yards) (Stalmaster and Newman 1978). However, only 50% of eagles tolerated disturbances of 150 m (164 yards) (USFWS 1986).

Habitat requirements for communal night roosting are different form those for diurnal perching. Communal roosts are invariably near a rich food resource and in forest stands that are uneven-aged and have at least a remnant of the old-growth forest component (Anthony et al. 1982). Close proximity to a feeding area is not the only requirement for night roosting sites, as there are minimum requirements for forest stand structure. In open areas, bald eagles also use cottonwoods and willows for night roosting (Isaacs and Anthony 1983). Most communal winter roosts used by bald eagles offer considerably more protection from the weather than diurnal habitat. Roost tree species and stand characteristics vary considerably throughout the Pacific Northwest (Anthony et al 1982) (USFWS 1986) (Paul 2004)].

The Snake Hells Canyon subbasin is known to provide winter foraging habitat for bald eagles (BLM 2002, USFS 2003b). Bald eagle monitoring has been conducted in the subbasin since 1979. Bald eagle counts over the last 20 years on the Snake River from the mouth of the Grande Ronde River to Temperance Creek have averaged 8.4 and ranged from 3 in 1989 to 18 in 1998, with a generally increasing trend (USFS 2003b). Count data from the lower Hells Canyon area (from the Grande Ronde River to the Clearwater River) also show an increasing trend (+8.47%), with an average of 2.4 birds observed per year (USGS 2003). Bald eagle counts are consistently lower on the Snake River than in adjacent areas with suitable habitat. Craig Johnson, BLM biologist, rated the foraging quality of the analysis area as fair to low fair. His conclusion was primarily due to low and potentially insufficient food availability. This conclusion is supported by the fact that bald eagles were found to concentrate below Hells Canyon Dam to feed on fish that had passed through the turbines (USFS 2003b).

The Snake River corridor is considered marginal potential nesting habitat due to limited forage and the rarity of large trees. Recent surveys have not detected any bald eagle nests within the subbasin (Cassirer 1995, USFS 2003b). One historical bald eagle nest has been reported in the subbasin near the mouth of Captain John Creek (Cassirer 1995). In 1999, a bald eagle nest was located along the Hells Canyon Reservoir just upstream of the subbasin (lower Middle Snake subbasin). A pair of eagles has occupied the nest for the last four years. The presence of this nest lowers the probability of a pair establishing within the Snake Hells Canyon subbasin due to competition for a limited food base (USFS 2003b). The general trend for nest sites located in Oregon has continued on a steady increase and now exceeds the recovery goal. Bald eagles are currently being considered for delisting by the USFWS. Monitoring of potential bald eagle nest sites along the Snake River corridor is conducted at least once a year during the nesting season by biologists from BLM, IPC, and the Payette and Wallowa-Whitman National Forests (USFS 2003b).

The status and distribution of bald eagle populations in the decades before World War II are poorly understood. Declines probably begin in some populations in the 19th century (USFWS 1986). By 1940, the bald eagle had "become rather an uncommon bird" except along the coast and Columbia River, and in Klamath Co. (Gabrielson and Jewett 1940). Habitat loss (cutting of nest trees) and direct persecution (shooting, trapping, poisoning), probably caused a gradual decline prior to 1940. However, the major factor leading to the decline and subsequent listing of the bald eagle was disrupted reproduction resulting from contamination by organochlorine pesticides, particularly DDT (USFWS 2003c).

Between 1945 and 1974 over 4.5 million acres (1.8 million ha) of National Forest in Oregon were sprayed with DDT an agricultural pesticide, (Henny and Nelson 1981). Undocumented quantities were also applied on private forests and agricultural crops, and for mosquito control around municipalities. In the late 1960s and early 1970s, it was determined that dichorophenyl-dichloroetheylene (DDE), the principal breakdown product of DDT, accumulated in the fatty tissues of adult female eagles. It impaired calcium release necessary for egg-shell formation, thus inducing thin-shelled eggs that are not viable, leading to reproductive failure (USFWS 2003c). The deleterious effects of DDT on reproduction (Stalmaster 1987) joined habitat loss and direct persecution as causes of decline through the early 1970's when the population may have reached its historical low. By then, nesting pairs were extirpated in northeastern Oregon (Isaacs and Anthony 2001), where applications of DDT on National Forest land were common and widespread (Henny and Nelson 1981) (Isaacs and Anthony 2003a). On December 31, 1972, DDT was banned from use in the United States (USFWS 2003c).

Loss of habitat, loss of prey and human disturbance are the greatest current threats to bald eagle populations. Actions identified by the Wallowa-Whitman National Forest and currently being implemented in portions of the subbasin that should result in continued improvement in bald eagle habitat include; implementation of management standards for livestock grazing to improve riparian conditions, maintaining snags to provide perches and/or nest trees, restoring fire regimes to maintain large tree species preferred by bald eagles like ponderosa pine and Douglas fir that respond to periodic burns, and continued efforts to protect and restore anadromous fish runs (USFS 2003b). Further development and expansion of these strategies is contained in the Imanha Subbasin Management Plan.

3.5.8 Agriculture, Pastures, and Mixed Environs

Mule Deer

Rocky Mountain mule deer (*Odocoileus hemionus)* are native to the Snake Hells Canyon subbasin and occupy a wide range of habitats. Mule deer are primarily browsers, so most of their diet comprises leaves and twigs of shrubs and trees, particularly during the winter. In the spring and summer, grass and forbs are also an important dietary component (IDFG 2003d). Winter range is a key component of mule deer habitat. Shrub species—including antelope bitterbrush (*Purshia tridentata*), rabbitbrush (*Ericameria* and *Chrysothamnus* spp.), juniper, and mountain mahogany (*Cercocarpus* spp.) that have a high fat content—provide critical nutrition in the critical winter months. Thermal cover, to reduce energy loss, and southfacing slopes, which collect less snow, are also important winter range components. As discussed in the earlier section about elk (see section 3.5.3), the subbasin has been recognized as having some of the most crucial big game winter habitat in the region. Deer and elk persist throughout much of the surrounding area based on the capacity of the Snake River Canyon to provide winter range and support these populations. Noxious weeds, human access, domestic livestock competition, depredation, public land availability, and social carrying capacity have been identified as important factor factors impacting mule deer winter range in the area (Christensen 2001).

The species was chosen as a focal species for the agriculture, pastures, and mixed environs WHT because complaints of mule deer foraging in and damaging agricultural areas is one of the primary factors limiting mule deer population objectives in the area. Oregon's green forage program was created in 1983 to assist landowners who are experiencing damage caused by wildlife and to increase social carrying capacity. The objective of the green forage program is to alleviate or prevent big game damage on private lands while benefiting wildlife by improving forage quality and quantity on public or private lands (ODFW 2001).

Mule deer populations fluctuate in response to both natural and human-influenced factors. Drought conditions reduce forage and cover values, while severe winter weather conditions can result in large losses of deer. Both conditions can cause poor deer condition and result in lower deer survival (ODFW 2001). Changes in habitat also affect mule deer populations. Mule deer are thought to have been less abundant throughout the west prior to European settlement. Historical conditions favored grassland communities and animals such as bighorn sheep and elk. Overgrazing by livestock in the late 1800s and early 1900s resulted in rangelands that were dominated by shrubs and forb species more favorable for deer, and populations increased.

The subbasin contains parts of nine game/wildlife management units in three states. The ODFW manages mule deer in the Chesnimnus, Snake River, and Pine Creek Wildlife Management Units as part of its Wallowa District. The IDFG is responsible for the management of mule deer in Game Management Units 22, 18, 13, 11. The WDFW manages deer in the Couse 181 and Grande Ronde 186 units.

Mule deer population estimates for the Wallowa District have been below the ODFW management objective of 26,800 for many years. Mule deer populations in the area have trended upward for the last five years, from a low of 17,400 in 1996 to 20,000 in 2001 (ODFW unpublished data). Mule deer populations in Washington were also low for many years but are now improving slowly due to recent good forage conditions and mild winters resulting in minimal overwinter mortality and excellent fawn production and survival. The CRP is also credited with increasing deer populations. Asotin County has 40,100 acres enrolled in the program. These large areas of continuous habitat provide excellent forage and fawning areas where little existed before (WDFW 2001).

3.5.9 Caves

Townsend's Western Big-Eared Bat

Townsend's western big-eared bat *(Corynorhinus townsendii townsendii*) is the most abundant of the subspecies of big-eared bats. Two eastern subspecies—the Ozark big-eared bat (*Corynorhinus townsendii ingens*) of Missouri, Oklahoma, and Arkansas and the Virginia big-eared bat (*C. t. virginianus*) of Kentucky, West Virginia, and Virginia—are listed by the USFWS as endangered(NatureServe 2003). The range of the western subspecies encompasses Oregon, Washington, Idaho, Nevada, and California (NatureServe 2003). Population numbers for the western subspecies are also considered very low and decreasing or stable in numbers (USFS 2003c). The Townsend's western big-eared bat has been designated as a species of concern by the state of Idaho, a candidate by the state of Washington, and sensitive-vulnerable by the state of Oregon. It is considered a sensitive species by Regions 1, 4, and 6 of the USFS and BLM (see section 3.1 for details). Townsend's western big-eared bats were chosen as a focal species for this assessment to represent the rare habitat feature of caves, which occur in the Snake Hells Canyon subbasin and support big-eared and many other species of bats.

Townsend's western big-eared bat activity usually begins well into the night, late relative to other bats. After an initial feeding period, the bat roosts and rests before a later feeding bout (NatureServe 2003). Townsend's western big-eared bat feeds on various flying insects near the foliage of trees and shrubs; the species relies heavily on moths (Barbour and Davis 1969).

Townsend's western big-eared bat mating begins in autumn and continues into winter. Ovulation and fertilization are delayed until late winter/early spring. Gestation lasts 2 to 3.5 months, and a litter of one is born in late spring/early summer The young can fly at 2.5 to 3 weeks and are weaned by 6 weeks. Females are sexually mature their first summer, but males are not sexually active until their second year. Females commonly form nursery colonies, generally of up to about 200 (Handley 1959). Individuals generally return to the same maternity roost in successive years (NatureServe 2003).

Townsend's western big-eared bat maternity and hibernation colonies are typically found in caves and mine tunnels. The species does not use crevices or cracks but rather hangs from the ceiling, generally near the zone of total darkness (Schmidly 1991). It commonly occurs in mesic habitats characterized by coniferous and deciduous forests (Kunz and Martin 1982). Similar species to the Townsend's western big-eared bat find habitat beneath the bark or in cavities of large-diameter trees (Gellman and Zielinski 1993). The potential for this type of habitat use in the subbasin is currently being studied on the Wallowa-Whitman National Forest. Bats are known to use snags as day roost habitat.

Temperature is a critical factor in selection of the habitat areas used by this species. Caves and mine shafts used for hibernation in winter are cold and generally close to freezing. These bats do not migrate south but may migrate to lower elevations in the Snake Hells Canyon subbasin in the winter. Natural vegetation around cave openings is also very important since it provides a thermal buffer keeping the caves cooler on hot days and warmer in old weather. Maintaining stable temperatures is very important to this species. Known habitat areas should contain buffers of uninterrupted tree and/or shrub canopy (where possible) of 100 feet in order to maintain shelter, foraging, and linkage habitats (USFS 2003c).

Townsend's big-eared bats have been monitored on the HCNRA from 1984 to the present. One of the six significant maternity colonies of Townsend's big-eared bats in Oregon occurs within the subbasin, as well as abundant foraging and hibernating habitat. Recent population decreases of nearly 50% have been recorded at two sites along the Snake River corridor (USFS 2003c).

Elimination of human disturbance in nursery and hibernation habitat is considered key to maintaining Townsend's western big-eared bat populations (and other bat species) in the subbasin. Gating known habitat areas is an effective way to reduce these impacts. Eleven gates are now in place in Hells Canyon. All known areas with bat use and human disturbance are now gated the entire year. This gating will provide protection for Townsend's big-eared bats during critical hibernaculums and maternity periods. An increase in population numbers is anticipated (USFS 2003c).

3.5.10 Environmental Conditions for Focal and Concern Species

Characterizing the overall habitat requirements of a wildlife species requires the consideration of three interrelated elements: the cover type (or WHTs), structural conditions, and environmental correlates. These features should be viewed as hierarchical in nature, with WHTs occurring at the broadest scale, structural conditions occurring at the stand level, and environmental correlates occurring at a site-specific or local level (Johnson and O'Neil 2001). This section evaluates the elements of habitat most important to the sensitive species in the subbasin. The technical team felt that, while the focal species they selected were good species to use to focus discussions of the issues and habitat concerns of the subbasin, a broader group should be used when identifying important habitat elements for management consideration. For this reason, wildlife species designated as federal or state threatened or endangered, state sensitive, BLM sensitive, USFS sensitive, or Partners in Flight focal species were also included in the following habitat association analysis. This group of 105 species are collectively referred to as "concern species" in the following discussion.

Wildlife Habitat Types

The WHTs and their general vegetative species composition were introduced in section 1.4. As described in section 1.7, land-use activities and human alterations to ecological processes have altered the distribution, distribution, and composition of these WHTs. These changes have influenced the composition and population dynamics of the wildlife communities dependent on the WHTs. Unfortunately, the paucity of historical records and issues of scale make quantifying these changes difficult, and estimates of change should be viewed cautiously. The best attempt at quantifying changes in the distribution of WHTs in the subbasin has been conducted by the Northwest Habitat Institute, and its data are presented in Table 32. Maps showing historical and current distributions of WHTs visible at the scale of the subbasin are shown in Appendix A.

Table 32. Changes in the abundance of WHTs in the Snake Hells Canyon subbasin (modified from NHI 2003)

Habitat Type	Historic (acres)	Current (acres)	Change (acres)	Change (percent)
Montane mixed conifer forest	16,353	33,483	17,130	105
Eastside mixed conifer forest	38,166	115,175	77,009	202
Lodgepole pine forest and woodlands	11,346	1,154	–10,192	–90
Ponderosa pine and woodlands	46,440	110,806	64,366	139
Alpine grasslands and shrublands	0	10,309	10,309	—
Western juniper and mountain mahogany woodlands	0	270	270	—
Subalpine parklands	11,204	0	–11,204	–100
Eastside grasslands (includes shrub-steppe)	422,704	239,834	–182,870	–43
Agriculture, pasture, and mixed environs	0	29,956	29,956	—
Urban and mixed enviorns	0	7,743	7,743	—
Lakes, rivers, ponds, and reservoirs	1,236	3,468	2,232	181
Herbaceous wetlands	0	55	55	—
Eastside riparian wetlands	4,806	0	–4,806	–100

The degree of impact changes in the availability of a WHT will have on a particular species depends on the degree of association a species has with the WHT. A species known to depend on a habitat for part or all of its life history requirements is considered closely associated with that WHT. A species identified as having a close association with a WHT has an essential need for this habitat for its maintenance and viability. Some species may be closely associated with more than one WHT during different times of the year or for different activities. Some species are not closely associated with any WHT but are rather generally associated with a number of WHTs. In this case, the WHTs play a supportive role in the species maintenance and viability, but the species may be more dependent on a particular structural condition (see information about structural condition below; Johnson and O'Neil 2001).

The WHTs that Snake Hells Canyon subbasin concern species were closely associated with during any life stage are displayed in Figure 45. A species may be closely associated with more than one WHT or with a WHT that does not occur in the subbasin. The open water, herbaceous wetland and montane conifer forest WHTs have the greatest total number of closely associated species (Figure 45). Therefore, alterations in these WHTs are likely to have the most widespread impacts on the ecosystem of the subbasin. The broad-scale historic and current WHT data displayed in Table 32 indicate that the abundance of these WHTs has increased within the subbasin. If the availability of habitat were the only factor influencing populations of the wildlife species closely associated with these habitats, their populations could be expected to have increased. However, as illustrated in section 3.5, this is not always the case. Many of the species dependent on these WHTs have experienced population declines, which can be partially explained by the influence of structural condition and habitat elements on wildlife habitat (discussed in the following section), as well as by out-of subbasin conditions (see section 4.2.1).

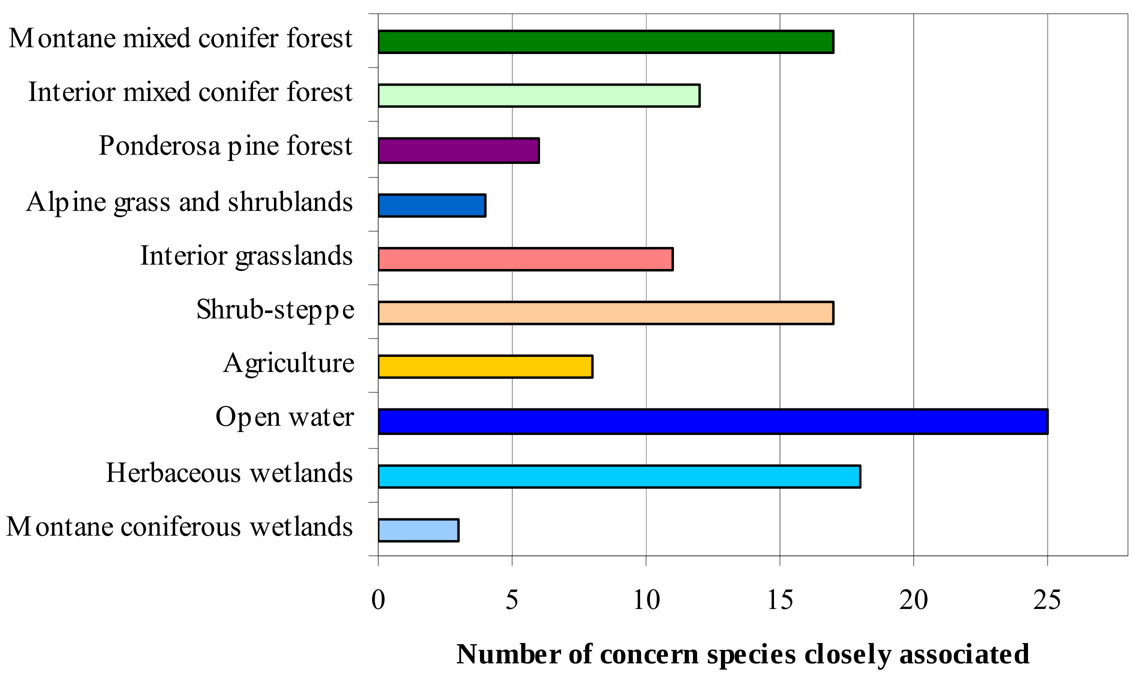

Figure 45. WHTs concern species of the Snake Hells Canyon subbasin are closely associated with.

Table 32 indicates that declines in the availability of the lodgepole pine, subalpine parklands, eastside grasslands, and riparian wetland WHTs have occurred in the subbasin. Some of these changes are likely the result of differences in the spatial scale and mapping techniques at which the historic and current WHT maps were compiled. For instance, subalpine parkland habitats in the subbasin may have declined slightly as a result of fire suppression in higher elevation habitats, but subalpine parkland habitats are still present in the subbasin and have not experienced the dramatic decline indicated by Table 32. Similarly, although riparian wetlands in the subbasin are reduced in extent and quality, they are still present.

Discussions with biological resource experts, as well as review of subbasin-specific literature and results of regional assessments, indicate that the reductions shown for riparian wetlands and interior grasslands are likely the most significant. These habitat types have declined in extent and quality in the subbasin, with impacts to the wildlife species that depend on them. For this reason, degradation and reductions in the extent of these types are considered to be among the primary limiting factors to wildlife in the subbasin. Additionally, declines in ponderosa pine (particularly mature types) have been shown to have occurred in the subbasin by finer-scale analysis conducted by the Cottonwood Field Office of the BLM (2002). Therefore, reduction in mature ponderosa pine habitats was also identified as one of the major limiting factors in the subbasin. See section 4.2.2 for a more detailed discussion of these limiting factors; see also the management plan for objectives and strategies aimed at reducing the impact of these limiting factors on the wildlife populations of the subbasin.

Structural Condition

Structural condition is another important feature determining the use of a habitat by a wildlife species. As with WHTs, a species widely known to depend on a structural condition for part or all of its life history requirements is considered closely associated with that structural condition. A species identified as having a close association with a structural condition has an essential need for this habitat for its maintenance and viability. Grassland, forest, agricultural, and urban habitats all exhibit structural conditions that influence wildlife habitat use. Due to the relatively small amount of agricultural and urban habitats contained in the subbasin, the relatively small number of closely associated species (eight for agriculture but none for urban), and time constraints, wildlife use of different structural conditions in these WHT was not considered.

Forest

Forest structural conditions are based on the following attributes: 1) tree size diameter at breast height, 2) percent canopy cover (or percent grass/forb cover), and 3) number of canopy layers. Johnson and O'Neil (2001) defined 26 different classes of forest structure conditions based on the attributes described in Table 33. Appendix E contains detailed descriptions of the characteristics of the forest structure classes.

Table 33. Attributes used to differentiate forest structure classes (Johnson and O'Neil 2001).

Tree Size (dbh)	
Shrub/Seedling	<1"
Sapling/Pole	1–9"
Small Tree	10–14"
Medium Tree	15–19"
Large Tree	20–29"
Giant Tree	≥30"

Percent Canopy Cover	
Open	10–39%
Moderate	40–69%
Closed	70–100%

Number of Canopy Layers	
Single Story	1 stratum
Multistory	2 or more strata

Twenty-two of the concern species with habitat in the subbasin are closely associated with a forest structural condition for a life activity (Figure 46). All of these species were closely associated with more than one structural condition. In general, the greatest number of species were closely associated with large to giant-sized class forests or early seral structural conditions, but concern species were closely associated with all of the structural conditions (Figure 46). This association illustrates the importance of maintaining a diversity of structural conditions on the landscape.

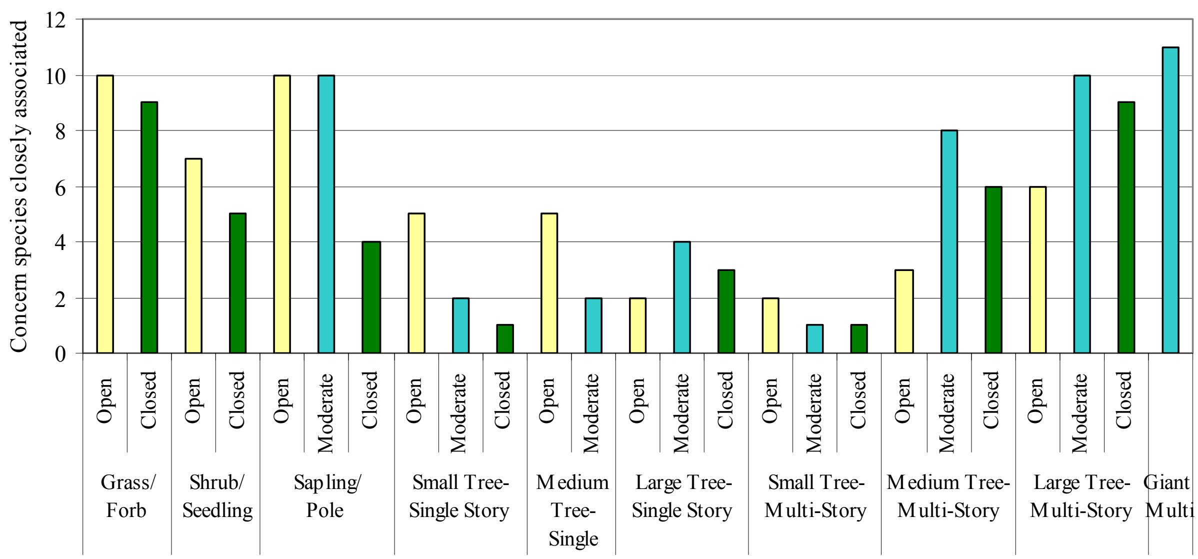

Figure 46. Number of concern species closely associated with forest structural conditions.

Grassland

Grassland structure is determined by 1) shrub height, 2) percent shrub cover (or percent grass/forb cover), and 3) shrub age class. Johnson and O'Neil (2001) defined 20 different classes of grassland structural conditions based on the attributes described in Table 34.

Appendix E contains more detailed descriptions of the characteristics of the grassland structure classes.

Table 34. Attributes used to differentiate grassland structure classes (Johnson and O'Neil 2001.

Shrub Height	
Low	≤1.6 ft
Medium	1.6–6.4 ft
Tall	6.5–16.5 ft

Percent Shrub Cover	
Open	10–69% shrub cover
Closed	70–100% shrub cover

Shrub Age Class	
Seedling/Young	negligible crown decadence
Mature	≤25% crown decadence
Old	26–100% crown decadence

Nineteen of the concern species are closely associated with a grassland structural condition for a life activity (Figure 47). Most of these species were closely associated with more than one structural condition. The greatest number of species were closely associated with grass/forb areas without shrubs. However, concern species were closely associated with a wide variety of grassland structural conditions (Figure 47). Maintaining a diversity of structural conditions and mimicking the natural pattern of distribution to which wildlife species have adapted should be the goal.

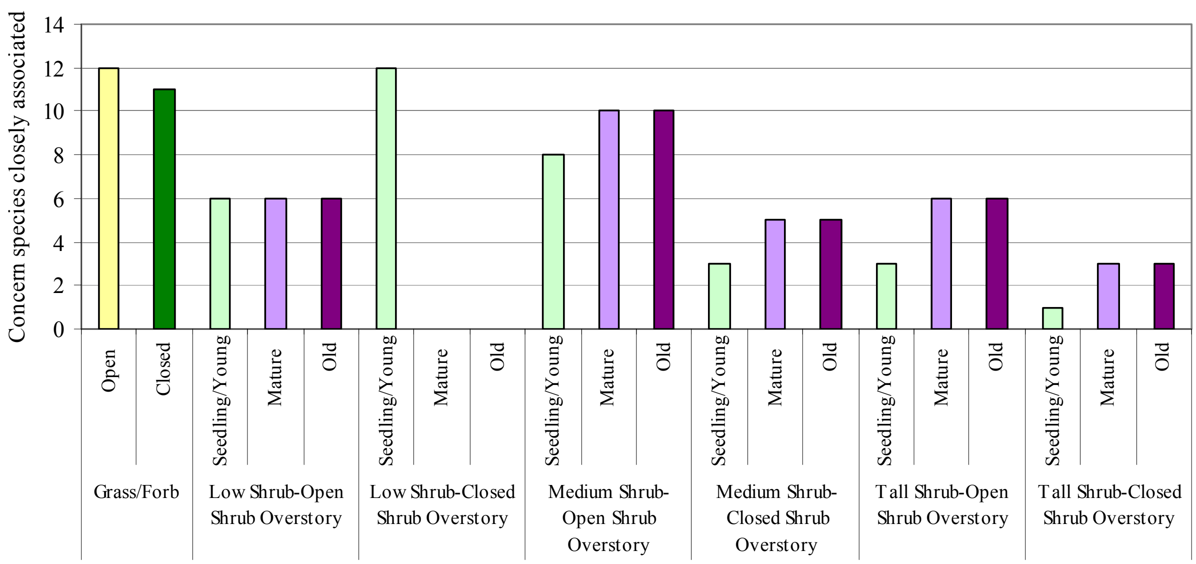

Figure 47. Number of concern species closely associated with grassland structural conditions.

Comparison of historic and current availability of structural conditions

Historic range of variability (HRV) is defined as the natural fluctuation of ecological and physical processes and functions that would have occurred in an ecosystem during a specified previous period of time. The Wallowa-Whitman National Forest has developed an HRV for the subbasin and surrounding area that identifies a range of forest structural stages that was likely to have occurred prior to Euro-American settlement of northeastern Oregon (approximately 1850) (USFS 2003a).

Table 35. Historic range of variability for forested structural stages by biophysical environment.

Biophysical Environment Groups	Structural Stage (%)			
	Very early	Early	Mid	Late
Group 1—Alpine fir and lodgepole pine cool-cold/moist	1-10 (10)	5-25 (10)	5-70 (45)	5-70 (35)
Group 2—Alpine fir and lodgepole pine cold/dry	1-10 (10)	5-25 (10)	5-70 (45)	5-70 (35)
Group 3—Alpine fir and lodgepole pine cool/dry	1-10 (10)	5-25 (20)	5-50 (40)	5-60 (30)
Group 4—Grand fir cool/dry	1-10 (10)	5-50 (15)	5-50 (50)	5-60 (25)
Group 5—Douglas-fir warm/dry	1-15 (10)	5-25 (15)	5-55 (50)	5-55 (25)
Group 6—Douglas-fir warm/moist	1-15 (10)	5-25 (15)	10-55 (45)	5-55 (30)
Group 7—Ponderosa pine hot/dry	1-15 (10)	5-25 (15)	5-70 (45)	5-70 (30)
Group 8—Ponderosa pine hot/moist	1-15 (10)	5-25 (15)	5-70 (40)	5-50 (35)

The Wallowa-Whitman National Forest has conducted comparisons of the current structure of portions of the subbasin's forests to the historic range at the scale of a 5th field HUC. Those seral/structural stages determined to be in excess of the HRV by biophysical environment for the watershed were identified as potentially available for treatment. Further analysis on these potentially available acres identified the number of acres having the highest risk for insect and disease infestations as well as those at greatest risk for high-intensity fire. This comparison allowed for vegetative treatment recommendations in the *Hells Canyon National Recreation Area Comprehensive Management Plan*. Comparisons of current data to the HRV were available for two 5th field watersheds in the subbasin: the Snake River Pittsburg watershed and the Snake River Rogersburg watershed. Analysis was conducted in the USFS Management Areas (MAs) where vegetative treatment is permissible. The analysis of the Snake River Rogersburg watershed was combined with two other watersheds that lie outside the subbasin, but conditions are considered to be relatively uniform. Analysis for the other 5th field HUC that falls within the HCNRA, Snake River–Hat Point, is planned within the next couple of years (USFS 2003a). The amount of late/old-structure forest was found to be below the historic range of variability on the Snake River Pittsburg watershed (Table 36). Late/old-structure forests in both watersheds were found to be highly susceptible to insects and disease as a result of forest densities and species composition. Both watershed's mid-seral structures substantially exceeded the HRV and were very susceptible to insects and disease. Comparisons of young sapling areas to the HRV were not conducted, but both watersheds had fewer than 3,000 acres (Table 36).

Table 36. Comparison of current vegetative structure to the historic range of variability for two watersheds in the upper Snake Hells Canyon subbasin (based on USFS 2003a).

Forested Vegetation Structure and Condition	Snake River-Pittsburg (MAs 4, 9,11,12)	Lower Imnaha, Upper Joseph, Snake River-Rogersburg (MAs 9,10,11)
Total acres late/old structure:	3,640	8,830
Acres of late/old structure in excess of HRV	–3,200	1,650
Acres of late/old highly susceptible to insects and diseases	1,735	2,125
Total acres of early/late to mid-structure:	16,800	16,300
Acres of early/ late to mid-structure in excess of HRV	4,425	2,450
Acres of early/ late to mid-structure highly susceptible to insects and diseases	6,220	1,950
Total acres of young saplings:	2,060	2,900
Acres of young saplings needing precommercial thinning	2,060	2,900

Key Environmental Correlates

Key environmental correlates (KECs) (also termed Habitat Elements) are specific substrates, habitat elements, and attributes of species' environments that are not represented by overall (macro) habitats and vegetation structural conditions. Key environmental correlates are the finest scale features that help to define wildlife habitat. KECs recognize and attempt to qualify the high degree of influence either positive or negative the environmental correlates exert of the realized fitness of a species (Johnson and O'Neil 2001). They include natural elements (both environmental and physical), 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 its habitat associations expands the concept and definition of a habitat, a term widely used only to characterize the vegetative community or structural condition occupied by a species (See Appendix J for KEC definitions; Johnson and O'Neil 2001). Failing to address and inventory KECs within these communities and conditions may lead to errors of commission; that is, species may be presumed to occur when in actuality they do not (Johnson and O'Neil 2001).

The technical team reviewed the KECs identified to influence the wildlife species of the subbasin. Based on their understanding of the factors most influencing wildlife populations in the subbasin they identified roads and noxious weeds as limiting factors. These limiting factors are discussed in greater detail in section 4.2.2. The technical team identified strategies for reducing the negative impacts of these KECs on the wildlife populations of the subbasin in the Snake Hells Canyon Subbasin Management Plan.

4 Limiting Factors and Conditions

4.1 Limiting Factors to Fish

4.1.1 Out-of-Subbasin Factors

All focal aquatic species are impacted to some degree by the effects of hydropower development on the Snake River both upstream and downstream of the Hells Canyon reach. Those impacts related to downstream hydropower development are considered to be "out-of-subbasin" effects since they only impact those fish moving to or from the subbasin. For organizational purposes, those impacts related to upstream hydropower developments are considered with in-subbasin effects and discussed below since they impact all aquatic species using the mainstem Snake River within the subbasin. Appendix G provides a regional overview of out-of-subbasin factors impacting anadromous fish in the Columbia Basin, including areas above Lower Granite Dam. Information presented here focuses on downriver impacts to Snake River stocks and, when possible, those populations or stocks specific to the Snake Hells Canyon subbasin.

It is generally accepted that hydropower development on the lower Snake River and Columbia River is the primary cause of decline and continued suppression of Snake River salmon and steelhead (WDFW et al. 1990; CBFWA 1991; Northwest Power Planning Council 1992; NMFS 1995, 1997; NRC 1995; IDFG 1998; Williams et al. 1998). However, less agreement exists about whether the hydropower system is the primary factor limiting recovery (Mamorek et al. 1998). This limiting factor keeps yearly effective population size low and increases genetic and demographic risk of localized extinction.

Currently, the estimated direct survival of Snake River spring/summer chinook smolts through the hydrosystem is between 40 and 60%, compared with an estimated survival rate during the 1970s of 5% to 40%. These improvements have occurred as a result of changes in the operation and configuration of the FCRPS, which include increased spill, barging, increased flow, changes in the operation of turbines, and new extended-length screens at McNary, Little Goose, and Lower Granite dams (NMFS 2000a).

Adult escapement of anadromous species remains low, even given significant hatchery production/reintroduction efforts. Low adult abundance has resulted in stocking at variable rates between years, depending on the availability of brood fish (Walters et al. 2001). Smolt-to-adult return rates (SAR), from smolts at the uppermost dam to adults returning to the Columbia River mouth, averaged 5.2% in the 1960s before the hydropower system was completed and only 1.2% from 1977 to 1994 (Petrosky et al. 2001) (Figure 48). These rates are below the 2 to 6% needed for recovery (Mamorek et al. 1998).

In contrast to the decline in SAR, numbers of smolts per spawner from Snake River tributaries did not decrease during this period, averaging 62 smolts per spawner before hydrosystem completion and 100 smolts per spawner afterward (Petrosky et al. 2001) (Figure 48). In this section, both spawner escapement and smolt yield are measured at the uppermost mainstem dam (currently Lower Granite). The increase in smolts per spawner was due to a reduction in density dependent mortality as spawner abundance declined. Accounting for density dependence, a modest decrease occurred in smolts per spawner from Snake River tributaries over this period but not of a magnitude to explain the severe decline in life-cycle survival (Petrosky et al. 2001).

The dams cause direct, indirect, or delayed mortality, mainly to emigrating juveniles (IDFG 1998, Nemeth and Kiefer 1999). As a result of this increased mortality, Snake River spring and summer chinook declined at a greater rate than downriver stocks, coincident with completion of the federal hydropower system (Schaller et al. 1999). Schaller et al. (1999) concluded that no other factors than hydropower development have played a significant role in the differential decline in performance between upriver and downriver stocks. The Snake River stocks above eight dams survived one-third as well as downriver stocks migrating through three dams for this time period, after taking into account factors common to both groups (Schaller et al. 1999; Deriso 2002). The additional decline in productivity of upriver stocks relative to downriver stocks indicates that this portion of the mortality is related to factors unique to upriver stocks. Patterns of Pacific Decadal Oscillation and salmon production would indicate that poor ocean conditions existed for Columbia River salmon after the late 1970s (Hare et al. 1999). However, the natural fluctuations of ocean productivity affecting all Columbia River stocks, in combination with mortality as a result of the hydrosystem, appear to have caused the severe declines in productivity and survival rates for the Snake River stocks. Temporal and spatial patterns of hatchery release numbers did not coincide with the differential changes in survival rates between upriver and downriver stocks (Schaller et al. 1999). Harvest rates were drastically reduced in the early 1970s, in response to declines in upriver stream-type chinook abundance. Given that changes in smolts per spawner cannot explain the decreases in SAR or overall survival rates for Snake River stocks, it appears that the altered migration corridor has had a strong influence on the mortality that causes these differences in stock performance.

The observations about SAR rates and smolts per spawner (Figure 48) indicate that the overall survival decline is consistent primarily with hydrosystem impacts and poorer ocean conditions (out-of-subbasin factors) rather than with large-scale impacts within the subbasins between the 1960s and present (Schaller et al. 1999, Petrosky et al. 2001). Because the smolt/spawner data represent aggregate populations from a mix of habitat qualities throughout the Snake River basin and are from a period after hydropower development, they do not imply that there is no room for survival improvement within the Salmon, Clearwater, Grande Ronde, and Imnaha subbasins. However, because of limiting factors outside the subbasin and critically reduced life-cycle survival for populations even in pristine watersheds, it is unlikely that potential survival improvements within the Snake River subbasins alone can increase survival to a level that ensures recovery of anadromous fish populations.

Predation of salmonid smolts by various species also represents a potential limiting factor to survival, particularly within reservoirs. Shively et al. (1996) found that pikeminnow predation would be minimized when water velocity was greater than 1 m/s and water depth exceeded 10 m, suggesting that predation by pikeminnow is not a significant threat to outmigrating salmon within the Snake Hells Canyon subbasin itself due to the riverine nature of the reach. However, predation by pikeminnow is substantial throughout all or portions of the downstream migration corridor. Northern pikeminnow, a native predator, have become well adapted to the habitat created by river impoundment and have been shown to have substantial predatory impacts on migrating salmonids (Beamesderfer and Rieman 1991, Petersen 1994, Collins et al. 1995).

Other key piscivorous fish species that may pose a potential limiting factor to anadromous salmonids include walleye, channel catfish, Pacific lamprey, yellow perch, largemouth bass, northern pike, and bull trout (NMFS 2000b). Although not necessarily associated with the Snake Hells Canyon reach, these species have been found to consume considerable numbers of outmigrating subyearling chinook and steelhead, and they are most closely associated with areas upstream and downstream of impoundments. Avian predator populations are also blamed for salmonid predation. These include the Caspian tern, double-crested cormorant, and three species of gulls (NMFS 2000b). Marine mammals, specifically members of the order Pinnepedia (e.g., Pacific harbor seals and California sea lions), represent additional threats to chinook and steelhead (NMFS 2000b).

Out-of-subbasin harvest of Snake River fall chinook, which were harvested up to a 70 to 80% exploitation rate in the lower Columbia River and the ocean (G. Mendel, WDFW, personal communication, May 2001), may have had substantial impacts to that population within the Snake Hells Canyon subbasin. Harvest on the Snake River stock was especially high during the years when they were mixed with particularly large returns of fall chinook salmon destined for the Hanford reach of the middle Columbia River. The listing of fall chinook under the ESA and renegotiations under the *Columbia River Fishery Management Plan* has substantially reduced the exploitation rate on the Snake River stock of fall chinook (G. Mendel, WDFW, personal communication, May 2001).

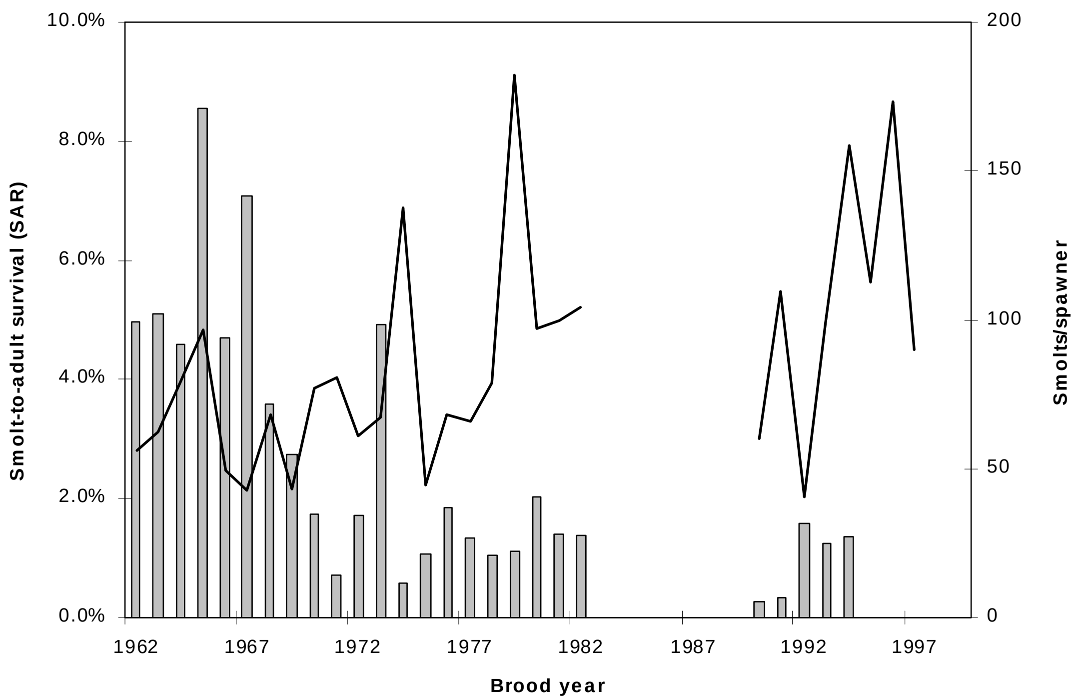

Figure 48. Smolt-to-adult survival rates (bars; SAR) and smolts/spawner (solid line) for wild Snake River spring and summer chinook. The SAR describes survival during mainstem downstream migration to adult returns, and the number of smolts per spawner describes freshwater productivity in upstream freshwater spawning and rearing areas (from Petrosky et al. 2001).

4.1.2 Local Limiting Factors—Overview

Hatcheries

The wild component of the Snake River spring/summer and fall chinook ESUs are currently considered to be at some risk of extinction due in part to the influence of hatcheries (NMFS 2000a). The hatchery contribution to Snake River fall chinook escapement has been estimated at greater than 47%[1] (Myers et al. 1998). Hatchery-origin spring/summer chinook comprise an estimated 80% of the Columbia River run (Lichatowich and Mobrand 1995).

The effectiveness of hatchery fish spawning in the wild has been considered to influence the growth rate of wild spring/summer and fall chinook (NMFS 2000a). NOAA Fisheries estimates the growth rate (lambda) of Snake River spring/summer chinook to be between 0.96 and 0.80; growth rate for Snake River fall chinook was estimated to be between 0.94 and 0.86.[2] For Snake River spring/summer chinook index stocks, extinction estimates 100 years from now range from 0.0 to 0.78, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0) and from 0.0 to 1.00, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%). For fall chinook, extinction risk estimates 100 years from now range from 0.40, assuming that hatchery fish spawning in the wild have not reproduced (i.e., hatchery effectiveness = 0) to 1.00, assuming that the hatchery fish spawning in the wild have been as productive as wild-origin fish (hatchery effectiveness = 100%; see Tables B-5 and B-6 in McClure et al. 2000).

Hydropower/Water Storage

As mentioned earlier, all focal aquatic species are impacted to some degree by the effects of hydropower development on the Snake River both upstream and downstream of the Hells Canyon reach. Those impacts related to downstream hydropower development are considered to be "out-of-subbasin" effects since they only impact those fish moving to or from the subbasin. Those impacts related to upstream hydropower developments are considered with in-subbasin effects and discussed below since they impact all aquatic species using the mainstem Snake River within the subbasin. The major impacts of hydropower development are on those species that primarily use the mainstem Snake River for much of their life history, particularly fall chinook and white sturgeon.

Fall chinook are particularly susceptible to the effects of hydropower development because of inundation of preferred spawning and rearing habitats in mainstem rivers and because juveniles migrate to the ocean in late spring, summer, and fall during low summer flows and high water temperatures. The changes to habitat, flow, and thermal regimes have affected spawn timing, spawning location, and outmigration success of fall chinook in the Snake Hells Canyon subbasin.

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[1] See Mendel (2000) for run composition at Lower Granite Dam. Initially, 67% of fish at Lower Granite Dam were hatchery origin, but with removal of hatchery fish at the dam, this value was reduced to 47% hatchery escapement past the dam.

[2] Estimates of median population growth rate, risk of extinction, and likelihood of meeting recovery goals are based on population trends observed during a base period beginning in 1980 and including 1999 adult returns (spring/summer chinook) or beginning in 1980 and including 1996 adult returns (fall chinook). Population trends are projected under the assumption that all conditions will stay the same.

Flow releases from Hells Canyon Complex were determined to play a significant role in shaping flow and temperature regimes in the Snake River downstream to RM 167 during fall chinook adult immigration, spawning, and egg incubation life history phases (Rondorf and Miller 1994; Rondorf and Tiffan 1994, 1996). Reservoir heating of water in upriver pools during summer months and its subsequent release out of Hells Canyon Dam likely contribute to documented higher water temperatures above the confluence of the Salmon River (Rondorf and Tiffan 1996). These temperatures may exacerbate fall chinook immigration and spawning delays, while accelerating egg incubation and juvenile emigration (Rondorf and Tiffan 1996). Consequently, the fish from the Snake Hells Canyon subbasin arrive at Lower Granite Dam, on average, up to four weeks later than they did before development of the Hells Canyon Complex and the four lower Snake River projects (NMFS 2000a). Johnson and Stangl (BLM 2000a) found that fall chinook fry emerging later than mid-May may not be large enough to begin their downstream migration as age 0 fish. Delays in chinook outmigration may also occur due to slack water impoundments (i.e., upper pool of Lower Granite Dam). Combined, the delays place juvenile migrants in reservoirs during periods when water temperatures approach chinook salmon's thermal tolerance (NMFS 2000a).

Studies examining smoltification timing suggest that the protracted emigration exhibited by Snake Hells Canyon subbasin fall chinook may confer a survival disadvantage to downstream migration life history phases (Rondorf and Tiffan 1997). Gill ATPase followed a trend of increasing activity until late June followed by a decline throughout the remainder of the summer (Rondorf and Tiffan 1997). Similarly, subyearling chinook exhibited the most net downstream movement at velocities of 6 to 18 in/s early in the season and less movement as the season progressed. This delay often places late-arriving fall chinook in unsuitable reservoir environments and may increase their susceptibility to predation.

Hydropower projects have isolated white sturgeon populations within the Snake Hells Canyon subbasin by restricting their movements into or out of the reach. Downstream impoundments have dramatically affected the historical food base of white sturgeon, as illustrated by the marked decrease in anadromous fish and lamprey returns following construction of the four lower Snake River dams (CBFWA 1999). The influence of upstream impoundments on flows may limit spawning and incubation success, alter thermal regimes, and decrease the amount of nutrients flowing downriver.

Harvest

Harvest of all wild chinook salmon has been curtailed in Idaho, Oregon, and Washington. The effects of in-subbasin harvest may not be a limiting factor to spring/summer or fall chinook within the Snake Hells Canyon subbasin. Out-of-basin harvest (as discussed previously) may, however, limit overall production of the species in the subbasin.

Incidental harvest of Snake River fall chinook by steelhead fisherman has been documented in the Snake Hells Canyon subbasin (BLM 2000a; G. Mendel, WDFW, personal communication, May 2001). The chance for hooking mortality or illegal harvest during the fall does exist and may represent a minor threat to the population.

The presence of steelhead fishermen and recreational jet boaters on reaches used during fall chinook migration, spawning, and rearing life history phases may pose a harassment or habitat disturbance threat to the species (BLM 2000a,b). This threat is greatest during spawning and incubation periods since boaters can cause disturbance or mortality to spawning fish and/or physical harm to redds and incubating eggs (BLM 2000a,b). Redds at highest risk are those constructed in shallow waters, but maintenance of Snake River flows from Hells Canyon Dam reduces the overall threat.

Predation

Predation in the Snake Hells Canyon subbasin constitutes a potential limiting factor to anadromous species. Although studies to date have focused on predation of fall chinook, other anadromous species migrating through the mainstem system may be similarly impacted, at least in the manner and locations of predation. The amount of predation may differ substantially by species, although data are not available for all species.

Studies of juvenile fall chinook loss to smallmouth bass predation in 1996 and 1997 determined that predation was greatest near hatchery release sites (i.e., Pittsburg Landing) directly after hatchery releases (Tiffan et al. 1999). The 1996–1997 study, which encompassed a 67-mile reach above Asotin, Washington (RM 147), estimated 256 smallmouth/mile measuring at least 175 mm; the greatest concentration of fish (254 fish/mile) occurred downstream of the confluence of the Salmon River (Tiffan et al. 1999).

Despite smallmouth bass concentrations, predation on wild subyearling fall chinook salmon by smallmouth bass in the Snake Hells Canyon subbasin was determined to be low and infrequent, yet it may represent a small portion of the mortality encompassed in survival estimates of the juvenile fall chinook outmigration to Lower Granite Dam (Tiffan et al. 1999). Predator–prey size relationships, such as those observed by Zimmerman (1997), may be related to the percentage of mortality realized by predation losses of subyearling chinook. Smallmouth bass were found to consume smaller chinook in the spring than did northern pikeminnow (see below), and they consumed far more subyearling chinook salmon in summer than they did yearling chinook salmon in spring (Zimmerman 1997). The size selectivity of smallmouth predation on chinook may reflect the degree and timing of habitat overlap, as suggested by Tabor et al. (1993), who attributed high levels of smallmouth bass predation on subyearling chinook salmon in the Columbia River to the overlap of rearing habitat of subyearling chinook with the preferred habitats of smallmouth bass in summer. The consequence of size-selective predation would be increased vulnerability of wild juvenile salmonids, which are smaller than chinook salmon and steelhead reared in hatcheries (Zimmerman 1997).

Prey Base

The loss of prey bases may limit both bull trout and white sturgeon in the Snake Hells Canyon subbasin, although this relationship is not clearly defined. For bull trout, this relates to the loss of the anadromous prey base (parr/smolts) on which bull trout become particularly reliant during subadult and adult life history stages (Rieman and McIntyre 1993). For white sturgeon, power peaking at Hells Canyon Dam may have reduced the usable habitat for food sources used by white sturgeon, including Pacific lamprey, aquatic insect larvae, and freshwater mussels.

Habitat Degradation—Snake River

The mainstem Snake River provides the primary habitat area for all life history stages of fall chinook and white sturgeon within the Snake Hells Canyon subbasin. Bull trout may use habitat in the mainstem Snake River during adult migration and/or subadult foraging and rearing life history phases (year-long). Steelhead and spring/summer chinook use the mainstem Snake River primarily as an important migration corridor. Primary spawning and rearing habitats for these species occur within the tributary systems.

The effects of the hydrosystem have considerably reduced fall chinook habitat. Preferred spawning and rearing habitats have been inundated, and water quality limited. Increased sediment deposition in mainstem Snake River substrate may limit spawning and rearing success, although amounts appear to be at acceptable levels currently (BLM 2000a). Reduced summer temperatures have restricted fall chinook spawning areas to those that will accumulate a minimum of 960 thermal units from November 15 (spawning phase) to early May (emergence/early rearing phase; BLM 2000a). Cool summer water temperatures are suboptimal for spring/summer chinook rearing as well (BLM 2000b).

Although white sturgeon appear to be reproducing successfully in the Snake Hells Canyon subbasin, the population may be limited by reductions or losses of certain life history pathways. Lack of available habitat for sturgeon in the 4- to 15-year-old age class (3- to 6-foot sturgeon) appears to be restricting the life history stage, as indicated by the excessively slow growth rates demonstrated by Coon (Coon et al. 1977, Coon 1978). The mechanism by which habitat condition is restricting the population is unclear.

Because bull trout primarily use habitat in the mainstem Snake River during adult migration (August–September) and/or subadult foraging and rearing life history phases (year-long), isolation and degradation of habitat (respectively) are considered to be primary limiting factors. Although currently undefined, the Imnaha/Snake River bull trout core population may be at risk if migratory connectivity is lost (M. Hanson, ODFW, personal communication, April 19, 2001). Bull trout occurring in smaller mainstem tributary streams, such as Granite and Sheep creeks, may be reliant on the refounding capacity of fluvial fish (e.g., Rieman and McIntyre 1993) originating from larger tributaries such as the Imnaha or Grande Ronde rivers. While this interaction currently represents a data gap (M. Hanson, ODFW, personal communication, April 19, 2001), studies have established the importance of the mainstem Snake as migration habitat (Buchanan et al. 1997; USFWS 2000b; Hemmingsen et al. 2001a,b) connecting the lower Salmon, Imnaha, Grande Ronde, and upriver portions of the Snake rivers (BLM 2000a,b). Inadequate water quality (i.e., excessive stream temperatures) or inadequate flow may jeopardize access to the smaller systems and limit potential utilization of mainstem habitat (see Appendix F).

Habitat Degradation—Tributaries

Information presented in this section complements that presented in sections 4.1.3 and 4.1.4. The intent is to provide an overview of findings from existing literature about the impacts of tributary habitat degradation on fish populations within the Snake Hells Canyon subbasin. Details regarding the relative importance of individual habitat characteristics are presented in the subsequent section detailing limiting factors to mainstem (section 4.1.3) or tributary habitats (Qualitative Habitat Assessment [QHA], section 4.1.4).

Habitat quality within tributaries of the Snake Hells Canyon subbasin may limit key life history phases for spring/summer chinook, bull trout, and steelhead (BLM 2000a,b). Since summer steelhead rely on tributary habitats for spawning and a majority of rearing, they are most limited by access and/or habitat suitability.

Tributary habitat within the subbasin is limited in both quantity and quality. The USFS, BLM, IDFG, WDFW, and ODFW have surveyed tributary creeks within the Snake Hells Canyon subbasin. Steep gradient, poor pool-riffle structure, limited spawning gravel, limited summer stream flows, and natural anadromous/resident fish barriers are believed to limit productivity in most of these creeks. A total of 409.4 miles of fish-bearing streams were identified in the HCNRA (USFS 1999). Nearly all fish-bearing tributaries within the HCNRA had high water quality, with good streamside cover and little streambank instability (USFS 1999).

Tributary habitats below the Salmon River confluence have been degraded by road construction, timber harvest, development in riparian areas and floodplains, agriculture, livestock grazing, mining, recreation, and water uses (i.e., irrigation and water diversions; BLM 2000b). These land uses have reduced the water quality, water quantity, and habitat diversity and quality, thereby limiting the amount and availability of migratory, spawning, and rearing habitat for spring/summer chinook, bull trout, and steelhead. Many tributaries have elevated levels of sediment and high summer water temperatures or low summer flows. High-flow events have also resulted in habitat degradation (BLM 2000b) by scouring spawning substrate, filling pool habitat, and in some cases exporting large organic material.

Habitat conditions in Granite and Sheep creeks are less limited than those in other tributaries due to their wilderness designation. Similar to the lower portion of the subbasin, high-flow events (such as those occurring in 1996) have caused severe channel scouring in some tributaries (BLM 2000a). Channel characteristics in the subbasin, such as high-gradient tributaries and low stream flow, are also considered to limit the amount of habitat usable by spring/summer chinook (Northwest Power Planning Council 1990; BLM 2000a,b).

4.1.3 Mainstem Limiting Factors

Local factors limiting focal fish species in mainstem habitats (Table 37) have been drawn from existing publications and supplemented with professional judgment to incorporate new and/or additional information. Information in Table 37 summarizes subsequent textual descriptions of impacts of hatcheries, hydropower, predation, prey base, and habitat degradation. This information also complements the results of QHA modeling efforts conducted to assess limiting factors in tributary habitat areas (see the above section).

Limiting factors have been assigned a value of 1 to 3, depending on the degree to which they are thought to limit specific species within each of two mainstem reaches (above/below the mouth of the Salmon River). A value of 1 indicates a principal or most influential limiting factor, whereas a value of 3 indicates a less influential factor limiting population(s). A value of 2 represents factors of intermediate influence on populations. While factors have been individually “ranked” to aid in interpretation, all factors listed in Table 37 are considered limiting to local populations, and cumulative impacts of several factors ranked as 2 or 3 may outweigh the influence of an individual factor ranked as 1. Bold type is used to highlight factors in Table 37 that function primarily outside the Snake Hells Canyon subbasin but serve to limit populations within mainstem habitats of the subbasin itself.

Table 37. Summary of factors limiting focal fish species within mainstem habitats of the Snake Hells Canyon subbasin. Scores indicate level of influence (1—greatest influence, 3—least influence). Factors shown in bold are out-of-subbasin issues limiting to populations within the subbasin.

		Low Temperature	High Temperature	Base Flow	Flow Variation	Bedload	Connectivity/ Passage	Hatchery Influence	Harvest/Fishing	Predation	Harassment	Competitors
Upper Mainstem Snake River (above Salmon River confluence)												
White Sturgeon	Egg-Larval				3					3		
	Juvenile						**1**		3	3		3
	Adult		3				**1**		3			
Bull Trout	Egg-Larval	—	—	—	—	—	—	—	—	—	—	—
	Juvenile											
	Adult						**1**		3			
Pacific Lamprey	Egg-Larval											
	Juvenile						**1**					
	Adult						**1**					
Redband/ Steelhead	Egg-Larval	—	—	—	—	—	—	—	—	—	—	—
	Juvenile						**1**			3		
	Adult						**1**					
Spring Chinook	Egg-Larval	—	—	—	—	—	—	—	—	—	—	—
	Juvenile						**1**			2		
	Adult						**1**					
Fall Chinook	Egg-Larval	3	3									
	Juvenile	3	1	2				3		1		
	Adult		**3**			3	**1**	3	**1**			
Lower Mainstem Snake River (below Salmon River confluence)												
White Sturgeon	Egg-Larval									2		
	Juvenile						**1**		3			3
	Adult		3				**1**		3			
Bull Trout	Egg-Larval	—	—	—	—	—	—	—	—	—	—	—
	Juvenile											
	Adult						**1**		3			
Pacific Lamprey	Egg-Larval											
	Juvenile						**1**					
	Adult						**1**					
Redband/ Steelhead	Egg-Larval	—	—	—	—	—	—	—	—	—	—	—
	Juvenile						**1**			3		
	Adult						**1**					
Spring Chinook	Egg-Larval	—	—	—	—	—	—	—	—	—	—	—
	Juvenile						**1**			2		
	Adult						**1**					
Fall Chinook	Egg-Larval	1			3							
	Juvenile	1	1	1				3		1		
	Adult		**3**				**1**	3	**1**		3	
Sockeye	Egg-Larval	—	—	—	—	—	—	—	—	—	—	—
	Juvenile						**1**					
	Adult						**1**					

4.1.4 Tributary Limiting Factors—Qualitative Habitat Assessment

Qualitative Habitat Assessment (QHA; Mobrand Biometrics 2003b) was used to evaluate the relative condition of habitat variables within 43 individual tributary streams or segments utilized by steelhead trout and to define relative protection versus restoration needs (limiting factors) of each stream. Steelhead trout were chosen because 1) information is most abundant regarding their distribution and habitat use within the subbasin, 2) they are more widely distributed throughout subbasin tributaries than most other focal species, and 3) their distribution overlaps that of bull trout and spring chinook in tributary habitats. Redband trout populations may be more widespread than steelhead as they exist in many tributaries above steelhead migration barriers. However, in completing QHA for steelhead, the habitat condition of the entire length of each occupied stream was evaluated since upstream factors dictate downstream habitat conditions (e.g., riparian degradation above a passage barrier may result in temperature limitations in reaches below the barrier). This decision functionally equalized the habitat areas/conditions evaluated for steelhead with the wider distribution of redband trout.

Information included in this section is not a direct reflection of QHA outputs (Raw data used in, and outputs from the QHA model are included in Appendix H). Adjustment was made to QHA restoration scores/ranks to account for relevant factors not considered within the QHA model itself (e.g., amount of available habitat). To account for the differing amount of habitat (length of stream used by steelhead) between streams, QHA restoration scores were standardized based on the average utilized length (2.0 miles) of streams used by steelhead within the subbasin. The estimated length utilized within each individual stream was divided by 2.0; the result was then multiplied by the original QHA restoration score for that reach. The streams were reranked according to the resultant scores. This weighting process is important in an area where few tributary reaches provide substantial amounts of habitat, and it emphasizes restoration of those that do. Since restoration for common issues within Hells Canyon tributaries will most commonly need to proceed along the length of the stream channel (not only the portion utilized by steelhead), this process should also build in some level of potential cost effectiveness to the results (For example, restoration of riparian habitat along 10 miles of channel to ameliorate high temperatures may have a fixed cost. Cost effectiveness is achieved by benefiting the largest amount of utilized habitat with that restoration effort/expenditure).

No adjustment was made to original QHA protection scores/ranks. Protection of both larger and smaller habitat areas used by steelhead is critical to maintaining population/habitat diversity, regardless of reach length. This concept is consistent with the guiding principles of the accompanying subbasin management plan and with the scientific principles of the Northwest Power and Conservation Council's Fish and Wildlife Program (Northwest Power Planning Council 2000).

Comparison of protection versus (adjusted) restoration ranks for each reach evaluated indicates that most reaches clearly delineate themselves for either protection or restoration as the primary objective (Table 38). Seven stream reaches fall into the "middle ground" with respect to both priorities and are therefore prioritized for both protection and restoration activities.

Reaches prioritized for restoration activities are presented in rank order in Table 39; those prioritized for protection are presented in rank order in Table 40. In each of these tables, habitat priority factors in need of restoration or protection (respectively) are highlighted using rankings drawn from the QHA model outputs[3].

In tributaries prioritized for restoration, the factors of greatest concern (limiting factors) are riparian condition, fine sediment, and channel stability (Table 39). Localized limiting factors prioritized for restoration in lesser numbers of tributaries include high and low flow, pollutants (associated with grazing activities), high and low temperature, channel form, and oxygen. Inherent in the definition of all restoration needs is the interim need to protect from further degradation those same issues until restoration activities can occur.

In tributaries prioritized for protection, priority issues include fine sediment, riparian condition, channel stability, and high flow (Table 40). In those streams prioritized for both protection (Table 40) and restoration (Table 39) actions, prioritized factors often overlap. In these cases, measures should be implemented to protect against worsening of the current situation, with a longer-term goal of restoration of the necessary conditions.

Due to the generally short nature of production reaches within Hells Canyon tributaries, substantial percentages of steelhead production may occur in relatively unprotected reach (Wild/Scenic corridor) of a seemingly well-protected watershed and focused restoration activities may be warranted (e.g., Kirkwook, Big Canyon, Saddle, and Salt creeks; Table 39). Approximately the lower 0.25 mile of most steelhead-bearing streams is within the Snake Wild/Scenic River corridor (exceptions are Redbird, Captain John, and Corral-N creeks and Cave Gulch). Although the existence of the Wild/Scenic River corridor offers some degree of protection, it is generally far less than that associated with wilderness or National Recreation Area status that encompasses the majority of many tributary watersheds (Table 39 and Table 40).

[3] Within QHA, a maximum of 11 ranks are possible within each reach (one for each habitat variable). Due to tie rankings, the number of unique ranks observed in any reach considered in this assessment did not exceed 6. To extract only priority information from the QHA matrix, the following rules were applied in creating Table 39 and Table 40: If 2 to 3 unique ranks existed for a given reach, the singlemost important issue is highlighted in summary tables; if 4 to 6 unique ranks existed, the two most important issues are highlighted in summary tables. When two ranks are presented, they are presented as "1" and "2" in the summary tables to more clearly illustrate relative priority; original ranks from the QHA model may differ, depending on tie scores, and are presented in Appendix H.

Table 38. Comparative restoration versus protection value for streams within the Snake Hells Canyon subbasin based on (modified) QHA ranks for each activity.

Protection Rank **Restoration Rank**[1]	**High (1-10)**	**Moderate (11-25)**	**Low (26-43)**
High (1-10) (Note: Cells in this row have streams listed in order of Restoration Rank)			Priority = Restore Captain John Creek Getta Creek Dry Creek Divide Creek Cave Gulch Redbird Creek Kirkwood Creek Corral Creek (N) Wolf Creek Big Canyon Creek
Moderate (11-20) (Note: Cells in this row have streams listed in order of Restoration Rank)		Priority = Protect & Restore Saddle Creek Salt Creek Sand Creek Sluice Creek Battle Creek Somers Creek Two Corral Creek	Priority = Restore Cottonwood Creek Corral Creek (S) Jones Creek Kirby Creek
Low (21-27) (Note: Cells in this row have streams listed in order of Protection Rank)	Priority = Protect Granite Creek Little Granite Creek Sheep Creek Temperance Creek Cook Creek Deep Creek Lookout Creek Tryon Creek Rush Creek Rattlesnake Creek Rough Creek Wild Sheep Creek Bull Creek	Priority = Protect Pleasant Valley Creek Durham Creek North Fk Battle Creek Stud Creek Hells Canyon Creek Bernard Creek Three Creeks	Priority = Protect Brush Creek West Creek

[1] A total of 43 streams/reaches were rated for both protection and restoration. Multiple ties in restoration rankings result in a maximum restoration rank of 27.

Table 39. Restoration ranks[1] for streams and habitat variables within each, for streams prioritized primarily for restoration within the Snake Hells Canyon subbasin.

Restoration Rank	Stream Name[2]	State	Length [3]	Watershed Protection[4, 5]	Riparian Condition	Channel form	Channel Stability	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants [6]	Obstructions
1	Captain John Creek	ID	8.8	Craig Mtn	1	—	2	2	2	2	—	—	—	—	—
2	Getta Creek	ID	4.8	None	2	—	2	2	2	2	—	—	2	1	—
3	Dry Creek	ID	4.8	None	1	—	1	1	1	1	—	—	—	—	—
4	Divide Creek	ID	2.8	None	1	—	1	1	2	2	—	—	—	2	—
5	Cave Gulch	ID	4.6	Craig Mtn	1	2	1	1	2	—	2	2	2	2	—
6	Redbird Creek	ID	3.2	Craig Mtn	1	—	2	2	2	—	—	—	—	—	—
7	Kirkwood Creek	ID	3.9	NRA	1	—	2	2	—	—	—	—	—	1	—
8	Corral Creek (N)	ID	1.8	Craig Mtn	2	—	1	2	—	—	—	—	—	—	—
9	Wolf Creek	ID	0.6	None	2	—	2	1	—	—	—	—	—	—	—
10	Big Canyon Creek	ID	1.5	NRA	1	—	—	1	—	—	—	—	—	—	—
11	Cottonwood Creek	ID	0.9	Craig Mtn	2	—	2	1	2	—	—	—	—	—	—
12	Saddle Creek *	OR	5.7	Wild.	1	—	—	—	—	—	—	—	—	—	—
13	Salt Creek *	OR	2.8	Wild.	1	—	—	1	—	—	—	—	—	—	—
14	Corral Creek (S)	ID	0.7	NRA	1	2	1	1	—	2	2	2	—	2	—
14	Sand Creek *	OR	2.1	Wild.	1	—	—	—	—	—	—	—	—	—	—
16	Jones Creek	ID	0.7	NRA	—	—	—	1	—	—	—	—	—	—	—
17	Sluice Creek *	OR	2.2	Wild.	1	—	—	—	—	—	—	—	—	—	—
18	Battle Creek *	OR	1.5	Wild.	1	—	—	—	—	—	—	—	—	—	—
18	Somers Creek *	OR	1.4	Wild.	—	—	—	1	—	—	—	—	—	—	—
20	Kirby Creek	ID	1.0	NRA	—	—	—	1	—	—	—	—	—	1	—
20	Two Corral Creek *	OR	0.5	Wild.	1	—	—	1	—	—	—	—	—	—	—

[1] Uses "adjusted" reach ranks (previously described) to give weight to amount of usable habitat (stream length). When two variable ranks are presented, scores of 1 and 2 are used to illustrate relative priority; original ranks from the QHA model may differ, dependent on tie scores, and are presented in Appendix H.

[2] Streams prioritized as "protect and restore" in Table 38 are included in both Table 39 and Table 40 and are marked with an asterisk (*).

[3] Measurement is an estimate of the length of channel utilized by steelhead rather than the overall channel length.

[4] Signifies the dominant protection status of the contributing watershed: Wild. = Wilderness Area; NRA = National Recreation Area; Craig Mtn.= Craig Mountain wildlife mitigation or study area. See section 1.5.2 for descriptions of protected status of these areas.

[5] Approximately the lower 0.25 mile of most streams is within the Snake Wild/Scenic River corridor and not afforded the greater protection often associated with the majority of the watershed. Exception sare Redbird, Captain John, Corral (N) creeks and Cave Gulch do not have portions contained within the WSR corridor.

[6] For this exercise, pollutants include inputs related to grazing activities.

Table 40. Protection ranks[1] for streams and habitat variables within each, for streams prioritized primarily for protection within the Snake Hells Canyon subbasin.

Protection Rank	Stream Name[2]	State	Length [3]	Current Protection[4,5]	Riparian Condition	Channel form	Channel Stability	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
1	Granite Creek	ID	14.9	Wild.	1	—	1	1	1	—	—	—	—	—	—
1	Little Granite Creek	ID	1.3	Wild.	1	—	1	1	1	—	—	—	—	—	—
1	Sheep Creek	ID	2.3	Wild.	1	—	1	1	1	—	—	—	—	—	—
4	Bull Creek	OR	0.3	Wild.	1	—	2	1	2	—	—	—	—	—	—
4	Cook Creek	OR	0.6	NRA	1	—	2	1	2	—	—	—	—	—	—
4	Deep Creek	OR	0.5	Wild.	1	—	2	1	2	—	—	—	—	—	—
4	Lookout Creek	OR	0.3	Wild.	1	—	2	1	2	—	—	—	—	—	—
4	Rattlesnake Creek	OR	0.4	Wild.	1	—	2	1	2	—	—	—	—	—	—
4	Rough Creek	OR	0.3	Wild.	1	—	2	1	2	—	—	—	—	—	—
4	Rush Creek	OR	2.0	Wild.	1	—	2	1	2	—	—	—	—	—	—
4	Temperance Creek	OR	2.5	Wild.	1	—	2	1	2	—	—	—	—	—	—
4	Tryon Creek	OR	0.3	Wild.	1	—	2	1	2	—	—	—	—	—	—
4	Wild Sheep Creek	OR	0.3	Wild.	1	—	2	1	2	—	—	—	—	—	—
14	Battle Creek *	OR	1.5	Wild.	2	—	2	1	2	—	—	—	—	—	—
14	Durham Creek	OR	0.1	Wild.	2	—	2	1	2	—	—	—	—	—	—
14	Hells Canyon Creek	OR	0.2	Wild.	2	—	2	1	2	—	—	—	—	—	—
14	N.Fk. Battle Creek	OR	0.3	Wild.	2	—	2	1	2	—	—	—	—	—	—
14	Pleasant Valley Cr.	OR	0.3	Wild.	2	—	2	1	2	—	—	—	—	—	—
14	Saddle Creek *	OR	5.7	Wild.	2	—	2	1	2	—	—	—	—	—	—
14	Sluice Creek *	OR	2.2	Wild.	2	—	2	1	2	—	—	—	—	—	—
14	Somers Creek *	OR	1.4	Wild.	1	—	2	2	2	—	—	—	—	—	—
14	Stud Creek	OR	0.3	Wild.	2	—	2	1	2	—	—	—	—	—	—
23	Bernard Creek	ID	1.5	Wild.	2	—	2	1	2	—	—	—	—	—	—
23	Salt Creek *	OR	2.8	Wild.	1	2	1	1	1	—	2	2	2	2	—
23	Sand Creek *	OR	2.1	Wild.	—	—	2	1	2	—	—	—	—	—	—
23	Three Creeks	ID	Unk	Wild.	2	—	2	1	2	—	—	—	—	—	—
23	Two Corral Creek *	OR	0.5	Wild.	1	2	1	1	1	—	2	2	2	2	—

[1] Uses "adjusted" reach ranks (previously described) to give weight to amount of usable habitat (stream length). When two variable ranks are presented, scores of 1 and 2 are used to illustrate relative priority; original ranks from the QHA model may differ, dependent on tie scores, and are presented in Appendix H.

[2] Streams prioritized as "protect and restore" in Table 38 are included in both Table 39 and Table 40 and are marked with an asterisk (*).

[3] Measurement is an estimate of the length of channel utilized by steelhead rather than the overall channel length.

[4] Signifies the dominant protection status of the contributing watershed: Wild. = Wilderness Area; NRA = National Recreation Area; Craig Mtn.= Craig Mountain wildlife mitigation or study area. See section 1.5.2 for descriptions of protected status of these areas.

[5] Approximately the lower 0.25 mile of most streams is within the Snake Wild/Scenic River corridor and not afforded the greater protection often associated with the majority of the watershed. Exception sare Redbird, Captain John, Corral (N) creeks and Cave Gulch do not have portions contained within the WSR corridor.

4.2 Limiting Factors to Wildlife

4.2.1 Out-of-Subbasin Factors

Many of the wildlife species of the Snake Hells Canyon subbasin spend a portion of their life cycle outside the subbasin boundaries. This can complicate and potentially reduce the effectiveness of wildlife management actions in the subbasin. Depending on the extent, location, and timing of seasonal movements, out of subbasin effects may range from limited to substantial.

Migratory birds are the species that travel the greatest distance outside of the subbasin. Two of the focal species in the subbasin are neotropical migrants that breed in the subbasin and winter in Mexico or Central America. Flammulated owls are the most migratory of all North American owls, going south of Mexico during most of the fall and winters. Grasshopper sparrows winter in the southern United States, south into Central America (Vickery 1996). Environmental toxins, and habitat degradation in these species winter habitats could have negative impacts on populations of the species in the Snake Hells Canyon subbasin. Birds migrating to Mexico and Central and South America, where environmental regulations are not as strong as in the U.S., continue to be exposed to relatively high levels of organochlorines. This group of chemicals includes DDT, the pesticide that caused egg shell thinning, reproductive failure and dramatic declines in bald eagle populations in the 1940s. DDT was banned in this country in 1972 but is still used in many other parts of the world (DeWeese et al. 1986).

Many other species in the subbasin make movements of smaller distance out of the subbasin. Large game species including the bighorn sheep, mountain goat, Rocky Mountain elk, and mule deer focal species may migrate into and out of the subbasin. This commonly results in crossing wildlife management units and potentially state boundaries and can complicate the setting of appropriate hunting seasons and harvest limits. Game species may experience greater hunting pressure when they move out of the subbasin into the more populated surrounding areas. Other potential out of subbasin impacts to game species include increased contact between bighorn sheep and domestic sheep and increased potential for disease transmission.

Species may migrate out of the subbasin in search of habitat and forage, finding high quality habitat may allow for increased populations in the subbasin, while use of unsuitable habitats may result in reduced populations. Agricultural areas are very limited in the subbasin but elk and particularly mule deer may migrate outside of the subbasin and forage on private agricultural lands. This results in reduced social carrying capacity and results in public pressure to reduce population management objectives. The relatively high quality grassland habitats of the subbasin provide suitable breeding habitats for grasshopper sparrow. But grasshopper sparrows are also documented to use agricultural areas and hayfields, these areas are not as suitable for breeding grasshopper sparrows and may serve as population sinks (Wisdom et al 2000).

Species with very large home ranges that occur in low densities may migrate into and out of the subbasin in search of prey and mates. Fisher, marten, and particularly lynx and wolverine are species with large home range sizes that may inhabit the Snake Hells Canyon subbasin. Maintaining and enhancing the integrity of movement corridors for these species may prove critical to maintaining genetic diversity and healthy populations of these species. For instance, mapping of documented wolverine sightings conducted by Edelmann and Copeland (1999) suggests that a narrow corridor in the Seven Devils mountain area of the subbasin may provide the only suitable habitat linking wolverine subpopulations in Idaho and Oregon. Reductions of dispersal rates through the corridor may impact the regional viability of wolverine by reducing genetic interchange and lowering the likelihood that all suitable habitat patches are continuously inhabited (Edelmann and Copeland 1999).

4.2.2 Local Limiting Factors

The primary limiting factors for wildlife in the Snake Hells Canyon subbasin were selected based on a comparison of threats identified for focal and concern species, with changes in habitat conditions identified at the scale of the WHT, structural condition and KEC in section 3.5.10. Addressing these habitat level limiting factors will provide the greatest benefit to the greatest number of species; the limiting factors were used as the starting point for the development of the objectives and strategies section of the *Snake Hells Canyon Management Plan.* There is a level of overlap between the limiting factors that is inherent to both this ecosystem level approach and the way the limiting factor were selected, for example, it was determined in section 3.5.10, that the loss and degradation of the grassland habitats in the subbasin was a primary limiting factor to the wildlife species that depend on these habitats. At the finer scale of the KEC it was determined that noxious weeds and invasive plant species were also primary limiting factor to the wildlife species of the subbasin. The impacts of noxious weed and invasive plant infestation have been most profound in the grassland habitats of the Hells Canyon subbasin and have been the primary mechanism for their degradation. The selection of both of these factors as limiting factors will result in some duplication in the development of objectives and strategies in the Management Plan but also provided an opportunity for the technical team to look at the issue from different perspectives and at different scales resulting in a more comprehensive plan for addressing these problems. A couple of limiting factors to focal species were identified that were not addressed at the habitat level, these species specific limiting factors are significant enough to the focal species to warrant consideration in the *Snake Hells Canyon Management Plan.* The approach chosen by the technical team of addressing coarse scale factors first and then looking for finer scale factors falling through the cracks has its president in numerous contemporary conservation ideas (TNC 2003).

Loss and degradation of grassland habitats

Grassland ecosystems have suffered the greatest losses of any habitats in the Columbia Plateau (Kagan et al.1999). The fescue-bunchgrass cover type which dominates the subbasins grasslands has declined by two thirds from historic levels across the Columbia Basin (Quigley and Arbelbide 1997). The subbasin falls at the edge of the Palouse Prairie, which has been identified as the most endangered ecosystem in the United States (Noss *et al.* 1995). Land conversion and livestock grazing coupled with the rapid spread of cheatgrass (*Bromus tectorum*) and a resulting change in the natural fire regime that has further altered the ecosystem (Altman and Holmes 2000 cited in Ashley and Stoval 2004).

The Snake Hells Canyon subbasin contains some of the healthiest grassland communities remaining in the Columbia Basin, but has still been affected by the disturbances that have eliminated most of these communities in the region (USFS 1999). Approximately 41,639 acres of the subbasin that once contained native grasslands have been converted to agriculture, pasture or urban environments. Most of this conversion has occurred in the northern/downstream portion of the subbasin (Figure 6). Much of the remaining grassland habitats in the subbasin have been altered due to livestock grazing, and the introduction of invasive plant species (BLM 2002).

Native grasslands of the region evolved without the heavy grazing pressures that occurred on the Great Plains (Mancuso and Moseley 1994). Heavy grazing in the late 1800s and early 1900s led to alterations in the community structure and aided in colonization by exotic annual grasses and noxious weeds (USFS 1999). Biological soil crusts are an important component of grassland habitats. Crusts reduce wind and water erosion by increasing soil stability, retaining moisture, and increase soil fertility through the addition of carbon, organic matter and soil micronutrients. Biological soil crusts develop slowly and are fragile in some areas crusts in the subbasin have been damaged through grazing, off-road vehicle use, invasion by exotic annual grasses, and fire (USFS 2003a).

Natural succession processes and changes in management have resulted recent upward trends in the condition of grassland habitats in much of the subbasin (USFS 2003a). However, many areas are still degraded and are reducing the subbasins ability to support grassland dependent wildlife species. Ten concern or focal wildlife species in the subbasin have been identified as being closely associated with grassland habitats, all of these species use these habitats for both feeding and breeding (Table 41; Johnson and O'Neil 2001).

Table 41. Concern and focal species closely associated with grassland habitats (Johnson and O'Neil 2001).

Common Name	Scientific Name
Burrowing Owl	*Speotyto canicularia*
Ferruginous Hawk	*Buteo regalis*
Grasshopper Sparrow	*Ammodramus savannarum*
Long-billed Curlew	*Numenius americanus*
Prairie Falcon	*Falco mexicanus*
Swainson's Hawk	*Buteo swainsoni*
Upland Sandpiper	*Bartramia longicauda*
Vesper Sparrow	*Pooecetes gramineus*
Western Pipistrelle	*Pipstrellus hesperus*
Western Small-footed Myotis	*Myotis ciiolabrum*

Additionally, two species that are thought to have been extirpated from the subbasin are closely associated with grassland habitats the sharp-tailed grouse and the white-tailed jackrabbit (Table 19). Grassland habitats are inhabited by numerous rare plant species in the subbasin including two species listed as Threatened under the Endangered Species Act, MacFarlane's four o'clock and Spalding's catchfly.

Two recent analysis of the condition of the grassland habitats have been conducted in the subbasin, one by the Forest Service in support of their HCRNA CMP (2003) and one by the Cottonwood office of the BLM in support of their lower Snake River EAWS (2002) (Figure 49 shows the areas considered in these analysis).

The Forest Service evaluates grassland seral stages to assess the current departure of a specific site from the Potential Natural Condition (PNC) for that site. A seral stage determination is an evaluation of the successional status of the plant community occurring on a site compared with the PNC that would occur on that site if succession progressed absent of outside influences. PNC is based on an evaluation of site characteristics including geology, soils, aspect, climate, elevation, etc., compared to similar site characteristics from areas evaluated and estimated by plant ecologists to be at or near their biotic potential. The types of vegetation associated with each seral class are described below; historically the grasslands in the HCNRA were dominated by mid to late seral-stage vegetation (USFS 2002a).

- Late- the natural/native species community perennial bunchgrasses dominate, with bare ground subordinate to other surface features (rock, gravel, microbiotic crusts, litter).
- Mid – native perennial forbs and grasses co-dominate with the potential natural community perennial bunchgrasses. Bare ground is subordinate or equivalent to other surface features.
- Early – native perennial forbs and other native grasses dominate over the potential natural community perennial bunchgrasses. Bare ground is equivalent to or more extensive than other surface features.
- Very early (Disclimax) – potential natural community perennial bunchgrasses are present on less than 5 percent of the stand. Bare ground is more extensive than other surface features.

Current information about the condition of HCNRA grasslands is limited and based on current and historic inventories (USFS 2002a). The USFS recently compared the existing grassland inventory information to the PNV to determine the ecological condition of grasslands on the HCNRA. Generally, satisfactory condition rangeland is in a mid-seral stage or later with a stable or improving condition trend. Two techniques were used to assess the condition of grasslands in the HCRNA. The first technique evaluated the ecological status and condition of permanent monitoring points on suitable or capable grazing lands. This technique identified that 76 percent of the sites were in satisfactory condition. The second technique analyzed ecological condition inventories on eight allotments, which included one vacant allotment selected to represent the diversity of conditions throughout the HCNRA. Analysis of capable and suitable acres on these allotments indicates 97 percent of the grazing allotments on the HCNRA are in satisfactory condition. Both analysis excluded areas such as historic homesteads, benches (plowed and farmed), and some of the flatter bottomlands and ridges where livestock were historically concentrated and where site potentials have been permanently altered; these areas contain the majority of early and very-early seral grasslands in the HCRNA (USFS 2003). Alternative E, the selected alternative in the Hells Canyon National Recreation Area Comprehensive Management Plan, focuses grassland restoration efforts in the HCNRA on deep soil benches in early seral condition (USFS 2003a).

The Cottonwood BLM assessed the condition of grasslands in their EAWS study area based on the percentage of the grassland dominated by noxious weeds and non-native grasses. Areas containing more than 70% native species were considered to be in good condition. Good condition grasslands were found to account for between 29 and 89 percent of the grassland habitats in the unit. The highest proportion of good condition grasslands was found to occur in the cottonwood creek subwatershed while mainstem Snake River subwatersheds tended to contain the lowest percentage of grasslands in good condition (Table 42). Although the methodology employed by the Cottonwood BLM in their assessment of grasslands in the middle sections of the subbasin is not directly comparable to those used by the Forest Service their analysis seems to indicate that overall grassland conditions in the middle portions of the subbasin are in inferior condition when compared to upstream areas. This is not surprising considering the higher rate of historic disturbance in these areas.

Table 42. Percent of grassland habitats in good condition (>70% native species) within Lower Snake River EAWS units

Unit Name	% of grassland in good condition
Captain John	61
Snake River and Tributaries 0303	29
Snake River and Tributaries 0401	49
Snake River and Tributaries 0402	49
Corral	61
Snake River, Cottonwood Creek	89

No quantitative information on the condition of grasslands in the lower subbasin was available but local knowledge indicates that grasslands in these areas are the most degraded. These areas are the most populated and land use has been the most intense (see Sections 1.6 and 1.7.) Most of the grassland habitats that have been converted to agriculture occur in the lower subbasin (Figure 6). And noxious weeds and invasive species are most prevalent in these areas (see section 1.7).

The loss and degradation of grassland habitats in the subbasin has the potential to impact the numerous wildlife species that depend on these habitats. Species that are closely associated with the eastside grassland WHT would be expected to be the most impacted but the numerous other species that use grassland habitats could also be affected. Strategies for the improvement of grassland habitat condition and protection of existing high quality grassland areas were developed by the Snake Hells Canyon technical team and are presented in the *Snake Hells Canyon Management Plan* (Objectives 10A and 10B).

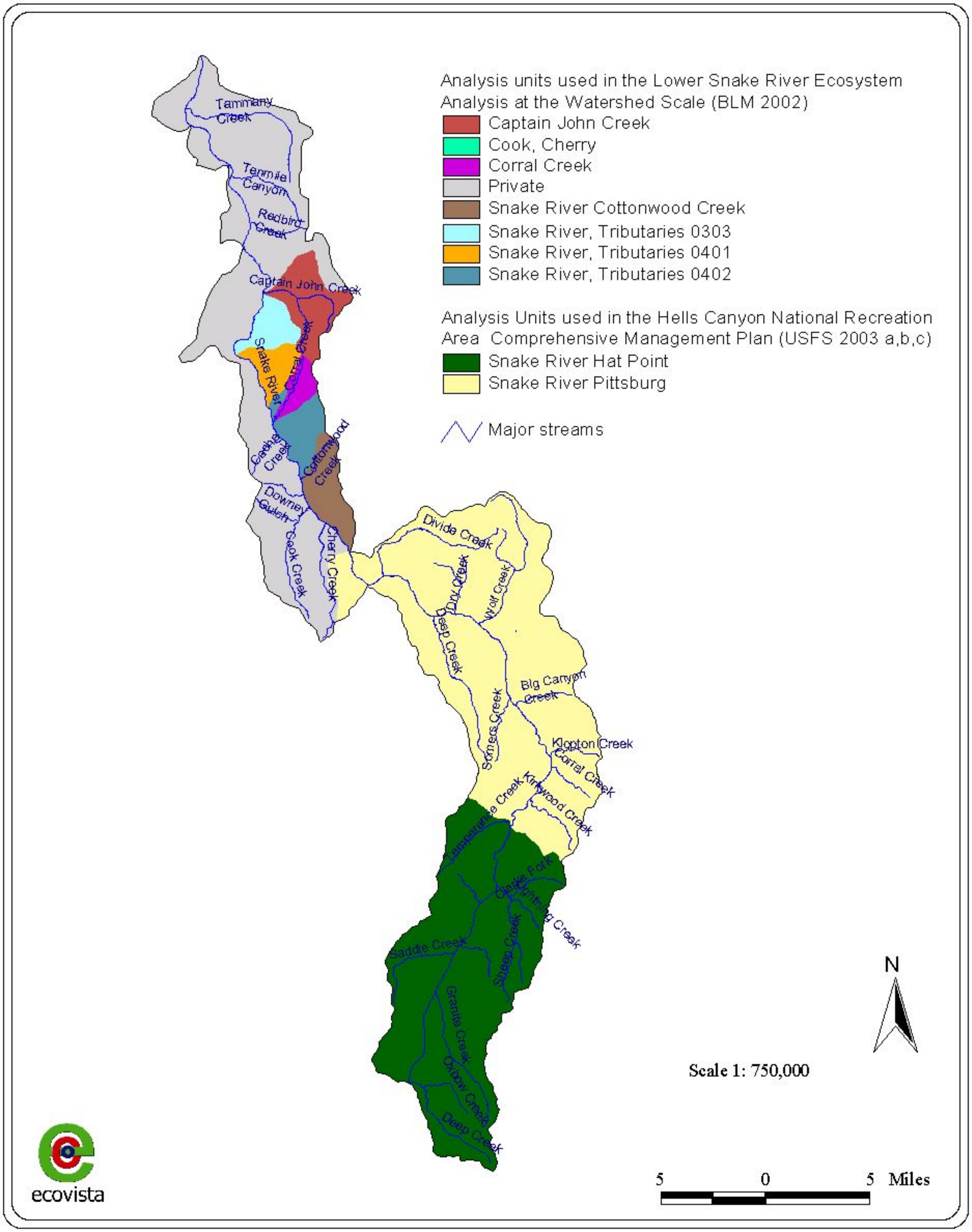

Figure 49. Location of analysis units used in two recent assessments of habitat conditions in the Snake Hells Canyon subbasin.

Riparian, Wetland and Spring Degradation

Riparian habitats in the Snake Hells Canyon subbasin have been altered through various human activities, most notably upstream hydropower development and livestock grazing. Riparian and wetland habitats are very important to both terrestrial and aquatic communities in the subbasin and these changes have the potential to impact numerous species. Twenty-eight concern or focal species have been identified as closely associated with the herbaceous wetland or interior riparian wetland WHTs (Table 43; Johnson and O'Neil 2002).

The Hells Canyon hydroelectric dam complex has altered flow and interrupted sediment processes within the mainstem Snake River. Historically, the upstream reaches of the Snake River and its tributaries provided sediment for the development and maintenance of fluvial and alluvial features within Hells Canyon. Clear water releases from Hells Canyon complex dams are reducing the abundance, size, and special distribution of fluvial and alluvial features, including beaches, within Hells Canyon. A comparison of sandbars before and after the installation of the Hells Canyon dam found that the surface area and number of beaches had declined by 75%, resulting in fewer depositional sites where riparian communities can develop (USFS 1999). Backwater areas, sandbars, and islands were always limited by the narrow, rocky canyon but a comparison of photos taken before the construction of Hells Canyon Dam (1950s) and current (1999) photographs indicate that fewer of these areas, especially smaller sites, may exist today than in the 1950s, and that they may have changed in extent. A reduction in the distribution of sandbar willow over this time period was also noted, while hackberry was found to be more abundant (Blair et al. 2001).

Below the confluence of the Salmon River 70 miles below Hells Canyon Dam, silt sand and gravel are more abundant on beaches and terraces along the river, due to deposition after peak flow events in the Salmon drainage. It is unclear whether these inputs to the downstream half of the subbasin compensate for the sediment trapping effect of Hells Canyon Dam (BLM 2002).

Reductions in the availability backwater pools has negative implications for amphibian species which use these for breeding and fish that use these areas as refugia. The reduced abundance of sandbars and islands and changes in the vegetative composition of riparian areas has implications for the numerous wildlife species that use these mainstem riparian habitats.

Heavy grazing has impacted the health of the riparian communities in the subbasin. Poor shrub regeneration was observed in the Craig Mountain area in riparian and shrubby draw habitats heavily used by livestock; this has reduced the suitability of these areas for yellow warblers and other shrub nesting birds (Mancuso and Moseley 1994). Damage to the hackberry communities along the Snake River is particularly damaging because of the many bird and other small animals that feed on their berries (Mancuso and Moseley 1994). Grazing pressure has aided in the colonization of the subbasins riparian zone by nonnative species. Conditions in riparian zones of much of the subbasin have generally improved in recent years and continue to exhibit an upward trend (USFS 1999).

Conditions in the riparian zones of much of the subbasin have shown recent improvements due to protection and restoration resulting from the 1992 listing of salmon as a threatened species (USFS 1999) and shifts in management focus in the Craig Mountain area after its purchase by BPA. Blair et al. (2001) found that the greatest change in wildlife habitat quality in the area of the subbasin above the Salmon confluence between 1950 and 1999 had been the improvement in the condition of tributary riparian zones. Canopy cover values, canopy height, and woody plant species diversity in these areas appears to have increased dramatically in many of the drainages. These changes are largely attributed to the elimination of grazing on most HCNRA allotments along the river (Blair et al. 2001). Strategies for further improvement of the condition of riparian and wetland habitats in the subbasin and the preservation of high quality areas were developed by the Technical Team in Objectives 11A and 11B of the *Snake Hells Canyon Management Plan.*

Table 43. Concern and focal species closely associated with herbaceous wetlands, and eastside riparian wetlands WHTs (Johnson and O'Neil 2001).

Common Name	Scientific Name
Bank swallow	*Riparia riparia*
Black-crowned night-heron	*Nycticorax nycticorax*
Bufflehead	*Bucephala albeola*
Caspian tern	*Sterna caspia*
Clark's grebe	*Aechmophorus clarkii*
Columbia spotted frog	*Rana luteiventris*
Common garter snake	*Thamnophis sirtalis*
Common loon	*Gavia immer*
Forster's tern	*Sterna forsteri*
Great blue heron	*Ardea herodias*
Great egret	*Ardea alba*
Harlequin duck	*Histrionicus histrionicus*
Horned grebe	*Podiceps auritus*
Long-legged myotis	*Myotis volans*
Northern leopard frog	*Rana pipiens*
Pallid bat	*Antrozous pallidus*
Pygmy nuthatch	*Sitta pygmaea*
Red-naped sapsucker	*Syhympicus nuchalis*
Red-necked grebe	*Podiceps grisegena*
Tailed frog	*Ascaphus truei*
Tiger salamander	*Ambystoma tigrinum*
Western grebe	*Aechmophorus occidentalis*
Western pipistrelle	*Pipistrelle hesperus*
Western small-footed myotis	*Myotis ciolabrum*
Western toad	*Bufo boreas*

Willow flycatcher	*Empidonax traillii*
Woodhouse's toad	*Bufo woodhousii*
Yellow-billed cuckoo	*Coccyzus americanus occidentalis*

Loss of Ponderosa Pine Habitats

Ponderosa pine forests have decreased across the Columbia Basin with an even more significant decrease in mature ponderosa pine (Quigley and Arbelbide 1997). Similar reductions have occurred in the Snake Hells Canyon Subbasin. In the BLM EAWS study area ponderosa pine habitats have experienced a significant decline due to timber harvest of mature ponderosa pine and fire suppression (BLM 2002). Reductions in this habitat type are thought to be less severe in the HCRNA than in other areas of the Columbia Basin. This is primarily due to the large areas designated as wilderness where timber harvest is now precluded and the uneven-aged forest management practices adopted on the HCNRA in 1975; however declines in the ponderosa pine habitat have occurred (USFS 1999).

Before the initiation of logging and fire suppression, ponderosa pine was maintained by regular underburning and contained relatively more shrubs than at present. Many areas of the subbasin covered by open ponderosa pine habitats are now dominated by denser stands of shade-tolerant tree species. In the Lower Snake River EAWS study area (Figure 49) mature stands of ponderosa pine were rare in all subwatersheds but most prevalent in the Captain John and Corral Creek subwatersheds. Protecting areas of existing mature ponderosa pine and facilitating the development of additional areas of ponderosa pine habitat is an important issue for the ponderosa pine dependent wildlife in the subbasin. Strategies for maintaining existing and developing additional mature ponderosa pine habitat were developed by the terrestrial subcommittee of the Snake Hells Canyon technical team and are outlined in the *Snake Hells Canyon Subbasin Management Plan* (Objectives 12A and 12B).

Table 44. Percent of forest stands comprise by mature ponderosa pine within Lower Snake River EAWS units

Unit Name	Mature Ponderosa % of Forest stands
Captain John	1-2%
Snake River and Tributaries 0303	<1%
Snake River and Tributaries 0401	none
Snake River and Tributaries 0402	none
Corral	1-2%
Snake River, Cottonwood Creek	none

These changes have likely impacted populations of ponderosa pine dependent wildlife species in the subbasin. Ponderosa pine habitats are important to a variety of wildlife in a variety of ways. Nearly all bald eagles observed in the Craig mountain area were perched in mature ponderosa pine trees along the Salmon and Snake rivers (Cassirer 1995). The focal species, white-headed woodpecker is completely dependant on the seeds of the Ponderosa pine for winter feeding and show a preference for these habitat types for nesting and foraging during other seasons of the year. Flammulated owl habitat includes open stands of fire-climax ponderosa pine or Douglas-fir forests (See Section 0 for details). Six focal or concern wildlife species in the subbasin are closely associated with ponderosa pine habitats and many more use these habitats.

Table 45. Concern and focal species closely associated with ponderosa pine habitats (Johnson and O'Neil 2001).

Common Name	Scientific Name
Flammulated Owl	*Otus flammeolus*
Great Gray Owl	*Strix nebulosa*
Long-legged Myotis	*Myotis volans*
Northern Goshawk	*Accipiter gentilis*
Pygmy Nuthatch	*Sitta pygmaea*
White-headed Woodpecker	*Picoides albolarvatus*

Changes in disturbance regime and vegetative structure

Timber harvest, fire suppression, livestock grazing and invasive plants have altered disturbance regimes and changed the abundance and distribution of both grassland and forest structural conditions in the subbasin from what was historically present (see sections 1.7.10 fire suppression and 3.5.10 habitat conditions for details). These changes have decreased the suitability of the subbasin to many species adapted to forest and grassland habitats with natural distributions and abundances of structural conditions (see section 3.5.10).

Harvest patterns in the upper elevation plateau area of Craig Mountain have resulted in moderate fragmentation and some isolation of old growth and mature stands (BLM 2002). Where past harvest has occurred on the HCRNA, most biophysical regions are deficit in the late and old structural stages. Therefore, improving the representation of late and old structural stages and increasing the number of large trees available for old growth-associated species harvest are objectives in the HCRNA CMP (USFS 2003a).

Fire suppression has resulted in increased accumulation of fuels, higher vegetation densities, a major shift in species composition and size class distribution of trees. The accumulation of duff, as well as increased density of vegetation and fuels, has created conditions in which even light severity fires can be damaging due to the concentrated heating of the tree bole. The accumulation of ground fuels along with denser, multi storied stand conditions has also created "fuel ladders" that cart fire into the tree canopy, resulting in high intensity crown fires. Unlike the moderate severity fires that burned historically, many wildfires now have the potential to impact soil productivity and increase erosion through the consumption of organic matter and high temperature that may result. In mid elevation forests, fire exclusion and other factors (e.g., timber harvest) have resulted in a shift from young and old single layer stands dominated by shade-tolerant tree species (e.g., Douglas-fir and grand fir). The development of dense, multi-layered stands has resulted in larger, more frequent stand-replacing fires and a greater susceptibility to insects and disease. Higher fuel loads also increase the potential for soil heating and higher mortality of trees and understory vegetation. The net result is wildfires that are more severe and more difficult to control (BLM 2002).

Approximately 60 percent of the lower Snake River EAWS study area is beyond the historic fire free interval and an additional 25% is at the upper limit of its fire free interval. A stand-replacing fire could cause significant damage to resource values and investments. The area should now be managed on a prescribed fire interval to maintain the historic integrity of this watershed (BLM 2002). Similar changes have occurred in other portions of the subbasin (Figure 21; Figure 22).

Exclusion of fire as a forest process has significantly changed wildlife habitat conditions. Lack of areas with fire-killed or weakened trees has impacted the black-backed woodpecker and other snag-dependent species in some areas. Lack of thinning effects of ground fires has allowed shade tolerant-tree species to crowd out important forage plants and compete for moisture and nutrients, discouraging the growth of large trees and maintenance of old growth conditions (BLM 2002).

Due to dense forest conditions the possibility of large-stand replacing fires is now greater than it was historically. These types of fires can negatively impact wildlife species that require mature stands or associated KECs. Large fires result in a more homogenous distribution of structural conditions and can reduce the diversity of species an area can support. Returning to a more natural fire regime through prescribed burning would reduce the threat of large-stand replacement fires and promote large diameter trees and snags. Strategies for restoring more natural disturbance regimes and forest structural conditions were developed by the Snake Hells Canyon technical team in Objective 13A of the *Snake Hells Canyon Subbasin Management Plan.*

Introduced plant species

The introduction of nonnative plant and animal species to the Snake Hells Canyon subbasin has reduced its ability to support native wildlife and plant species. Introduced plants in the subbasin often out compete native plant species and alter ecological processes reducing habitat suitability (Quigley and Arbelbide 1997). Many invasives are not palatable to either livestock or wildlife, nor do they provide suitable habitat for wildlife species. For example, purple loosestrife is not readily eaten nor does it provide nesting habitat. However, it replaces aquatic species, which provide quality habitat (USFS 2003a).

Weed problems in the subbasin are most severe in the grassland habitats. The naturally open structure of the subbasins grassland vegetation, its soils, and climate, and the transport provided by the Snake River, have predisposed it to invasion by weeds, especially by species of Mediterranean origin. Invasive plant species are more established in the lower areas of the subbasin where disturbance has been the most intense. Invasive species in the subbasin are spreading and are becoming increasingly prevalent in the HCRNA and wilderness areas of the upper subbasin (USFS 2003a). Yellow starthistle and cheatgrass are the invasive species currently having the greatest impact on the subbasin. These plants easily invade low elevational rangelands in poor ecological condition and are widespread in the lower subbasin (BLM 2001). Numerous other non native plants inhabit the subbasin, of the 650 plant species documented for Craig Mountain, about 150 (23%) are nonnative (Mancuso and Moseley 1994).

Yellow starthistle

Yellow-star thistle is most prevalent in the area of the subbasin downstream to Frenchy Creek (BLM 2002). In some areas it forms a monoculture and completely dominates, yellow starthistle limits the quality of big game habitat in the lower subbasin. Yellow starthistle is considered the greatest threat to the habitat of the Black Butte bighorn sheep herd of Washington. (WDFW 1999c). Yellow starthistle infestations may also explain why deer populations along the Snake River Breaks portions of GMU 181 have not increased compared to other deer populations in the area. Efforts to control the spread of yellow-star by using aerial application of herbicide have been fairly aggressive in this area but are failing to slow its advance (WDFD 1999c).

Cheatgrass

Cheatgrass, an annual grass native to the Mediterranean, was one of the first invasive plants in the subbasin and was first documented about 1890 (BLM 2002). Cheatgrass has an enormous seed-producing capacity, rapid and flexible germination behavior, and ability to out-compete seedlings of bluebunch wheatgrass (Harris 1967, Mack and Pyke 1983). The natural open spaces in bunchgrass communities predisposed them to invasion after disturbance and cheatgrass was well adapted to the climate and soils of the area. Livestock grazing was the disturbance that most commonly allowed for the establishment of cheatgrass into the bunchgrass communities of the subbasin. Once established cheatgrass easily out-competes native bunchgrass seedlings on harsher sites, and decreases replacement of older grass plants which may be dying out of the community (BLM 2002). Cheatgrass dries out earlier in the season than bunchgrasses and can cause an earlier more frequent fire regime burning bunchgrasses before they have a chance to set seed and furthering its own spread. Cheatgrass is very widespread in the subbasin but is most prevalent in areas of historic overgrazing (USDA 2003a).

Cheatgrass has degraded conditions for wildlife species adapted to native bunchgrass communities. In addition, areas where cheatgrass has replaced the more deep rooted perennial species have a higher susceptibility to surface erosion, and lower organic matter production below ground (BLM 2002). Cheatgrass has also been demonstrated to negatively impact biotic crusts which can further enhance erosion rates and reduce water quality (USFS 2003a).

Other noxious weeds

Numerous other invasive species have been documented in the subbasin and are becoming increasingly prevalent, others are documented to occur in surrounding areas and the potential for establishment within the subbasin is of great concern. The Invaders database (2002) has documented the occurrence of 73 plant species legally designated as "noxious" by Idaho, Oregon or Washington State in the five counties partially contained in the Snake Hells Canyon subbasin (Figure 1). Not all of these 73 species have been documented to occur within the Snake Hells Canyon subbasin, but because of their proximity to the subbasin the noxious weed species presented in (Appendix I) have the greatest potential to establish in the subbasin. The potential impacts of the establishment of these species on the ecosystem of the subbasin are not well understood but have the potential to be devastating. The results of two survey efforts for noxious weeds within the subbasin were provided to the subbasins project team, these efforts were completed in support of the HCRNA CMP, and the Hells Canyon Dam relicensing effort (USFS 2003a; Krichbaum 2000).

As part of the FERC relicensing process the Idaho Power Company contracted Eagle Cap Consulting Inc. to conduct noxious weed surveys along the Snake River from the confluence of the Salmon River upstream to Weiser, Idaho during 998 and 1999. The survey length was broken into five reaches; from the salmon confluence upstream to Hells Canyon Dam, Hells Canyon Reservoir, Oxbow Reservoir, Brownlee Reservoir and Brownlee Dam to Weiser. Surveys were conducted using a subsampling scheme in which one quarter-mile segment was randomly selected for sample in each shoreline mile. Each one-quarter mile survey segment extended 50 meters upslope from the mean high water mark and is referred to as a unit. The study area contained 405 units (Krichbaum 2000).

For the purposes of this study, 'noxious weeds' were defined as those on either Idaho or Oregon's state noxious weed lists. In addition, to these species four invasive riparian species were also considered, *Amorpha fruticosa* (false indigo), *Elaeagnus angustifolia* (Russian-olive), *Phalaris arundinacea* (reed canarygrass), and *Tamarix* spp. (tamarisk). The survey reach from the confluence of the Salmon to Hells Canyon Dam falls within the Snake Hells Canyon Subbasin. The reach within the subbasin had the lowest average number of different weed species per unit (2.4 species/unit), while the Oxbow Reservoir reach had the highest (8.4 species/unit) (Krichbaum 2000). Nineteen of the noxious weed/invasive riparian species surveyed for were found in the Salmon to Hells Canyon Dam Reach (Table 46). Thirteen species were detected in the upstream reaches of the study that were not located in the Salmon to Hells Canyon Dam Reach. (St. Johns wort (*Hypericum perforatum*), common houndstounge (*Cynoglossum officinale*), and Scotch thistle (*Onopordum acanthium*) represented the greatest number of populations in the Hells Canyon Dam Reach while St. Johns wort, Scotch thistle, and erect cinquefoil (*Potentilla recta*) cover the greatest average are per unit (Table 46; Krichbaum 2000).

Table 46. Size and species of noxious weed populations found in surveys from the Salmon confluence to Hells Canyon Dam (Krichbaum 2000).

Scientific Name	Common Name	# of Weed Populations Found	Average Total Net Area per unit (mi^2)
Agropyron repens	quackgrass	1	0.004
Ambrosia artemisiifolia	annual ragweed	1	0.002
Amorpha fruticosa	false indigo	11	0.7
Cardaria draba	whitetop	4	7
Chondrilla juncea	rush skeletonweed	6	0.7
Cirsium arvense	Canada thistle	2	0.2
Cirsium vulgare	bull thistle	28	1
Conium maculatum	poison hemlock	1	0.008
Convolvulus arvensis	field morning glory	22	1
Crupina vulgaris	common crupina	1	8
Cynoglossum officinale	common houndstounge	48	8
Cyperus esculentus	yellow nut sedge	6	0.2
Equisetum arvense	common horsetail	9	2
Hypericum perforatum	St. Johns wort	112	200
Linaria dalmatica	dalmatian toadflax	3	0.1
Onopordum acanthium	Scotch thistle	38	30
Phalaris arundinacea	reed canarygrass	3	0.2
Potentilla recta	erect cinquefoil	21	20
Tribulus terrestris	puncturevine	4	0.1

The Wallowa-Whitman National Forest maintains a GIS base documenting the locations of noxious weeds in the forest. Not all USFS lands in the subbasin have been surveyed for noxious weeds and not all areas have had equal intensities of survey. The Snake River/Pittsburg 5th field HUC had significantly more species of noxious weeds documented and a greater area of coverage than the Snake River/Hat point 5th field HUC (Table 47).

Table 47. Distribution of noxious weed species in the HCRNA by 5th field HUC (REO 2003).

5th field HUC Name	Common Name	Scientific Name	Area documented infested (Acres)
Snake River/Pittsburg	Bull thistle	*Cirsium vulgare*	0.9
	Canada thistle	*Cirsium arvense*	7.3
	Diffuse knapweed	*Centaurea diffusa*	131.6
	Dodder	*Cuscuta*	7.2
	Hoary cress-whitetop	*Cardaria draba*	28.4
	Leafy spurge	*Euphorbia esula*	0.9
	Puncture vine	*Tribulus terrestris*	12.3
	Purple loosestrife	*Lythrum salicaria*	0.8
	Rush skeletonweed	*Chondrilla juncea*	0.8
	Scotch thistle	*Onopordum acanthium*	357.4
	Yellow starthistle	*Centaurea solstitialis*	34.4
	Total		**582.1**
Snake River/Hat Point	Rush skeletonweed	*Chondrilla juncea*	10.6

5th field HUC Name	Common Name	Scientific Name	Area documented infested (Acres)
	Scotch thistle	*Onopordum acanthium*	57.8
	Yellow starthistle	*Centaurea solstitialis*	0.9
	Total		**69.3**

Preventing the spread and establishment of noxious weeds and invasive plants in the subbasin is a high priority for the subbasins management agencies. The Snake Hells Canyon subbasin is within the Tri-State Weed Management Area (WMA). Numerous federal, state, county, tribal and private organizations are working together in the area to coordinate weed education, prevention and control efforts such as biological control insects and herbicide applications. Strategies for preventing the establishment of new invasive species and reducing the rate of spread or eliminating established invaders were developed by the terrestrial subcommittee of the Snake Hells Canyon technical team (Objectives 9A and 9B in the Management Plan). The introduction and spread of invasive species is tied to other activities in the subbasin including road construction and use, livestock grazing, fire, timber harvest and other soil disturbing activities. Strategies developed by the technical team to address these issues and included in the Management Plan will also help to reduce the impact of introduced plant species on the subbasin.

Nutrient Flow Reduction

The flow of nutrients into the subbasin has been altered by the construction of Hells Canyon Dam and the reduction of anadromous fish runs through the subbasin. The reduction of these nutrient flows has potentially impacted numerous wildlife species and the subbasins ecosystem as a whole.

Hells Canyon Dam effectively acts as a sediment trap; the reduced deposition of sediments and gravels to the beaches and terraces of the subbasin has resulted in fewer depositional sites where riparian communities can develop and a reduction in primary productivity and associated nutrient production. The potential repercussions of this are immense and could filter up the food chain to all of the lifeforms inhabiting the subbasin. Further research to quantify these impacts is necessary and was called for as a strategy under objective 15A of the *Snake Hells Canyon Subbasin Management Plan*.

The concept of Key Ecological Functions (KEFs) refers to the main ecological roles of a species or group of species that influence diversity, productivity or sustainability of ecosystems (see section 3.1 and Appendix D for details). Salmonids provide a variety of KEFs in the subbasin and across the Columbia Basin and form an important link between marine, freshwater aquatic and terrestrial environments. Anadromous salmon help to maintain ecosystem productivity and may be regarded as a keystone species. Salmon runs input organic matter and nutrients to the trophic system through multiple levels and pathways including direct consumption, excretion, decomposition, and primary production. Direct consumption occurs in the form of predation, parasitism, or scavenging of the live spawner, carcass, egg, or fry life stages. Carcass decomposition and the particulate and dissolved organic matter released by spawning fish deliver nutrients to primary producers (Cederholm et al. 2000). Relationships between wildlife species and salmon vary in terms of their strength; the categories that have been developed to characterize these relationships and are briefly described below see (Cederholm et al. 2000 and Johnson and O'Neil 2001 for more details):

- Strong-consistent relationship-Salmon play or historically played an important role in this species distribution viability, abundance and or population/status. The ecology of this wildlife species is supported by salmon, especially at particular lifestages or during specific seasons.
- Recurrent relationship- The relationship between salmon and this species is characterized as routine, albeit occasional, and often in localized areas (thus affecting only a small portion of this species population).
- Indirect relationship- Salmon play an important routine, but indirect link to this species. The relationship could be viewed as one of a secondary consumer of salmon; for example salmon support other wildlife that are prey of this species.
- Rare relationship- Salmon play a very minor role in the diet of these species often amounting to less than 1 percent of the diet.

Salmon fishes (including their eggs) are a major source of high-energy food that allows for successful reproduction and enhanced survival of many wildlife species. Sixty-seven birds, twenty-three mammals, three reptiles and one amphibian species thought to inhabit the Blue Mountain Province consume salmon during one or more of salmon's lifestages (IBIS 2003). Twenty-five of the ninety-four total species in the province with a relationship to salmon are concern or focal species, these species and their relationship to salmon are displayed in Table 48, species with more than one type of relationship consume salmon during multiple salmon lifestages. The reductions in the salmon runs of the subbasin described in section 3.4, have reduced nutrient inputs into the ecosystem and probably the suitability of the subbasin for many of the wildlife species that consume salmon. Strategies for restoring salmon runs and salmon habitat in the subbasin were developed by the aquatic subcommittee in Objectives 1A, 2A, 3A, 3B, 8A, 8B, and 8C, in the Management Plan. Strategies for reducing the impact of nutrient losses on the wildlife of the subbasin were developed by the terrestrial subcommittee in Objective 15A in the Management Plan.

Table 48. Concern or focal species of the Snake Hells Canyon subbasin that consume salmon during one or more salmonid lifestages (IBIS 2003).

Common Name	Scientific Name	Relationship
American marten	*Martes americana*	Rare
American white pelican	*Pelecanus erythrorhynchos*	Recurrent
Bald eagle	*Haliaeetus leucocephalus*	Strong-consistent, indirect
Bank swallow	*Riparia riparia*	Indirect
Barrow's goldeneye	*Bucephala islandica*	Recurrent, Rare
Black-crowned night-heron	*Nycticorax nycticorax*	Recurrent
Caspian tern	*Sterna caspia*	Strong-consistent
Clark's grebe	*Aechmophorus clarkii*	Recurrent
Common garter snake	*Thamnophis sirtalis*	Rare

Common Name	Scientific Name	Relationship
Common loon	*Gavia immer*	Recurrent, Rare
Fisher	*Martes pennanti*	Rare
Forster's tern	*Sterna forsteri*	Recurrent
Gray wolf	*Canis lupus*	Recurrent
Great blue heron	*Ardea herodias*	Recurrent
Great egret	*Ardea alba*	Rare
Gyrfalcon	*Falco rusticolus*	Indirect
Harlequin duck	*Histrionicus histrionicus*	Strong-consistent, indirect
Horned grebe	*Podiceps auritus*	Rare
Osprey	*Pandion haliaetus*	Strong-consistent
Peregrine falcon	*Falco peregrinus*	Indirect
Red-necked grebe	*Podiceps grisegena*	Rare
Turkey vulture	*Cathartes aura*	Recurrent
Western grebe	*Aechmophorus occidentalis*	Recurrent, Rare
Willow flycatcher	*Empidonax traillii*	Indirect
Wolverine	*Gulo gulo*	Rare

Roads and habitat fragmentation

Even though road densities in the subbasin are relatively low, the transportation system of the Snake Hells Canyon subbasin is a limiting factor to wildlife populations in some areas of the subbasin. Road densities in the subbasin based on the distribution of 1:100,000 scale roads are illustrated in Figure 50. The dense road networks sometimes associated with timber harvest or private road network are not always captured at this scale and it is usually advisable to use 1:24,000 or finer scale road layers in analysis of road densities. The Wallowa-Whitman National Forest maintains a 1:24,000 scale roads layer (REO 2003), that was made available for this process, but this layer did not cover the entire subbasin. A comparison of the Wallowa-Whitman National Forest layer with the 1:100,000 layer available across the subbasin from ICBEMP (2003) did not reveal significant differences and so for consistencies sake the ICBEMP layer was used in calculating road densities across the subbasin.

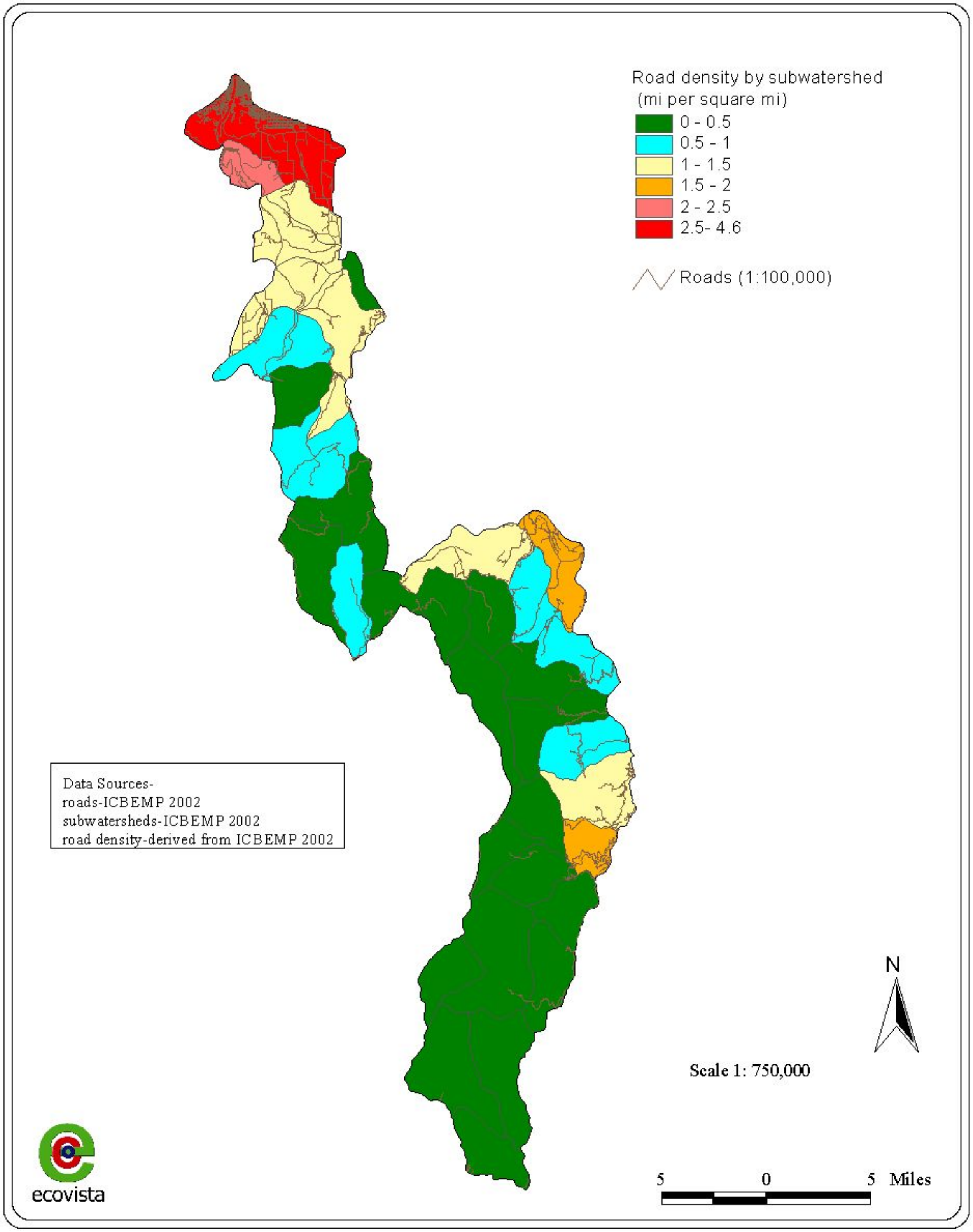

Figure 50. Roads and road densities in the subwatersheds of the Snake Hells Canyon subbasin

More than 65 species of terrestrial vertebrates in the interior Columbia River Basin have been identified as being negatively affected by road-associated factors (Wisdom et al. 2000). Road-associated factors can negatively affect habitats and populations of terrestrial vertebrates both directly and indirectly. Wisdom et al. (2000) identified 13 factors consistently associated with roads in a manner deleterious to terrestrial vertebrates (Table 49). The Wallowa-Whitman National Forest uses the following classes to quantify in general terms the impact of roads on wildlife sensitive to open roads: low impacts can be expected in areas with a density less than 1.0 mi./sq. mi, a moderate impact at densities between 1.0-2.5 mi./sq. mi., and a high impact when densities are greater than 2.5 mi./sq. mi. of open road (USFS 2003a). Based on this definition the only subwatersheds in the subbasin that contain high road densities are those associated with Lewiston in the lower subbasin. The Forest Service and other land management agencies in the subbasin, identify roads that are posing a threat to the subbasins fish and wildlife resources and impose restrictions, make closures, or have the road removed. The HCRNA CMP identified roads for closure in its selected alternative, the removal of these roads will help reduce the impact of roads on the wildlife populations of the subbasin. The technical team developed strategies for further reducing the impacts of roads on wildlife in the subbasin in Objective 14A of the Management Plan.

Table 49. Thirteen road-associated factors with deleterious impacts on wildlife (Wisdom et al. 2000).

Road-Associated Factor	Effect of Factor in Relation to Roads
Snag reduction	Reduction in density of snags due to their removal near roads, as facilitated by road access
Down log reduction	Reduction in density of large logs due to their removal near roads, as facilitated by road access
Habitat loss and fragmentation	Loss and resulting fragmentation of habitat due to establishment and maintenance of road and road right-of-way
Negative edge effects	Specific case of fragmentation for species that respond negatively to openings or linear edges created by roads
Overhunting	Nonsustainable or nondesired legal harvest by hunting as facilitated by road access
Overtrapping	Nonsustainable or nondesired legal harvest by trapping as facilitated by road access
Poaching	Increased illegal take (shooting or trapping) of animals as facilitated by road access
Collection	Collection of live animals for human uses (e.g., amphibians and reptiles collected for use as pets) as facilitated by the physical characteristics of roads or by road access
Harassment or disturbance at specific use sites	Direct interference of life functions at specific use sites due to human or motorized activities, as facilitated by road access (e.g., increased disturbance of nest sites, breeding leks or communal roost sites)

Road-Associated Factor	Effect of Factor in Relation to Roads
Collisions	Death or injury resulting from a motorized vehicle running over or hitting an animal on the road
Movement barrier	Preclusion of dispersal, migration or other movements as posed by a road itself or by human activities on or near a road or road network
Displacement or avoidance	Spatial shifts in populations or individual animals away from a road or road network in relation to human activities on or near a road or road network
Chronic negative interaction with humans	Increased mortality of animals due to increased contact with humans, as facilitated by road access

Species or Guild Specific

Improving the habitat level limiting factors discussed above will improve conditions for most of the subbasins wildlife species. After determining the broad habitat level factors that were limiting the subbasins wildlife the technical team reviewed the habitat requirements and threats to focal and T&E species discussed in sections 3.1 and 3.5. The group looked for important threats and limiting factors to these species that would not be corrected by addressing the habitat level limiting factors discussed above. These species or guild level limiting factors are discussed below.

Disease transmission between domestic sheep and bighorn sheep

Disease transmission from domestic sheep and goats has proven to be the largest threat to wild bighorn sheep populations in the tri-state region of Oregon, Washington, and Idaho. When bighorn sheep come in contact with infected domestic sheep, bighorns usually die of pneumonia within 3-7 days of contact (Martin et al. 1996, Schommer and Woolever 2001). Because exposed bighorns do not die immediately, infected individuals may return to their herd and infect other individuals, which can cause 70–100% of the herd to die (ODFW 2003d). The significant Hells Canyon die-off of 1995-96 was believed to have started when a feral goat interacted with wild bighorns in the Tenmile drainage south of Asotin (Cassirer et al. 1996). During the 1995-96 die-off, the Black Butte, Mtn. View, and Wenaha herds experienced 75, 65, and 50 percent mortality, respectively (Cassirer et al. 1996). The die off did not affect the Asotin Creek herd (Fowler 1999). The transmission of disease from domestic sheep populations to bighorns is the primary factor limiting bighorn sheep populations in the subbasin. Though research to estimate carrying capacity of the existing habitat is needed, grassland habitat quantity and quality appear to be adequate to support the herd (Cassirer, IDFG pers com. 2004).

Disturbance of bat roosts and hibernacula

Fifteen species of bats likely inhabit the subbasin during parts of the year (USFS 2003a, Appendix C). Bats in the subbasin have been documented to use caves with suboptimal temperature and humidity conditions that result in reduced reproductive success. This may indicate a shortage of suitable maternity roost sites in the area (Betts 1997). Protection of bat breeding, roosting and resting sites from disturbance is a management priority for the subbasin. The Townsend's western big-eared bat focal species is extremely sensitive to disturbance, especially in nursery colonies, with human intrusions often resulting in bats abandoning the area. Visitation to nursery caves should be avoided from May 1 through August 30 (Perkins and Schommer 1991 cited in USFS 2003a). Disturbance to a hibernating colony may cause the bats to stir and become active, which may cost them an excessive portion of their limited energy reserves. If repeated, disturbances may result in reproductive failure, abandonment of the site, or death from starvation. Eliminating human disturbance in nursery and hibernation habitat is crucial for big-eared bats during critical periods. Caves and mineshafts that are used for hibernation would be protected from disturbance from November 1 to April 1 each year. Four gates are in place in caves on the HCRNA, but three more are needed (USFS 2003a). Caves in other areas of the subbasin may also require protection.

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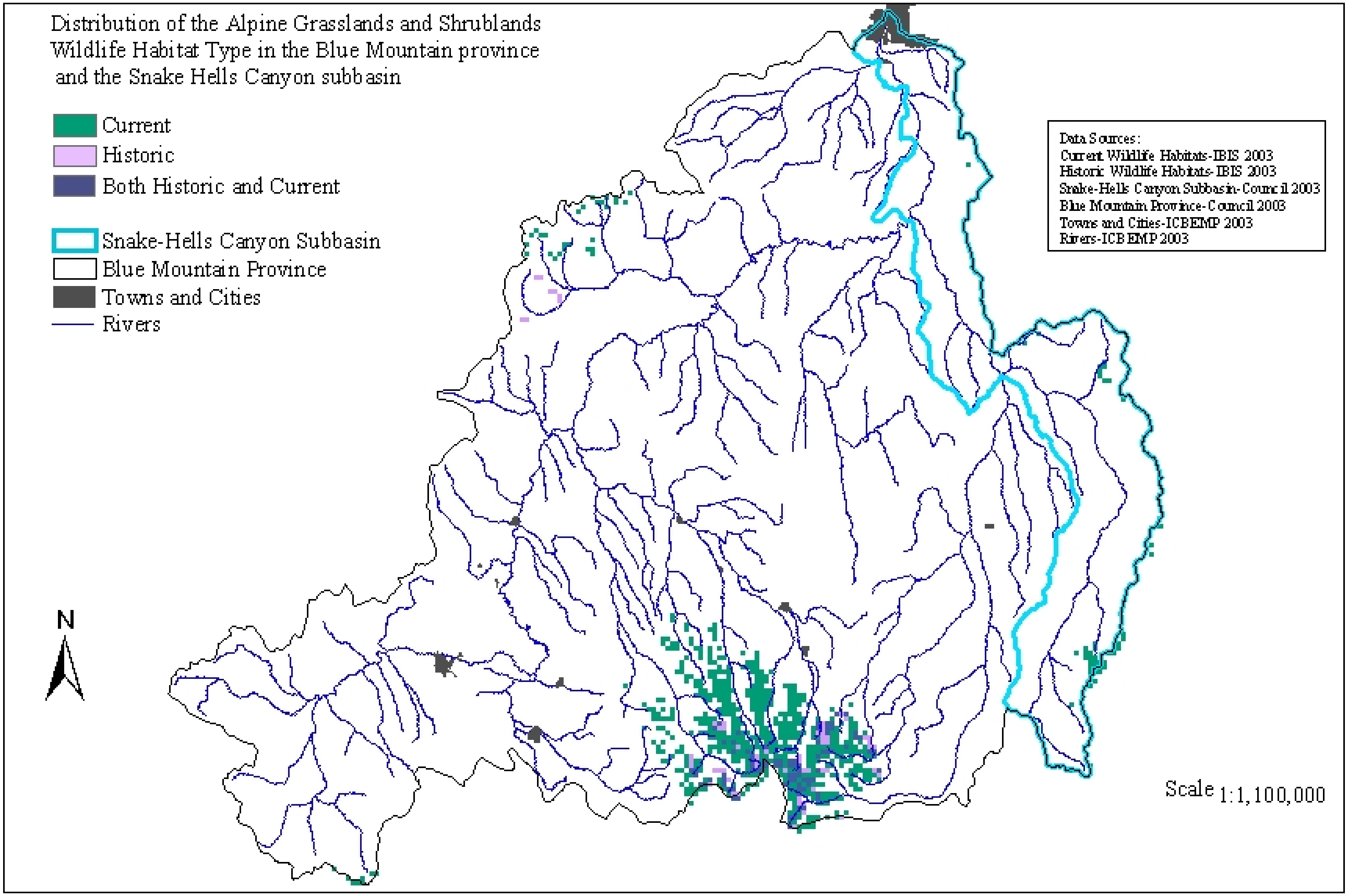
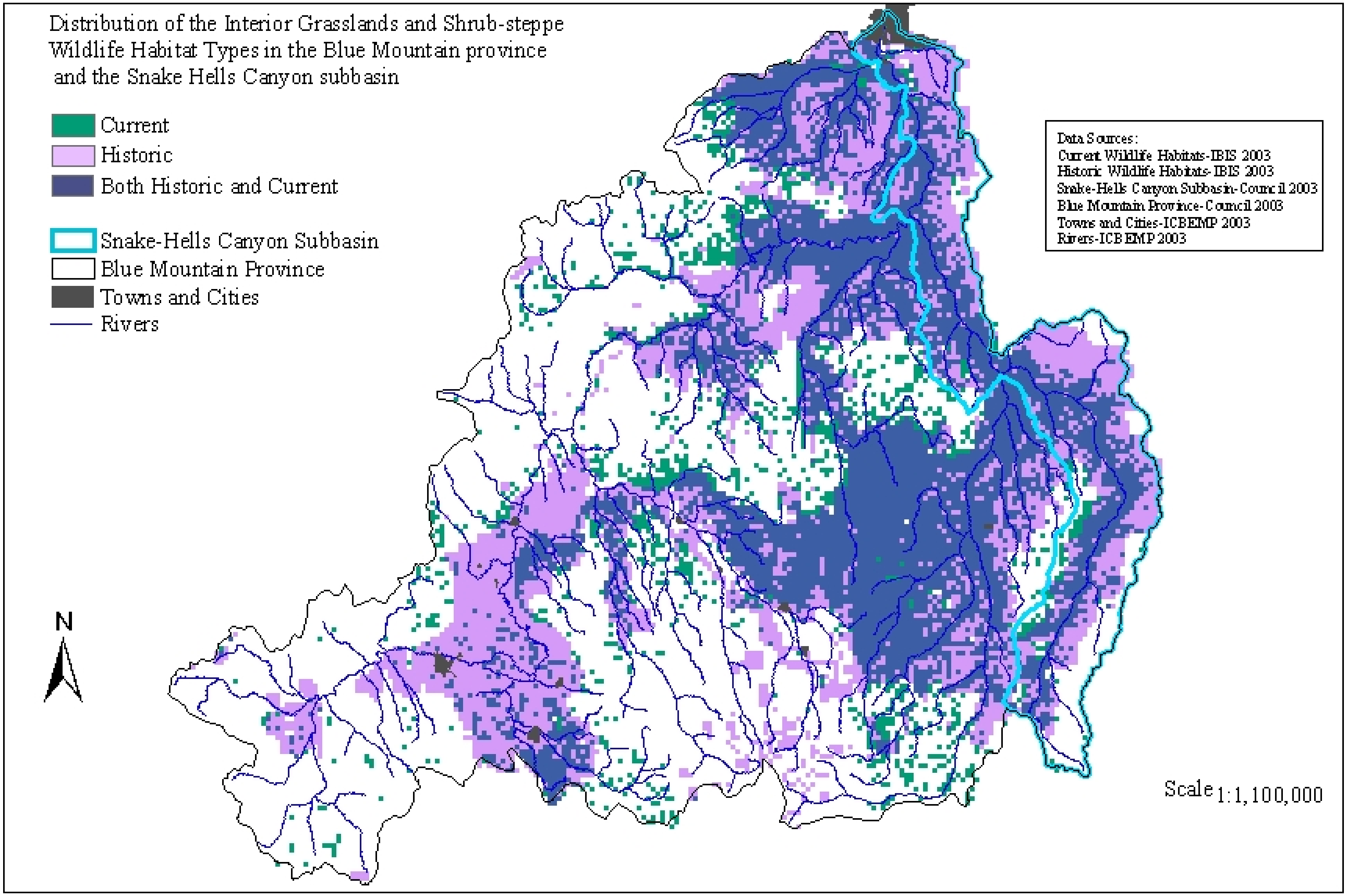
6 Appendices

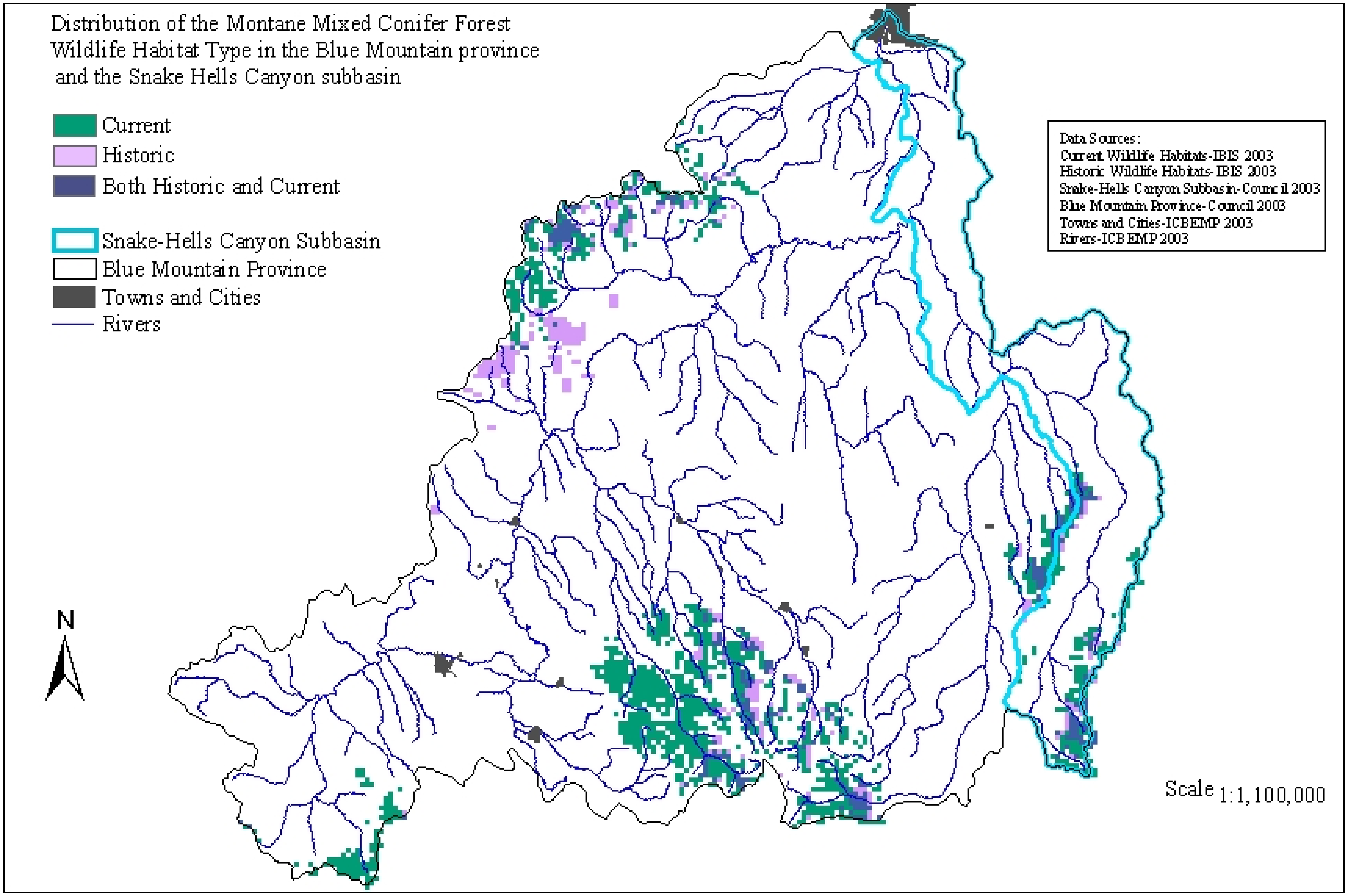
Appendix A

DISTRIBUTION OF CURRENT AND HISTORIC WILDLIFE HABITAT TYPES IN THE SNAKE HELLS CANYON SUBBASIN AND BLUE MOUNTAIN PROVINCE (note some Widlife Habitat Type distributions were not visible at the province scale and so were not displayed)

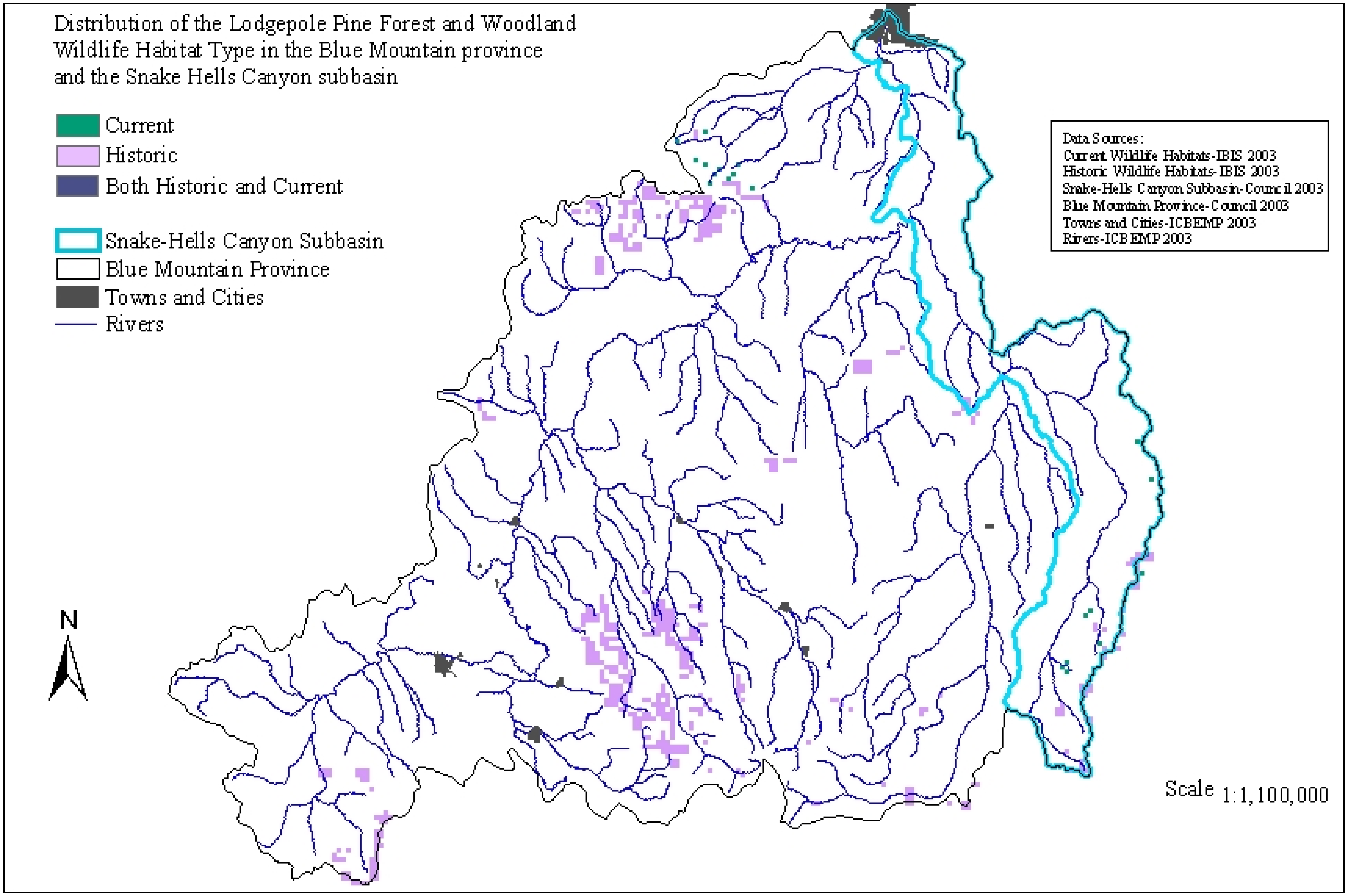


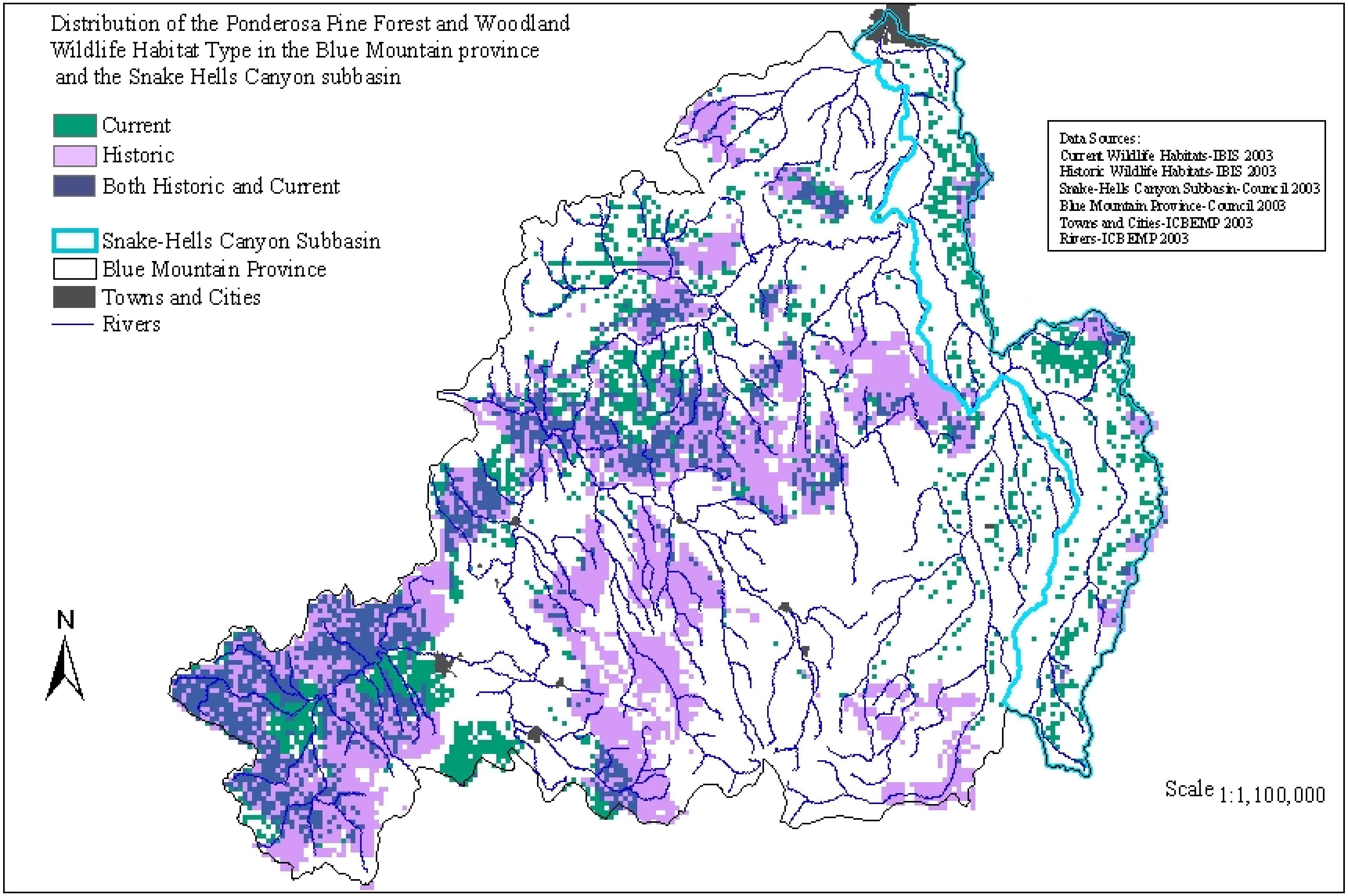
Distribution of the Alpine Grasslands and Shrublands Wildlife Habitat Type in the Blue Mountain province and the Snake Hells Canyon subbasin
Current
Historic
Both Historic and Current
Snake-Hells Canyon Subbasin
Blue Mountain Province
Towns and Cities
Rivers
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Snake-Hells Canyon Subbasin-Council 2003
Blue Mountain Province-Council 2003
Towns and Cities-ICBEMP 2003
Rivers-ICBEMP 2003
N
Scale 1:1,100,000


Distribution of the Interior Grasslands and Shrub-steppe Wildlife Habitat Types in the Blue Mountain province and the Snake Hells Canyon subbasin
Current
Historic
Both Historic and Current
Snake-Hells Canyon Subbasin
Blue Mountain Province
Towns and Cities
Rivers
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Snake-Hells Canyon Subbasin-Council 2003
Blue Mountain Province-Council 2003
Towns and Cities-ICBEMP 2003
Rivers-ICBEMP 2003
N
Scale 1:1,100,000



Distribution of the Montane Mixed Conifer Forest
Wildlife Habitat Type in the Blue Mountain province
and the Snake Hells Canyon subbasin
Current
Historic
Both Historic and Current
Snake-Hells Canyon Subbasin
Blue Mountain Province
Towns and Cities
Rivers
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Snake-Hells Canyon Subbasin-Council 2003
Blue Mountain Province-Council 2003
Towns and Cities-ICBEMP 2003
Rivers-ICBEMP 2003
N
Scale 1:1,100,000


Distribution of the Lodgepole Pine Forest and Woodland
Wildlife Habitat Type in the Blue Mountain province
and the Snake Hells Canyon subbasin
Current
Historic
Both Historic and Current
Snake-Hells Canyon Subbasin
Blue Mountain Province
Towns and Cities
Rivers
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Snake-Hells Canyon Subbasin-Council 2003
Blue Mountain Province-Council 2003
Towns and Cities-ICBEMP 2003
Rivers-ICBEMP 2003
N
Scale 1:1,100,000


Distribution of the Ponderosa Pine Forest and Woodland
Wildlife Habitat Type in the Blue Mountain province
and the Snake Hells Canyon subbasin
Current
Historic
Both Historic and Current
Snake-Hells Canyon Subbasin
Blue Mountain Province
Towns and Cities
Rivers
Data Sources:
Current Wildlife Habitats-IBIS 2003
Historic Wildlife Habitats-IBIS 2003
Snake-Hells Canyon Subbasin-Council 2003
Blue Mountain Province-Council 2003
Towns and Cities-ICBEMP 2003
Rivers-ICBEMP 2003
N
Scale 1:1,100,000

Appendix B

SPECIES THAT CONTRIBUTED TO THE SELECTION OF PORTIONS OF THE SNAKE HELLS CANYON SUBBASIN IN THE CONSERVATION PORTFOLIO FOR THE MIDDLE ROCKIES-BLUE MOUNTAIN ECOREGION (TNC 2003).

Common Name	Scientific Name
Fish and Wildlife Species	
Northern goshawk	*Accipiter gentilis*
White sturgeon	*Acipenser transmontanus*
Grey wolf	*Canis lupus*
Townsend's western big-eared bat	*Corynorhinus townsendii townsendii*
Bobolink	*Dolichonyx oryzivorus*
American peregrine falcon	*Falco peregrinus anatum*
Shortface lanx	*Fisherola nuttalli*
Columbia pebblesnail	*Flumunicola fuscus*
California wolverine	*Gulo gulo luscus*
Bald eagle	*Haliaeetus_leucocephalus*
Lynx	*Lynx canadensis*
Fisher	*Martes pennanti*
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*
Redband trout	*Oncorhynchus mykiss gairdneri*
Steelhead	*Oncorhynchus mykis mykiss*
Chinook	*Oncorhynchus tshawytscha*
Mountain quail	*Oreortyx pictus*
Costate mountainsnail	*Oreohelix idahoensis idahoensis*
Boulder Pile mountainsnail	*Oreohelix jugalis*
Striate mountainsnail	*Oreohelix strigosa goniogyra*
Flammulated owl	*Otus flammeolus*
Black-backed woodpecker	*Picoides arcticus*
Three-toed woodpecker	*Picoides tridactylus*
Bull trout	*Salvelinus confluentus*
Pygmy nuthatch	*Sitta pygmaea*
Northern Idaho ground squirrel	*Spermophilus brunneus brunneus*
Plants	
Seven Devil's onion	*Allium tolmiei* var. *persimile*
Hells Canyon (eared) rockcress	*Arabis hastatula*
Green-band mariposa lily	*Calochortus macrocarpus* var.*maculosus*
Broad-fruit mariposa lily	*Calochortus_nitidus*
Idaho hawksbeard	*Crepis bakeri* ssp. *idahoensis*
Davis' fleabane	*Erigeron engelmannii* var. *davisii*
Cliff buckwheat	*Eriogonum scopulorum*

Common Name	Scientific Name
Palouse goldenweed	*Haplopappus liatriformis*
Hazel’s prickly phlox	*Leptodactylon pungens* ssp. *hazeliae*
Membrane-leaved (thinsepal) monkeyflower	*Mimulus hymenophyllus*
Stalk-leaved monkeyflower	*Mimulus patulus*
MacFarlane’s four o’clock	*Mirabilis macfarlanei*
Least (small) phacelia	*Phacelia minutissima*
Barton’s raspberry	*Rubus bartonianus*
Spalding’s catchfly	*Silene spaldingii*
Sand dropseed	*Sporobolus cryptandrus*
Plant Associations and Habitats	
Grand fir	*Abies grandis*
Subalpine fir/Whitebark pine	*Abis lasiocarpa/ Pinus albicaulis*
Netleaf hackberry/ Bluebunch wheatgrass	*Celtis reticulata/Pseudoroegneria spicata*
Curlleaf Mountain Mahogany	*Cerocarpus ledifloius*
Onespike Oatgrass/ Sandberg bluegrass	*Danthonia_unispicata-Poa_secunda*
Wildbuck wheat/Bluebunch wheatgrass	*Eriogonum heracleoides /Pseudoregneria spicata*
Western larch	*Larix occidentalis*
Lodgepole pine	*Pinus contorta*
Ponderosa pine/ Pinegrass	*Pinus ponderosa/ Calamagrostis rubescens*
Quaking aspen, black hawthorn	*Populus tremuloides/Crataegus douglasii*
Douglas-fir	*Pseudotsuga menziesii*
Douglas-fir/grand fir	*Pseudotsuga menziesii/Abies grandis*
Douglas-fir/lodgepole pine	*Pseudotsuga menziesii/Pinus contorta*
Western red cedar	*Thuja plicata*
Alpine	various
Badlands/Breaks	various
Big Sagebrush Steppe	various
Bitterbrush	various
Canyon Grasslands	various
Low Sagebrush Steppe	various
Mesic Upland Shrubs	various
Mixed Mesic Forest	various
Mixed Sagebrush Steppe	various
Native Grass or Forb	various
Ponderosa Pine Forest and Woodland	various
Subalpine Fir	various
Subalpine Meadow	various

Appendix C

FISH AND WILDLIFE SPECIES OF THE SNAKE HELLS CANYON SUBBASIN.

Table 50. Fish species currently inhabiting the Snake Hells Canyon subbasin.

	Origin[1]	**Location**[2]	**Status**[3]	**Comments**
Bull trout (*Salvelinus confluentus*)	N	R, T	ESA T	
Spring/summer chinook salmon (*Oncorhynchus tshawytscha*)	N	R, T	ESA T	
Fall chinook salmon (*O. tshawytscha*)	N	R	ESA T	
Summer steelhead (*O. mykiss*)	N	R, T	ESA T	
Sockeye salmon (*O. nerka*)	N	R	ESA-E	Migration corridor only
Redband trout (*O. mykiss*)	N	R, T	U/C	True redbands are U; generic RBT are C
Westslope cutthroat trout (*O. clarki lewisii*)	N	R,T	C	
White sturgeon (*Acipenser transmontanus*)	N	R	C	
Mountain whitefish (*Prosopium williamsoni*)	N	R, T	C	
Pacific lamprey (*Lampetra tridentata*)	N	R, T	ID–E	Idaho–endangered
Peamouth (*Mylocheilus caurinus*)	N	R, T	I	
Northern pikeminnow (*Ptychocheilus oregonensis*)	N	R, T	C	
Bridgelip sucker (*Catostomus columbianus*)	N	R, T	C	
Largescale sucker (*Catostomus macrocheilus*)	N	R, T	C	
Chiselmouth (*Acrocheilus alutaceus*)	N	R, T	C	
Longnose dace (*Rhinichthys cataractae*)	N	R, T	R/I	
Speckled dace (*Rhinichthys osculus*)	N	R, T	A	
Leopard dace (*Rhinichthys falcatus*)	N	R, T	I	
Redside shiner (*Richardsonius balteatus*)	N	R, T	C	
Torrent sculpin (*Cottus rhotheus*)	N	R, T	R	
Paiute sculpin (*Cottus beldingi*)	N	R, T	C	
Shorthead sculpin (*Cottus confusus*)	N	R, T	C	
Mottled sculpin (*Cottus bairdi*)	N	R, T	C	
Common carp (*Cyprinus carpio*)	E	R, T	R/I	
Bullhead, brown (*Ictalurus nebulosus*)	E	R, T	R/I	
Channel catfish (*Ictalurus natalis*)	E	R, T	R/I	
Smallmouth bass (*Micropterus dolomieu*)	E	R, T	U/I	
Largemouth bass (*Micropterus salmoides*)	E	R, T	I	
White crappie (*Pomoxis annularis*)	E	R, T	I	
American shad (*Alosa sapidissima*)	E	R, T		

[1] Origin: N=Native stock, E=exotic

[2] Location: R=mainstem rivers, T=tributaries

[3] Fish species abundance based on average number of fish per 100m^2: A=abundant, R=rare, U=uncommon, C=common, and I=insufficient data; ESA T=listed threatened under Endangered Species Act; ESA E=listed endangered under Endangered Species Act

Table 51. Wildlife species of the Snake Hells Canyon subbasin (IBIS 2003).

Amphibians and Reptiles	
Long-toed salamander	*Ambystoma macrodactylum*
Tiger salamander	*Ambystoma tigrinum*
Tailed frog	*Ascaphus truei*
Western toad	*Bufo boreas*
Rubber boa	*Charina bottae*
Painted turtle	*Chrisemys picta*
Racer	*Coluber constrictor*
Western rattlesnake	*Crotalus viridis*
Ringneck snake	*Diadophis punctatus*
Idaho giant salamander	*Dicamptodon aterrimus*
Northern alligator lizard	*Elgaria coerulea*
Western skink	*Eumeces skiltonianus*
Night snake	*Hypsiglena torquata*
Short-horned lizard	*Phrynosoma douglassi*
Gopher snake	*Pituophis catenifer*
Pacific tree frog	*Pseudacti regilla*
Bullfrog	*Rana catesbeiana*
Northern leopard frog	*Rana pipiens*
Spotted frog	*Rana pretiosa*
Sagebrush lizard	*Sceloporus graciosus*
Western fence lizard	*Sceloporus occidentalis*
Great Basin spadefoot toad	*Spea intermontana*
Western terrestrial garter snake	*Thamnophis elegans*
Common garter snake	*Thamnophis sirtalis*
Birds	
Cooper's hawk	*Accipiter cooperii*
Northern goshawk	*Accipiter gentilis*
Sharp-shinned hawk	*Accipiter striatus*
Northern saw-whet owl	*Aegolius acadicus*
White-throated swift	*Aeronautes saxatilis*
Chukar	*Akctoris chukar*
Grasshopper sparrow	*Ammodramus savannarum*
American wigeon	*Anas americana*
Green-winged teal	*Anas crecca*
Mallard	*Anus platyrhynchos*
Golden eagle	*Aquila chrysaetos*
Great blue heron	*Ardea herodias*
Short-eared owl	*Asio flammeus*

Long-eared owl	*Asio otus*
Ruffed grouse	*Bonasa umbellus*
Canada goose	*Branta canadensis*
Bufflehead	*Bucephala albeola*
Common goldeneye	*Bucephala clangula*
Red-tailed hawk	*Buteo jamaicensis*
Rough-legged hawk	*Buteo lagopus*
Ferruginous hawk	*Buteo regalis*
Swainson's hawk	*Buteo swainsoni*
Pine siskin	*Cardeuelis pinus*
American goldfinch	*Cardeuelis tristis*
Common redpoll	*Carduelis flammea*
Cassin's finch	*Carpodacus cassinii*
House finch	*Carpodacus mexicanus*
Purple finch	*Carpodacus pupureus*
Brown creeper	*Certhia americana*
Vaux'sSwift	*Chaetura vauxi*
Lark sparrow	*Chondestes grammacus*
Common nighthawk	*Chordeiles minor*
Northern harrier	*Circus cyaneus*
Northern flicker	*Colaptes auratus*
Olive-sided flycatcher	*Contopus borealis*
Western wood-pewee	*Contopus sordidulus*
American crow	*Corvus brachyrhnchos*
Common raven	*Corvus corax*
Blue jay	*Cyanocita cristata*
Blue grouse	*Dendrogapus obscurus*
Bobolink	*Dolichonyx oryzivorus*
Pileated woodpecker	*Dryocopus pileatus*
Hammond's flycatcher	*Empidonax hammondii*
Dusky flycatcher	*Empidonax oberholseri*
Cordilleran flycatcher	*Empidonax occidentalis*
Willow flycatcher	*Empidonax traillii*
Homed lark	*Eremophilia alpestris*
Brewer's blackbird	*Euphagus cyanocephalus*
Merlin	*Falco columbus*
Prairie falcon	*Falco mexicanus*
American kestrel	*Falco sparverius*
Common snipe	*Gallinago gallinago*
Northern pygmy-owl	*Glaucidium gnoma*
Bald eagle	*Haliaeetus leucocephalus*

Barn swallow	*Hirundo rustica*
Yellow-breasted chat	*Icteria virens*
Northern oriole	*Icterus galbula*
Dark-eyed Junco	*Junco hyemalis*
Ring-billed gull	*Larus delawarensis*
Rosy finch	*Leucosticte arctoa*
Red crossbill	*Loxia curvirostra*
White-winged crossbill	*Loxia leucoptera*
Wild turkey	*Meleagris gallopavo*
Lincoln’s sparrow	*Melospiza lincolnii*
Song sparrow	*Melospiza melodia*
Common merganser	*Mergus merganser*
Brown-headed cowbird	*Molothrus ater*
Clark’s nutcracker	*Nucifraga columbiana*
Mountain quail	*Oreortyx pictus*
Osprey	*Pandion haliaetus*
Black-capped chickadee	*Parus atricaphillus*
Mountain chickadee	*Parus gambeli*
Chestnut-backed chickadee	*Parus rufescens*
Savannah sparrow	*Passerculus sandwichensis*
Fox sparrow	*Passerella iliaca*
Lazuli bunting	*Passerina amoena*
Gray jay	*Perisoeus canadensis*
Common poorwill	*Phalenoptilus nuttallii*
Ring-necked pheasant	*Phasianus colchicus*
Black-headed grosbeak	*Pheuticus melanocephalus*
Black-billed magpie	*Pica pica*
White-headed woodpecker	*Picoides albolarvatus*
Black-backed woodpecker	*Picoides arcticus*
Pine grosbeak	*Pinicola enucleator*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Western tanager	*Piranga ludoviciana*
Snow bunting	*Plectrophenax nivalis*
Vesper sparrow	*Pooecetes gramineus*
Bank swallow	*Riparia riparia*
Rock wren	*Salpinctes obsoletus*
Say’s pheobe	*Sayornis saya*
Red-breasted nuthatch	*Sitta canadensis*
White-breasted nuthatch	*Sitta carolinensis*
Pygmy nuthatch	*Sitta pygmue*
Burrowing owl	*Speotyto canicularia*

American tree sparrow	*Spizella arborea*
Brewer's sparrow	*Spizella breweri*
Chipping sparrow	*Spizella passerina*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Great gray owl	*Strix nebulosa*
Bard owl	*Strix varia*
Western meadowlark	*Stumella neglecta*
Tree swallow	*Tachycineta bicolor*
Violet-green swallow	*Tachycineta thalassina*
Greater yellowlegs	*Totanus melanoleucus*
Barn owl	*Tyto alba*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Mourning dove	*Zenaida macmum*
White-crowned sparrow	*Zonotrichia leucophrys*
Harris' sparrow	*Zonotrichia querula*
Spotted sandpiper	*Actitus macularia*
Red-winged blackbird	*Agelaius phoeniceus*
Northern pintail	*Anas acuta*
American pipit	*Anthus spincletta*
Black-chinned hummingbird	*Archilochus alexandri*
Cedar waxwing	*Bombycilla cedorum*
Bohemian waxwing	*Bombycilla garrulus*
Great-homed owl	*Bubo virginianus*
Lapland longspur	*Calcarius lapponicus*
California quail	*Callipepla californica*
Turkey vulture	*Cathartes aura*
Veery	*Catharus fuscescens*
Hermit thrush	*Catharus guttatus*
Swainson's thrush	*Catharus ustulatus*
Canyon wren	*Catherpes mexicanus*
Belted kingfisher	*Ceryle alcyon*
Killdeer	*Charadrius vociferus*
American dipper	*Cinclus mexicana*
Evening grosbeak	*Coccothrastes vespertinus*
Yellow-billed cuckoo	*Coccyzus americanus*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Rock dove	*Columba livia*
Steller's jay	*Cyanocita stelleri*
Black swift	*Cypseloides niger*
Yellow-rumped warbler	*Dendroica coronata*
Yellow warbler	*Dendroica petechia*

Townsend's warbler	*Dendroica townsendi*
Gray catbird	*Dumetella carolinenis*
Peregrine falcon	*Falco peregrinus*
Common yellowthroat	*Geothylpis trichas*
Cliff swallow	*Hirundo pyrrhonota*
Varied thrush	*Ixoreus naevius*
Northern shrike	*Lanius excubitor*
Loggerhead shrike	*Lanius ludovicianus*
Herring gull	*Larus argentatus*
California gull	*Larus californicus*
Lewis' woodpecker	*Melanerpes lewis*
Northern mockingbird	*Mimus polyglottos*
Townsend's solitaire	*Myadestes townsendi*
Macgillivray's warbler	*Oporomis tolmiei*
Sage thrasher	*Oreoscoptes montanus*
Flammulated owl	*Otus flammeolus*
Western screech owl	*Otus kenniwtti*
House sparrow	*Passer domesticus*
Gray partridge	*Perdix perdix*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Picoides villosus*
Ruby-crowned ringlet	*Regulus calendula*
Golden-crowned ringlet	*Regulus satrapa*
Broad-tailed hummingbird	*Selasophomus platycercus*
Rufous hummingbird	*Selasphorus rufus*
American redstart	*Setophaga ruticilla*
Mountain bluebird	*Sialia currucoides*
Western bluebird	*Sialia mexicana*
Williamson's sapsucker	*Sphyrapicus thyroideus*
Calliope hummingbird	*Stellula calliope*
European starling	*Sturnus vulgaris*
Red-naped sapsucker	*Syhympicus nuchalis*
House wren	*Troglodytes aedon*
Winter wren	*Troglodytes troglodytes*
American robin	*Turdus migratorius*
Eastern kingbird	*Tyrannus tyrannus*
Western kingbird	*Tyrannus verticalis*
Nashville warbler	*Venniwra ruficapilla*
Orange-crowned warbler	*Vermivora celata*
Warbling vireo	*Vireo gilvus*
Red-eyed vireo	*Vireo olivaceus*

Solitary vireo	*Vireo solitatius*
Wilson's warbler	*Wilsonia pusilla*
Mammals	
Moose	*Alces alces*
Pallid bat	*Antrowus pallidus*
Coyote	*Canis latrans*
Beaver	*Castor canadensis*
Rocky Mountain elk	*Cervus elaphus*
Southern red-backed vole	*Clethrionomys gapperi*
Big brown bat	*Eptesicu fuscus*
Porcupine	*Erethizon dorsatum*
Spotted bat	*Euderma maculata*
Yellow-pine chipmunk	*Eutamias anwenus*
Red-tailed chipmunk	*Eutamius ruficaudus*
Mountain lion	*Felis concolor*
Lynx	*Felis lynx*
Bobcat	*Felis rufus*
Northern flying squirrel	*Glaucomys sabrinus*
Little brown myotis	*Iuyotis lucifugus*
Silver-haired bat	*Lasionycteris noctivagans*
Hoary bat	*Lasiurus cinereus*
Snowshoe hare	*Lepus americanus*
White-tailed jackrabbit	*Lepus townsendii*
River otter	*Lutra canadensis*
Yellow-bellied marmot	*Marmota flaviventris*
Marten	*Martes americana*
Striped skunk	*Mephitis mephitis*
Pygmy shrew	*Microsorex hoyi*
Long-tailed vole	*Microtus longicaudus*
Montane vole	*Microtus montanus*
House mouse	*Mus musculus*
Ermine	*Mustela erminea*
Long-tailed weasel	*Mustela frenata*
Mink	*Mustela vision*
California myotis	*Myotis californicus*
Small-footed myotis	*Myotis ciliolabrum*
Long-eared myotis	*Myotis evotis*
Fringed myotis	*Myotis thysanodes*
Long-legged myotis	*Myotis volans*
Yuma myotis	*Myotis yumanensis*
Bushy-tailed woodrat	*Neotoma cinerea*

Mule deer	*Odocoileus hemionus*
White-tailed deer	*Odocoileus virginianus*
Muskrat	*Ondatra zibethicus*
Bighorn sheep	*Ovis canadensis*
Great basin pocket mouse	*Perognathus parvus*
Deer mouse	*Peromyscur maniculatus*
Western pipistrelle	*Pipstrellus hesperus*
Townsend's western big-eared bat	*Corynorhinus townsendii townsendii*
Raccoon	*Procyon lotor*
Western harvest mouse	*Reithrodontomys megalotis*
Coast mole	*Sapanus orarius*
Masked shrew	*Sorex cinereus*
Dusky shrew	*Sorex monticolus*
Water shrew	*Sorex palustris*
Preble's shrew	*Sorex preblii*
Vagrant shrew	*Sorex vagrans*
Merriam's shrew	*Sortx merriami*
Columbian ground squirrel	*Spermophilus columbianus*
Golden-mantled ground squirrel	*Spermophilus lateralis*
Spotted sunk	*Spilogale gracilis*
Mountain cottontail	*Sylvilagus nuttallii*
Red squirrel	*Tamiasciurus hudsonicus*
Badger	*Taxidea taxus*
Northern pocket gopher	*Thomomys talpoides*
Black bear	*Ursus americanus*
Red fox	*Vulpes vulpes*
Western jumping mouse	*Zapus princeps*

Appendix D

CRITICAL FUNCTIONAL LINK SPECIES OF THE BLUE-MOUNTAIN PROVINCE AND THEIR FUNCTIONS (IBIS 2003).

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
1_1_1_13	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Bark/cambium/bole feeder**	American Beaver	*Castor canadensis*	Open Water—Lakes, Rivers, and Streams
1_1_1_13	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Bark/cambium/bole feeder**	Black Bear	*Ursus americanus*	Alpine Grasslands and Shrublands Westside Grasslands Interior Grasslands
1_1_1_3	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Browser (leaf, stem eater)**	Wild Turkey	*Meleagris gallopavo*	Westside Grasslands
1_1_1_3	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Browser (leaf, stem eater)**	White-tailed Deer (eastside)	*Odocoileus virginianus ochrourus*	Agriculture, Pastures, and Mixed Environs
1_1_1_6	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Sap feeder**	House Finch	*Carpodacus mexicanus*	Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs
1_1_1_7	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Root feeders**	Northern Pocket Gopher	*Thomomys talpoides*	Agriculture, Pastures, and Mixed Environs
1_1_1_7	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Root feeders**	Black Bear	*Ursus americanus*	Westside Grasslands Herbaceous Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
1_1_1_8	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Nectivore (nectar feeder)**	Black-chinned Hummingbird	*Archilochus alexandri*	Shrub-steppe
1_1_1_8	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Nectivore (nectar feeder)**	Rufous Hummingbird	*Selasphorus rufus*	Westside Grasslands
1_1_1_9	Trophic relationships: Heterotrophic consumer: Primary consumer (herbivore): **Fungivore (fungus feeder)**	Deer Mouse	*Peromyscus maniculatus*	Urban and Mixed Environs
1_1_2_1_3	Trophic relationships: Heterotrophic consumer Secondary consumer Invertebrate eater **Freshwater or marine zooplankton**	Long-toed Salamander	*Ambystoma macrodactylum*	Upland Aspen Forest Alpine Grasslands and Shrublands Westside Grasslands Montane Coniferous Wetlands
1_1_2_2_1	Trophic relationships: Heterotrophic consumer: Secondary consumer: Vertebrate eater: **Piscivorous (fish eater)**	Raccoon	*Procyon lotor*	Urban and Mixed Environs
1_1_5	Trophic relationships: Heterotrophic consumer: **Cannibalistic**	Black Bear	*Ursus americanus*	Mesic Lowlands Conifer-Hardwood Forest Upland Aspen Forest Alpine Grasslands and Shrublands Westside Grasslands
1_1_6	Trophic relationships: Heterotrophic consumer: **Coprophagous (feeds on fecal material)**	American Pika	*Ochotona princeps*	Alpine Grasslands and Shrublands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
1_1_6	Trophic relationships: Heterotrophic consumer: **Coprophagous (feeds on fecal material)**	Snowshoe Hare	*Lepus americanus*	Mesic Lowlands Conifer-Hardwood Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Montane Coniferous Wetlands
1_1_7	Trophic relationships: Heterotrophic consumer: **Feeds on human garbage/refuse**	Mew Gull	*Larus canus*	Open Water—Lakes, Rivers, and Streams
1_1_7_1	Trophic relationships: Heterotrophic consumer: Feeds on human garbage/refuse: **Aquatic (e.g., offal and bycatch of fishing boats)**	Mew Gull	*Larus canus*	Open Water—Lakes, Rivers, and Streams
3_1	Organismal relationships: **Controls or depresses insect population peaks**	Big Brown Bat	*Eptesicus fuscus*	Urban and Mixed Environs
3_15	Organismal relationships: **Pirates food from other species**	American Crow	*Corvus brachyrhynchos*	Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs
3_16	Organismal relationships: **Interspecific hybridization**	American Crow	*Corvus brachyrhynchos*	Urban and Mixed Environs
3_2	Organismal relationships: **Controls terrestrial vertebrate populations (through predation or displacement)**	Raccoon	*Procyon lotor*	Urban and Mixed Environs
3_3	Organismal relationships: **Pollination vector**	Rufous Hummingbird	*Selasphorus rufus*	Alpine Grasslands and Shrublands Westside Grasslands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_4_1	Organismal relationships: Transportation of viable seeds, spores, plants or animals: **Disperses fungi**	Deer Mouse	*Peromyscus maniculatus*	Westside Grasslands Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs
3_4_4	Organismal relationships: Transportation of viable seeds, spores, plants or animals: **Disperses insects and other invertebrates**	Golden-mantled Ground Squirrel	*Spermophilus lateralis*	Lodgepole Pine Forest and Woodlands Upland Aspen Forest
3_4_6	Organismal relationships: Transportation of viable seeds, spores, plants or animals: **Disperses vascular plants**	Golden-mantled Ground Squirrel	*Spermophilus lateralis*	Upland Aspen Forest
3_5	Organismal relationships: **Creates feeding, roosting, denning, or nesting opportunities for other organisms**	Great Blue Heron	*Ardea herodias*	Open Water—Lakes, Rivers, and Streams
3_5_1	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: **Creates feeding opportunities (other than direct prey relations)**	Great Blue Heron	*Ardea herodias*	Open Water—Lakes, Rivers, and Streams
3_5_1_1	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: Creates feeding opportunities: **Creates sapwells in trees**	Red-breasted Sapsucker	*Sphyrapicus ruber*	Mesic Lowlands Conifer-Hardwood Forest Westside Grasslands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_5_2	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: **Creates roosting, denning, or nesting opportunities**	Great Blue Heron	*Ardea herodias*	Mesic Lowlands Conifer-Hardwood Forest Westside Grasslands Open Water—Lakes, Rivers, and Streams Herbaceous Wetlands Interior Riparian-Wetlands
3_5_2	Organismal relationships: Creates feeding, roosting, denning, or nesting opportunities for other organisms: **Creates roosting, denning, or nesting opportunities**	Red Squirrel	*Tamiasciurus hudsonicus*	Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands
3_6_2	Organismal relationships: Primary creation of structures (possibly used by other organisms): **Ground structures**	Bushy-tailed Woodrat	*Neotoma cinerea*	Upland Aspen Forest Shrub-steppe Agriculture, Pastures, and Mixed Environs Montane Coniferous Wetlands Interior Riparian-Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_6_3	Organismal relationships: Primary creation of structures (possibly used by other organisms): **Aquatic structures**	American Beaver	*Castor canadensis*	Mesic Lowlands Conifer-Hardwood Forest Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Upland Aspen Forest Subalpine Parkland Montane Coniferous Wetlands
3_7_1	Organismal relationships: User of structures created by other species: **Aerial structures**	Black Tern	*Chlidonias niger*	Open Water—Lakes, Rivers, and Streams
3_7_1	Organismal relationships: User of structures created by other species: **Aerial structures**	Virginia Opossum	*Didelphis virginiana*	Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs
3_7_2	Organismal relationships: User of structures created by other species: **Ground structures**	Deer Mouse	*Peromyscus maniculatus*	Montane Mixed Conifer Forest Upland Aspen Forest Subalpine Parkland Alpine Grasslands and Shrublands Agriculture, Pastures, and Mixed Environs Urban and Mixed Environs Montane Coniferous Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_7_3	Organismal relationships: User of structures created by other species: **Aquatic structures**	Fisher	*Martes pennanti*	Subalpine Parkland
3_7_3	Organismal relationships: User of structures created by other species: **Aquatic structures**	Mink	*Mustela vison*	Lodgepole Pine Forest and Woodlands Upland Aspen Forest Westside Grasslands Interior Grasslands Shrub-steppe
3_8	Organismal relationships: **Nest parasite**	House Finch	*Carpodacus mexicanus*	Urban and Mixed Environs
3_8_1	Organismal relationships: Nest parasite: **Interspecies parasite**	Redhead	*Aythya americana*	Open Water—Lakes, Rivers, and Streams
3_8_1	Organismal relationships: Nest parasite: **Interspecies parasite**	Brown-headed Cowbird	*Molothrus ater*	Mesic Lowlands Conifer-Hardwood Forest Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Upland Aspen Forest Subalpine Parkland Westside Grasslands Interior Grasslands Shrub-steppe Agriculture, Pastures, and Mixed Environs Montane Coniferous Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
3_8_2	Organismal relationships: Nest parasite: **Common interspecific host**	Greater Scaup	*Aythya marila*	Open Water—Lakes, Rivers, and Streams
3_8_2	Organismal relationships: Nest parasite: **Common interspecific host**	House Finch	*Carpodacus mexicanus*	Urban and Mixed Environs
3_9	Organismal relationships: **Primary cavity excavator in snags or live trees**	Black Bear	*Ursus americanus*	Interior Grasslands Herbaceous Wetlands
6_1	Wood structure relationships (either living or dead wood): **Physically fragments down wood**	White-tailed Deer (eastside)	*Odocoileus virginianus ochrourus*	Agriculture, Pastures, and Mixed Environs
6_2	Wood structure relationships (either living or dead wood): **Physically fragments standing wood**	Black Bear	*Ursus americanus*	Alpine Grasslands and Shrublands Herbaceous Wetlands
7_1	Water relationships: **Impounds water by creating diversions or dams**	American Beaver	*Castor canadensis*	Mesic Lowlands Conifer-Hardwood Forest Montane Mixed Conifer Forest Interior Mixed Conifer Forest Lodgepole Pine Forest and Woodlands Ponderosa Pine & Interior White Oak Forest and Woodlands Upland Aspen Forest Subalpine Parkland Open Water—Lakes, Rivers, and Streams Herbaceous Wetlands Montane Coniferous Wetlands Interior Riparian-Wetlands

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
7_2	Water relationships: **Creates ponds or wetlands through wallowing**	American Beaver	*Castor canadensis*	Open Water—Lakes, Rivers, and Streams
7_2	Water relationships: **Creates ponds or wetlands through wallowing**	Rocky Mountain Elk	*Cervus elaphus nelsoni*	Alpine Grasslands and Shrublands Interior Grasslands Shrub-steppe
8_1	Vegetation structure and composition relationships: **Creates standing dead trees (snags)**	Black Bear	*Ursus americanus*	Alpine Grasslands and Shrublands Westside Grasslands Interior Grasslands
8_2	Vegetation structure and composition relationships: **Herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)**	Moose	*Alces alces*	Open Water—Lakes, Rivers, and Streams
8_3	Vegetation structure and composition relationships: **Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)**	Canada Goose	*Branta canadensis*	Open Water —Lakes, Rivers, and Streams
8_3	Vegetation structure and composition relationships: **Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)**	Montane Vole	*Microtus montanus*	Agriculture, Pastures, and Mixed Environs

KEF Code	KEF Description	Species Common Name	Species Scientific Name	Wildlife Habitat Type
8_3	Vegetation structure and composition relationships: **Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)**	Rocky Mountain Elk	*Cervus elaphus nelsoni*	Mesic Lowlands Conifer-Hardwood Forest

Appendix E

DESCRIPTIONS OF FOREST AND GRASSLAND STRUCTURAL CONDITIONS (Johnson and O'Neil 2001).

Table 52. Descriptions of structural conditions in forest habitats

Structural Condition	Description
Grass/Forb–Open	Grass/Forb dominated with <70% coverage by grasses and forbs. Shrubs and small seedlings may be present, but do not dominate stand, (seedlings < 10% canopy cover), and there can be remnant trees (trees remaining from the previous stand) that can provide <10% canopy cover.
Grass/Forb–Closed	Grass/Forb dominated with >70% coverage by grasses and forbs. Shrubs and small seedlings may be present, but do not dominate stand, (seedlings < 10% canopy cover), and there can be remnant trees (trees remaining from the previous stand) that can provide <10% canopy cover.
Shrub/Seedling–Open	Seedlings are large enough to add structure to the stand but are small enough that the structure is similar to shrubs and may have remnant trees (trees remaining from the previous stand) that can provide <10% canopy cover. There is <70% cover of shrubs or seedlings. Tree size has <1" dbh, and there is only a single canopy stratum.
Shrub/Seedling–Closed	Seedlings are large enough to add structure to the stand but are small enough that the structure is similar to shrubs. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is >70% cover of shrubs or seedlings. Tree size has <1" dbh, and there is only a single canopy stratum.
Sapling/Pole–Open	The canopy is open enough that understory vegetation may be abundant. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 10-39% cover of sapling and pole-sized trees. Tree size is 1"-9" dbh, and there is a single canopy stratum.
Sapling/Pole–Moderate	Understory development is hampered by available light and moisture. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 40-69% cover of sapling and pole-sized trees. Tree size is 1"-9" dbh, and there is a single canopy stratum.
Sapling/Pole–Closed	The understory is depauperate or absent. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is > 70% cover of sapling and pole-sized trees. Tree size is 1"- 9" dbh and there is a single canopy stratum.
Small Tree–Single Story–Open	A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 10-39% cover of small trees, with <10% cover of other tree sizes. Tree size is 10-14" dbh, and there is a single canopy stratum.
Small Tree–Single Story–Moderate	Some grass/forb or shrub understory may be present. Remnant trees (green trees remaining from the previous stand) can provide <10% canopy cover. There is 40-69% cover of small trees with <10% cover of other sized trees. Tree size is 10-14" dbh, and there is a single canopy stratum.
Small Tree–Single Story–Closed	Grass/Forb or shrub understory minor or absent. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is > 70% cover of small trees, with <10% cover of other sized trees. Tree size is 10-14" dbh, and there is a single canopy stratum.

Structural Condition	Description
Medium Tree–Single Story–Open	A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 10-39% cover of medium trees, with <10% cover of other sized trees. Tree size is 15-19" dbh, and there is a single canopy stratum.
Medium Tree–Single Story–Moderate	Grass/Forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is 40-69% cover of medium trees with <10% cover of other sized trees. Tree size is 15-19" dbh, and there is a single canopy stratum.
Medium Tree–Single Story–Closed	A grass/forb or shrub understory may be present. Remnant trees (trees remaining from the previous stand) can provide <10% canopy cover. There is >70% cover of medium trees with <10% cover of other sized trees. Tree size is 15-19" dbh, and there is a single canopy stratum.
Large Tree–Single Story–Open	Grasses, shrubs, and/or seedlings may occur in the understory. There is 10-39% cover of large and/or giant size trees with <10% cover of other sized trees. Tree size is 20"-29" dbh, and there is a single canopy stratum.
Large Tree–Single Story–Moderate	Some grass/forb or shrub understory may be present. There is 40-69% cover of large and/or giant trees with <10% cover of other sized trees. Tree size is 20"-29" dbh, and there is a single canopy stratum.
Large Tree–Single Story–Closed	Grasses, shrubs, and/or seedlings may occur in the understory. There is >70% cover of large and/or giant trees with <10% cover of other sized trees. Tree size is 20"-29" dbh, and there is a single canopy stratum.
Small Tree–Multistory–Open	These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present. There is 10-39% total canopy cover dominated by small trees, at least 10% or more canopy cover of 1 or more other smaller tree sizes. Tree size is 10"-14" dbh, and there are two or more canopy strata.
Small Tree–Multistory–Moderate	These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 40-69% total canopy cover dominated by small trees, at least 10% or more canopy cover of 1 or more other smaller tree sizes. Tree size is 10"-14" dbh, and there are two or more canopy strata.
Small Tree–Multistory–Closed	These stands have an overstory of small trees with a distinct subcanopy of saplings and/or poles. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory extremely limited or absent. There is >70% total canopy cover dominated by small trees, at least 10% or more canopy cover of 1 or more other smaller tree sizes. Tree size is 10-14" dbh, and there are two or more canopy strata.

Structural Condition	Description
Medium Tree - Multistory-Open	These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 10-39% total canopy cover dominated by medium trees, at least 10% or more canopy cover of 1 or more smaller tree sizes. Tree size is 15”-19” dbh, and there are two or more canopy strata.
Medium Tree–Multistory–Moderate	These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb or shrub understory may be present, but is probably limited. There is 40-69% total canopy cover dominated by medium trees, at least 10% or more canopy cover of 1 or more smaller tree sizes. Tree size is 15”-19” dbh, and there are two or more canopy strata.
Medium Tree–Multistory–Closed	These stands have an overstory of medium trees with a distinct subcanopy of smaller trees. Scattered larger trees may be present but make up less than 10% canopy cover. Grass/forb understory may be present, but is probably limited. There is >70% total canopy cover dominated by medium trees, at least 10% or more canopy cover of 1 or more smaller tree sizes. Tree size is 15”- 19” dbh, and there are two or more canopy strata.
Large Tree–Multistory–Open	These stands have an overstory of large or giant sized trees with one or more distinct canopy layers of smaller trees. Stands > 40% cover of giant trees are classified in the “Giant, multistoried” stage. In westside forests, stands dominated by large trees, usually have giant trees scattered in the stand, with lower numbers in eastside forests. Grass/Forb or shrub understory often present, especially in canopy gaps. There is 10-39% total canopy cover, with at least 10% or more canopy cover from large and/or giant trees and another 10% or more canopy cover from 1 or more smaller tree size classes. Tree size is 20”-29” dbh, and there are two or more canopy strata.
Large Tree–Multistory–Moderate	These stands have an overstory of large or giant sized trees with one or more distinct canopy layers of smaller trees. Stands > 40% cover of giant trees are classified in the “Giant, multistoried” stage. In westside forests, stands dominated by large trees, usually have giant trees scattered in the stand, with lower numbers in eastside forests. Grass/Forb or shrub understory often present, especially in canopy gaps. There is 40-69% total canopy cover, at least 10% or more canopy cover from large trees with another 10% or more canopy cover from 1 or more smaller tree size classes. Tree size is 20”-29” dbh, and there are two or more canopy strata.
Large Tree–Multistory–Closed	These stands have an overstory of large or giant sized trees with one or more distinct canopy layers of smaller trees. Stands > 40% cover of giant trees are classified in the “Giant, multistoried” stage. In westside forests, stands dominated by large trees, usually have giant trees scattered in the stand, with lower numbers in eastside forests. Grass/Forb or shrub understory often present, especially in canopy gaps. There is >70% total canopy cover, at least 10% or more canopy cover from large trees with another 10% or more canopy cover from 1 or more smaller tree size classes. Tree size is 20”- 29” dbh, and there are two or more canopy strata.
Giant Tree–Multistory	These stands have an overstory of giant sized trees with one or more distinct canopy layers of smaller trees. Stands with <40% canopy cover are classified in the “large tree–multistory–open”, stage. There is > 40% canopy cover. Tree size is > 30” dbh, and there are two or more canopy strata.

Table 53. Descriptions of structural conditions in grassland habitats

Structural Condition	Description
Grass/Forb - Open	Grasslands that have <10% shrub cover and < 10% tree canopy cover. Grasses and forbs cover less than 70% of the ground, and bare ground is evident.
Grass/Forb– Closed	Grasslands that have <10% shrub cover and <10% tree canopy cover. Grasses and forbs cover >70% of the ground.
Low shrub– Open Shrub Overstory– Seedling/Young	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Low shrub– Open Shrub Overstory– Mature	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is < 25%.
Low shrub– Open Shrub Overstory– Old	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >10% and <70% and may have <10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is > 25%.
Low shrub– Closed Shrub Overstory– Seedling/Young	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >70% and may have <10% tree canopy cover. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Low shrub– Closed Shrub Overstory– Mature	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >70% and may have <10% tree canopy cover < 10%. Crown decadence is < 25%.
Low shrub– Closed Shrub Overstory– Old	Shrublands with shrubs < 0.5 m (1.6 ft) tall and shrub canopy cover >70% and may have <10% tree canopy cover. Crown decadence is > 25%.
Medium shrub– Open Shrub Overstory– Seedling/Young	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >10% and <70% and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Medium shrub– Open Shrub Overstory Mature	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >10% and <70% and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is < 25%.

Structural Condition	Description
Medium shrub–Open Shrub Overstory–Old	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >10% and <70% and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is > 25%.
Medium shrub–Closed Shrub Overstory–Seedling/Young	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >70%, and may have < 10% tree canopy cover. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Medium shrub–Closed Shrub Overstory–Mature	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >70%, and may have < 10% tree canopy cover. Crown decadence is < 25%
Medium shrub–Closed Shrub Overstory–Old	Shrublands with shrubs 0.5–2.0 m tall (1.6–6.5 ft.) and shrub canopy cover >70%, and may have < 10% tree canopy cover. Crown decadence is > 25%.
Tall shrub–Open Shrub Overstory–Seedling/Young	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >10% and <70%, and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Tall shrub–Open Shrub Overstory–Mature	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >10% and <70% and may have < 10% tree canopy cover. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is < 25%.
Tall shrub–Open Shrub Overstory–Old	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >10% and <70%, and may have tree canopy cover < 10%. Areas with less than 10% shrub cover are categorized as Grass/Forb. Crown decadence is > 25%.
Tall shrub–Closed Shrub Overstory–Seedling/Young	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >70%, and may have tree canopy cover < 10%. These are post-disturbance regenerating shrublands dominated by seedlings or young shrubs. Mature, legacy shrubs may persist from before the disturbance, but occur as scattered singles or widely scattered clumps. Crown decadence is negligible.
Tall shrub–Closed Shrub Overstory–Mature	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6–16.5 ft) and shrub canopy cover >70%, and may have tree canopy cover < 10%. Crown decadence is < 25%.
Tall shrub–Closed Shrub Overstory–Old	Shrublands with shrubs > 2.0 m and <5.0 m tall (6.6- 16.5 ft) and shrub canopy cover >70%, and may have < 10% tree canopy cover. Crown decadence is > 25%.

Appendix F

ATTRIBUTES OF IDAHO SUBWATERSHEDS AS THEY RELATE TO BULL TROUT THREATS (REPRODUCED FROM IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY 1998).

Subwatershed Name (5th, 6th and 7th code HUC)	**HUC Code**	**Area of Subwater-shed** (Acres) a=approx.	**Ownership** list in order of most ownership 1=USFS 2=BLM 3=COE 4=IDL 5=IDFG 6=Plum Creek 7=Potlatch 8=Other	**Bull Trout Distribution**		**Threats to Bull Trout**				
				Current (Since 1985) SER=Spawning / Early Rearing SAR=Sub Adult and Adult Rearing SNF=Surveyed Not Found DNP=Documented Not Present SSR=Suspected Spawning/Rearing SNP=Suspected Not Present UKN=Unknown	**Historical** (Prior to 1985)	**Passage Barrier** C=Culvert D=Dam I=Irrigation Diversion (include number	**Illegal Harvest** H=Hi impact L=Low impact N=No impact	**Brook Trout** Y=Yes N=No U=Unknown	**Roads** Miles/Sq Mile	**Timber Harvest** Percent Cut <15% 15-25% 25-50% 50-75% 75-100%
Snake River	0000	248,800	1,8,4,2	SAR	SAR	Dam	L	Y	1-3/m2	<5%
Divide Creek	0201	19,738	8,4,2,1	SNF	SNF		N	N	1-3/m2	<10%
Dry Creek	0103	7,040 a	8,2	SNF	SNF		N	N	<1/m2	0
Wolf Creek	0301	26,740	8,4,2	SNF	SNF		N	N	1-3/m2	<15%
Getta Creek	0402	11,520 a	8,2,4,1	SNF	SNF		N	N	1-3/m2	<15%
Highrange Creek	0401	3,840 a	8,2,1	SNF	SNF		N	N	1-3/m2	<5%
Big Canyon Creek	0501	6,600 a	1,8	SNF	SNF		N	N	<1/m2	<5%
Kurry Creek	0502	5,440 a	1	SNF	SNF		N	N	1-3/m2	<5%
Klopton Creek	0503	4,350 a	1	SNF	SNF		N	N	<1/m2	<5%
Kirkwood Creek	0602	9,280 a	1,8	SNF	SNF		N	N	1-3/m2	<5%
Sheep Creek	0702	24,580 a	1,8	SER	SER		L	N	<0.5/m2	<5%
Bernard Creek	0801	5,060 a	1	SNF	SNF		N	N	0/m2	0
Granite Creek	0901	20,800 a	1	SER	SER		L	N	0/m2	0
Tammany Creek	0101	20,500 a	8 Private	SNF	SNF		N	N	>3/m2	0%
Tenmile	0202	8,320 a	8	SNF	SNF		N	N	1-3/m2	0%
Redbird Creek	0201	5,760 a	8,5	SNF	SNF		N	N	<1/m2	0%
Captain John Creek	0302	16,720	5,2,4,8	SNF	SNF		N	N	1-3/m2	0-15%%
Corral Creek	0403	5,120 a	2,5,8	SNF	SNF		N	N	1-3/m2	<5%
Cottonwood Creek	0501	5,760 a	1,2,4,5,8	SNF	SNF		N	N	<1/m2	0%

Appendix G

REGIONAL IMPACTS OF OUT-OF-SUBBASIN FACTORS IMPACTING ANADROMOUS FISH SPECIES.

Information on out-of-subbasin effects to aquatic species is taken from the memo by Mobrand Biometrics (2003a) describing how these effects were addressed in regional EDT modeling efforts. EDT estimates survival and capacity of a focal species (e.g., spring chinook salmon) within a defined study area (e.g., a subbasin) based on habitat characteristics and combines this with predefined survival rates outside the study area. These predefined survival rates have been termed the "out-of-subbasin effects" or OOSE. These survival rates have been determined only for spring and fall chinook salmon; No rates are available regarding steelhead.

As a contribution to the need to supply subbasin planners with a set of assumptions regarding the out-of-subbasin effects, Mobrand Biometrics (2003a) provided the assumptions that are currently incorporated in the Ecosystem Diagnosis and Treatment model that is being used by subbasin planners. These out-of-subbasin assumptions in EDT were developed as part of the Council's Multi-species Framework Project. Calculations behind the results provided here were documented in the final project report to the Council from Mobrand Biometrics and in Marcot et al. (2002). The Framework assumptions were intended to capture conditions prevailing in the region around the year 2000. The current out-of-subbasin assumptions in EDT are based on passage and hydrologic modeling done by the Council, National Marine Fisheries Service and other participants in the Council's Framework Project.

The OOSE are defined by Mobrand Biometrics (2003a) as the total survival rate of juvenile fish from the mouth of the subbasin to their return to the subbasin as adults. OOSE accounts for survival conditions through the hydroelectric system, the Columbia River below Bonneville Dam, the estuary, the ocean and any harvest occurring outside the subbasin. To be specific, OOSE = Survival through the hydro system X survival in the lower Columbia River X survival through the estuary X survival in the ocean X overall harvest rate. This definition of the OOSE makes it equivalent to the smolt to adult survival rate or SAR that has been used in other modeling efforts. The SAR is specific for a species and is related to the position of the subbasin within the Columbia Basin and especially relative to its position within the hydroelectric system. In other words, because the SAR (OOSE) is affected by survival through the hydroelectric system (see equation above), the SAR is affected by the number of dams that fish must traverse to get to and from the subbasin. As a result, we see SARs generally decline going upstream through the Columbia River basin.

Because the out-of-subbasin assumptions reduce to the SARs that result from the model, Mobrand Biometrics (2003a) represents the combined effect of all current OOSE assumptions in EDT as the SARs for spring and fall chinook salmon projected from various points in the Columbia Basin (Table 54). These SARs include all considerations for dam passage, survival below Bonneville Dam, survival through the Columbia estuary and the ocean and assumed harvest outside the subbasin. The hope is that by focusing on the SARs (which can be related to empirical survival estimates), the region can avoid becoming embroiled in debates over details of individual survival components as part of the subbasin planning process. This is consistent with direction provided by the Council in previous reports on the OOSE issue.

The results in Table 54 are provided to clarify the assumptions that are available to subbasin planners regarding the SARs in EDT. SAR has been estimated from empirical data in a few subbasins in the PATH process and elsewhere. Mobrand Biometrics has compared the estimated SARs in EDT to available empirical estimates of SARs and find them generally in agreement.

Table 54. Smolt-to-adult survival rates (SAR) for spring and fall chinook currently used in the Ecosystem Diagnosis and Treatment model.

	Spring Chinook		*Fall Chinook migrants*	
	SAR	**Expl. Rate**	**SAR**	**Expl. Rate**
Lower Granite Pool	0.9%	6.8%	0.4%	45%
Little Goose Pool	1.0%		0.4%	
Lower Monumental Pool	1.1%		0.5%	
Ice Harbor Pool	1.3%		0.6%	
Lower Snake	1.4%		0.8%	
McNary Pool	1.4%	6.8%	0.7%	45%
John Day Pool	1.5%		0.8%	
The Dalles Pool	2.0%		0.9%	
Bonneville Pool	2.2%		1.0%	
Lower Columbia	3.1%		1.4%	
Wells Pool	0.7%	6.8%	0.3%	45%
Rock Island Pool	0.9%		0.4%	
Wanapum Pool	1.1%		0.4%	
Priest Rapids Pool	1.2%		0.6%	
Hanford Reach	1.4%		0.8%	

The results in Table 54 approximate the survival rates that would be applied to spring and fall chinook entering the Columbia River or Snake River at the points in the table. For example, spring chinook entering the Snake River at the head of Lower Granite pool (from the Snake Hells Canyon subbasin) would be subject to a SAR of 0.9% in EDT. This SAR incorporates an assumed harvest on spring chinook of 6.8%. Fall chinook from the Snake Hells Canyon subbasin would be subject to a SAR of 0.4% in EDT. This SAR incorporates an assumed harvest on spring chinook of 45%. The SARs for fall chinook represent survival of actively migrating juveniles. Because fall chinook also include a component of fish that rear for some period within the mainstem Columbia and Snake Rivers, total survival of fall chinook from each point may differ from the results in Table 1.

The SARs in Table 54 represent survival under “typical” conditions in the Columbia River and the ocean. Empirical estimates of SAR that have been reported in the PATH process and elsewhere vary widely between years reflecting environmental variation including regime shifts in ocean survival conditions. However, the EDT assessment is intended to characterize the potential of current habitat in a subbasin with respect to a focal species and does not include environmental variability.

Table 55 and Table 56 provide the schedule of survival rates at each dam for each month of the year for spring and fall chinook salmon. In EDT, fish leave the subbasin and enter the mainstem across a range of months. They move down at travel speeds related to flow, encountering daily survival rates in the reservoirs. Fish are then passed through a dam where they encounter the survival rates in the tables below. A portion of the fish may be transported downstream. The dam survival rates below were calculated using the National Marine Fisheries Service's SimPass model with conditions specified in the Biological Opinion prevailing in 2000. Other mainstem passage survival assumptions are described in Marcot et al. (2002).

Table 55. Yearling (spring) chinook dam survival rates currently used in EDT (Marcot et al. 2002).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Granite	0.9	0.9	0.93	0.98	0.98	0.98	0.95	0.95	0.95	0.95	0.9	0.9
Little Goose	0.9	0.9	0.93	0.98	0.98	0.98	0.95	0.95	0.95	0.95	0.9	0.9
Lower Monumental	0.9	0.9	0.93	0.96	0.96	0.96	0.94	0.94	0.94	0.94	0.9	0.9
Ice Harbor	0.9	0.9	0.94	0.97	0.97	0.97	0.97	0.97	0.95	0.95	0.9	0.9
McNary	0.9	0.9	0.94	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97
John Day	0.9	0.9	0.93	0.96	0.96	0.96	0.96	0.96	0.94	0.94	0.9	0.9
The Dalles	0.9	0.9	0.94	0.98	0.98	0.98	0.98	0.98	0.9	0.9	0.9	0.9
Bonneville	0.9	0.9	0.92	0.95	0.95	0.95	0.95	0.95	0.93	0.93	0.9	0.9
Rocky Reach	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Rock Island	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Wanapum	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Priest Rapids	0.89	0.89	0.89	0.95	0.95	0.95	0.95	0.95	0.89	0.89	0.89	0.89
Wells	0.9	0.9	0.9	0.97	0.97	0.97	0.97	0.97	0.89	0.89	0.89	0.89

Table 56. Subyearling (fall) chinook dam survival rates currently used in EDT (Marcot et al. 2002).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Granite	0.9	0.9	0.95	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.9	0.9
Little Goose	0.9	0.9	0.94	0.96	0.96	0.96	0.94	0.94	0.94	0.94	0.9	0.9
Lower Monumental	0.9	0.9	0.94	0.95	0.95	0.95	0.95	0.94	0.94	0.93	0.9	0.9
Ice Harbor	0.9	0.9	0.93	0.96	0.96	0.96	0.96	0.96	0.94	0.94	0.9	0.9
McNary	0.9	0.9	0.96	0.98	0.98	0.98	0.98	0.98	0.95	0.95	0.95	0.95
John Day	0.9	0.9	0.95	0.97	0.97	0.97	0.97	0.97	0.95	0.95	0.9	0.9
The Dalles	0.9	0.9	0.93	0.98	0.98	0.98	0.98	0.98	0.9	0.9	0.9	0.9
Bonneville	0.9	0.9	0.91	0.93	0.93	0.93	0.93	0.93	0.91	0.91	0.9	0.9
Rocky Reach	0.89	0.89	0.91	0.93	0.93	0.93	0.93	0.93	0.89	0.89	0.89	0.89
Rock Island	0.89	0.89	0.9	0.93	0.93	0.93	0.93	0.93	0.89	0.89	0.89	0.89
Wanapum	0.89	0.89	0.91	0.92	0.92	0.92	0.92	0.92	0.89	0.89	0.89	0.89
Priest Rapids	0.89	0.89	0.9	0.92	0.92	0.92	0.92	0.92	0.89	0.89	0.89	0.89
Wells	0.89	0.89	0.94	0.97	0.97	0.97	0.97	0.97	0.89	0.89	0.89	0.89

Appendix H

RAW DATA AND RESULTS OF THE QUALITATIVE HABITAT ASSESSMENT (QHA) MODEL.

Various input and output information from the QHA model is presented to provide transparency regarding data inputs, and allow readers the opportunity to consider possible alternative interpretations of outputs. All data inputs represent professional judgments since no suitable and timely method could be developed for defensibly transforming real habitat data into categorical classifications used by the QHA model. Regional biologists within IDFG and ODFW most familiar with the streams of interest populated the QHA model, and their input was subsequently reviewed by the subbasin aquatic technical team. No changes were requested or made to original data inputs based on technical team review.

To aid in interpretation, within each of the tables presented below names of streams located in Oregon have been shaded; names of streams in Idaho are unshaded.

The following information is presented in this appendix:

Model Inputs:

1. Existing conditions
2. Reference conditions
3. Species habitat hypotheses
4. Species use/distribution

Model Outputs:

1. Habitat scores
2. Habitat ranks
3. Confidence scores
4. Summary table of model outputs and revised restoration scores[4]
5. Tornado diagram—Illustration of habitat scores (protection and/or restoration) by reach including both original and revised restoration scores.

Readers interested in detailed explanation of the QHA model development and function are referred to the QHA Users Guide (Mobrand Biometrics 2003b).

[4] Revision of restoration scores is discussed in section 4.1. To account for the differing amount of habitat (length of stream used by steelhead) between streams QHA restoration scores were standardized based on the average usable length (2.0 miles) of each stream used by steelhead within the subbasin. The estimated length utilized within each individual stream was divided by 2.0; the result was then multiplied by the original QHA restoration score for that reach.

Existing Conditions:

Scoring	
Confidence Rating	Attribute Rating
0 = Unknown	0 = <20% of
1 = Speculative	1 = 40% of
2 = Expert Opinion	2 = 60% of
3 = Well Documented	3 = 80% of
	4 = 100% of

Describe the existing physical structure of the stream

Definitions

Attribute Confidence	2	2	2	2	2	2	2	2	2	2	2	
Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Confidence
Bernard Creek	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	1
Big Canyon Creek	1.0	2.0	1.5	3.0	3.0	2.0	3.0	3.0	1.0	3.0	3.0	1
Brush Creek	3.0	2.0	2.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	1
Captain John Creek	2.0	3.0	3.0	3.0	3.0	2.0	4.0	4.0	3.0	3.0	4.0	2
Cave Gulch	1.0	1.0	1.0	3.0	2.5	1.5	3.0	3.0	1.0	3.0	3.0	1
Corral Creek (N)	1.0	2.0	1.0	3.0	1.5	1.0	3.0	2.5	1.0	3.0	2.5	1
Corral Creek (S)	1.0	1.0	1.0	3.0	2.0	1.0	3.0	3.0	1.5	3.0	2.0	0
Cottonwood Creek	2.0	2.0	2.0	2.5	2.0	2.0	3.0	3.0	2.5	3.0	3.0	2
Divide Creek	1.0	2.0	1.0	2.0	2.0	1.0	3.0	3.0	2.0	2.0	2.5	2
Dry Creek	1.0	1.0	1.0	3.0	2.0	1.0	3.0	3.0	1.0	3.0	3.0	1
Getta Creek	1.0	2.0	2.0	3.0	2.0	1.0	3.0	3.0	1.0	1.0	2.5	1
Granite Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2
Jones Creek	2.0	2.0	2.0	3.0	2.0	1.0	3.0	3.0	1.0	3.0	1.0	0
Kirby Creek	2.0	2.0	2.0	3.5	3.0	2.0	4.0	4.0	2.0	3.0	3.0	0
Kirkwood Creek	2.0	2.5	2.5	3.5	3.0	2.5	3.5	4.0	3.0	2.0	3.0	1
Little Granite Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	1
Redbird Creek	1.0	2.0	2.0	3.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	1
Saddle Creek	3.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Sheep Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2
Sluice Creek	3.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Somers Creek	4.0	4.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Temperance Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	3.0	2
West Creek	2.0	2.0	2.0	4.0	2.0	2.0	4.0	4.0	2.0	4.0	2.0	0
Wolf Creek	1.0	2.0	1.0	1.0	2.0	1.0	3.0	3.0	1.0	1.0	2.5	2
Three Creeks	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	1
Cook Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Deep Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Lookout Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Tryon Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Pleasant Valley Cr.	3.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Durham Creek	3.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Two Corral Creek	3.0	4.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Salt Creek	3.0	4.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Sand Creek	2.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Rush Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Rattlesnake Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Rough Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Wild Sheep Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Bull Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Battle Creek	3.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2

Reference Conditions:

Scoring		
Confidence Rating		Attribute Rating
0 = Unknown		0 = <20% of
1 = Speculative		1 = 40% of
2 = Expert Opinion		2 = 60% of
3 = Well Documented		3 = 80% of
		normative

Describe the natural physical condition of the stream

Definitions

Reach Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Confidence
Attribute Confidence	2	2	2	2	2	2	2	2	2	2	2	
Bernard Creek	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	1
Big Canyon Creek	2.0	3.0	2.0	4.0	3.0	2.0	4.0	4.0	2.0	4.0	3.0	1
Brush Creek	3.0	2.0	2.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	1
Captain John Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2
Cave Gulch	2.0	2.0	2.0	4.0	3.0	2.0	4.0	4.0	2.0	4.0	3.0	1
Corral Creek (N)	2.0	3.0	3.0	4.0	2.0	2.0	4.0	4.0	2.0	4.0	3.0	1
Corral Creek (S)	2.0	2.0	2.0	4.0	2.0	2.0	4.0	4.0	2.0	4.0	2.0	0
Cottonwood Creek	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	1
Divide Creek	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	2
Dry Creek	2.0	2.0	2.0	4.0	3.0	3.0	4.0	4.0	2.0	4.0	3.0	1
Getta Creek	2.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	1
Granite Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2
Jones Creek	2.0	2.0	2.0	4.0	2.0	2.0	4.0	4.0	2.0	4.0	2.0	0
Kirby Creek	2.0	2.0	2.0	4.0	3.0	2.0	4.0	4.0	2.0	4.0	3.0	1
Kirkwood Creek	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	2
Little Granite Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	1
Redbird Creek	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	4.0	1
Saddle Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Sheep Creek	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2
Sluice Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Somers Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Temperance Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
West Creek	2.0	2.0	2.0	4.0	2.0	2.0	4.0	4.0	2.0	4.0	2.0	0
Wolf Creek	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	1
Three Creeks	3.0	3.0	3.0	4.0	3.0	3.0	4.0	4.0	3.0	4.0	3.0	1.0
Cook Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Deep Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Lookout Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Tryon Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Pleasant Valley Cr.	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Durham Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Two Corral Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Salt Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Sand Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Rush Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Rattlesnake Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Rough Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Wild Sheep Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Bull Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2
Battle Creek	4.0	4.0	3.0	4.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	2

Species Habitat Hypotheses:

Species habitat hypothesis

Assign a weight to each attribute (0-2) relative to its importance to the life stage

Habitat utilization life stages	Life Stage Weight (1-3)	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
Spawning and incubation	3	2.0	1.0	1.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	0.0
Growth and feeding	3	1.0	1.0	2.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0
Migration (A&J)	1	1.0	1.0	1.0	0.5	1.0	0.0	0.5	1.0	0.0	0.0	2.0

Species use/distribution

	Reference Condition					Current Condition				
	Describe how reaches would be used by focal spp.				Confidence in	Describe how reaches are used by focal spp.				Confidence in
Reach Name	Range	Spawn/Inc	Growth/Feed	Migration	Reference distn	Range	Spawn/Inc	Growth/Feed	Migration	Current distn
Bernard Creek	1	1	1		1	1	1	1		2
Big Canyon Creek	1	1	1		1	1	1	1		2
Brush Creek	1	1	1		1	1	1	1		2
Captain John Creek	1	1	1		1	1	1	1		2
Cave Gulch	1	1	1		1	1	1	1		2
Corral Creek (N)	1	1	1		1	1	1	1		2
Corral Creek (S)	1	1	1		1	1	1	1		2
Cottonwood Creek	1	1	1		1	1	1	1		2
Divide Creek	1	1	1		1	1	1	1		2
Dry Creek	1	1	1		1	1	1			2
Getta Creek	1	1	1		1	1	1	1		2
Granite Creek	1	1	1		1	1	1	1		2
Jones Creek	1	1	1		1	1	1	1		2
Kirby Creek	1	1	1		1	1	1	1		2
Kirkwood Creek	1	1	1		1	1	1	1		2
Little Granite Creek	1	1	1		1	1	1	1		2
Redbird Creek	1	1	1		1	1	1	1		2
Saddle Creek	1	1	1		1	1	1	1		2
Sheep Creek	1	1	1		1	1	1	1		2
Sluice Creek	1	1	1		1	1	1	1		2
Somers Creek	1	1	1		1	1	1	1		2
Temperance Creek	1	1	1		1	1	1	1		2
West Creek	1	1	1		1	1	1	1		2
Wolf Creek	1	1	1		1	1	1	1		2
Three Creeks	1	1	1		1	1	1	1		2
Cook Creek	1	1	1		1	1	1	1		2
Deep Creek	1	1	1		1	1	1	1		2
Lookout Creek	1	1	1		1	1	1	1		2
Tryon Creek	1	1	1		1	1	1	1		2
Pleasant Valley Cr.	1	1	1		1	1	1	1		2
Durham Creek	1	1	1		1	1	1	1		2
Two Corral Creek	1	1	1		1	1	1	1		2
Salt Creek	1	1	1		1	1	1	1		2
Sand Creek	1	1	1		1	1	1	1		2
Rush Creek	1	1	1		1	1	1	1		2
Rattlesnake Creek	1	1	1		1	1	1	1		2
Rough Creek	1	1	1		1	1	1	1		2
Wild Sheep Creek	1	1	1		1	1	1	1		2
Bull Creek	1	1	1		1	1	1	1		2
Battle Creek	1	1	1		1	1	1	1		2
N.Fk. Battle Creek	1	1	1		1	1	1	1		2
Stud Creek	1	1	1		1	1	1	1		2
Hells Canyon Creek	1	1	1		1	1	1	1		2

Habitat Scores:

Habitat scores can range between -1 and +1. Weighted protection scores are indices of what is "good" about a stream
The weighted restoration scores are what is "bad" about a stream, i.e. a high (negative) protection score means
that the reach or attribute is close to the reference condition and hence might be considered for protection, whereas
a high (positive) restoration score means the reach or attributes is far from the reference condition and
might be considered for restoration.

Weighted Protection Habitat Scores

Reach Name	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
Bernard Creek	-0.53	-0.8	-0.4	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.4	-0.5	0.0
Big Canyon Creek	-0.35	-0.3	-0.3	-0.4	-0.8	-0.8	-0.3	-0.4	-0.4	-0.1	-0.4	0.0
Brush Creek	-0.50	-0.8	-0.3	-0.5	-1.0	-0.8	-0.4	-0.5	-0.5	-0.4	-0.5	0.0
Captain John Creek	-0.47	-0.5	-0.4	-0.8	-0.8	-0.8	-0.3	-0.5	-0.5	-0.4	-0.4	0.0
Cave Gulch	-0.31	-0.3	-0.1	-0.3	-0.8	-0.6	-0.2	-0.4	-0.4	-0.1	-0.4	0.0
Corral Creek (N)	-0.29	-0.3	-0.3	-0.3	-0.8	-0.4	-0.1	-0.4	-0.3	-0.1	-0.4	0.0
Corral Creek (S)	-0.30	-0.3	-0.1	-0.3	-0.8	-0.5	-0.1	-0.4	-0.4	-0.2	-0.4	0.0
Cottonwood Creek	-0.37	-0.5	-0.3	-0.5	-0.6	-0.5	-0.3	-0.4	-0.4	-0.3	-0.4	0.0
Divide Creek	-0.28	-0.3	-0.3	-0.3	-0.5	-0.5	-0.1	-0.4	-0.4	-0.3	-0.3	0.0
Dry Creek	-0.28	-0.3	-0.1	-0.1	-0.8	-0.5	-0.1	-0.4	-0.4	-0.1	-0.4	0.0
Getta Creek	-0.31	-0.3	-0.3	-0.5	-0.8	-0.5	-0.1	-0.4	-0.4	-0.1	-0.1	0.0
Granite Creek	-0.64	-1.0	-0.5	-1.0	-1.0	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	0.0
Jones Creek	-0.35	-0.5	-0.3	-0.5	-0.8	-0.5	-0.1	-0.4	-0.4	-0.1	-0.4	0.0
Kirby Creek	-0.43	-0.5	-0.3	-0.5	-0.9	-0.8	-0.3	-0.5	-0.5	-0.3	-0.4	0.0
Kirkwood Creek	-0.45	-0.5	-0.3	-0.6	-0.9	-0.8	-0.3	-0.4	-0.5	-0.4	-0.3	0.0
Little Granite Creek	-0.64	-1.0	-0.5	-1.0	-1.0	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	0.0
Redbird Creek	-0.36	-0.3	-0.3	-0.5	-0.8	-0.5	-0.3	-0.4	-0.4	-0.4	-0.4	0.0
Saddle Creek	-0.56	-0.8	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Sheep Creek	-0.64	-1.0	-0.5	-1.0	-1.0	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	0.0
Sluice Creek	-0.56	-0.8	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Somers Creek	-0.56	-1.0	-0.5	-0.8	-0.8	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Temperance Creek	-0.58	-1.0	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
West Creek	-0.43	-0.5	-0.3	-0.5	-1.0	-0.5	-0.3	-0.5	-0.5	-0.3	-0.5	0.0
Wolf Creek	-0.24	-0.3	-0.3	-0.3	-0.3	-0.5	-0.1	-0.4	-0.4	-0.1	-0.1	0.0
Three Creeks	-0.53	-0.8	-0.4	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.4	-0.5	0.0
Cook Creek	-0.58	-1.0	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Deep Creek	-0.58	-1.0	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Lookout Creek	-0.58	-1.0	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Tryon Creek	-0.58	-1.0	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Pleasant Valley Cr.	-0.56	-0.8	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Durham Creek	-0.56	-0.8	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Two Corral Creek	-0.53	-0.8	-0.5	-0.8	-0.8	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Salt Creek	-0.53	-0.8	-0.5	-0.8	-0.8	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Sand Creek	-0.53	-0.5	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Rush Creek	-0.58	-1.0	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0
Rattlesnake Creek	-0.58	-1.0	-0.5	-0.8	-1.0	-0.8	-0.4	-0.5	-0.5	-0.5	-0.5	0.0

Weighted Restoration Habitat Scores

Reach Name	Reach Score	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
Bernard Creek	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Big Canyon Creek	0.11	0.3	0.1	0.1	0.3	0.0	0.0	0.1	0.1	0.1	0.1	0.0
Brush Creek	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Captain John Creek	0.17	0.5	0.1	0.3	0.3	0.3	0.3	0.0	0.0	0.1	0.1	0.0
Cave Gulch	0.14	0.3	0.1	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Corral Creek (N)	0.18	0.3	0.1	0.5	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.0
Corral Creek (S)	0.13	0.3	0.1	0.3	0.3	0.0	0.1	0.1	0.1	0.1	0.1	0.0
Cottonwood Creek	0.16	0.3	0.1	0.3	0.4	0.3	0.1	0.1	0.1	0.1	0.1	0.0
Divide Creek	0.25	0.5	0.1	0.5	0.5	0.3	0.3	0.1	0.1	0.1	0.3	0.0
Dry Creek	0.17	0.3	0.1	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.0
Getta Creek	0.20	0.3	0.1	0.3	0.3	0.3	0.3	0.1	0.1	0.3	0.4	0.0
Granite Creek	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jones Creek	0.08	0.0	0.0	0.0	0.3	0.0	0.1	0.1	0.1	0.1	0.1	0.0
Kirby Creek	0.02	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Kirkwood Creek	0.09	0.3	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.3	0.0
Little Granite Creek	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Redbird Creek	0.17	0.5	0.1	0.3	0.3	0.3	0.1	0.1	0.1	0.0	0.1	0.0
Saddle Creek	0.02	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sheep Creek	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sluice Creek	0.02	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Somers Creek	0.02	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperance Creek	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West Creek	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wolf Creek	0.30	0.5	0.1	0.5	0.8	0.3	0.3	0.1	0.1	0.3	0.4	0.0
Three Creeks	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cook Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deep Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lookout Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tryon Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pleasant Valley Cr.	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Durham Creek	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Two Corral Creek	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Salt Creek	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sand Creek	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rush Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rattlesnake Creek	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Habitat Ranks:

This page ranks the habitat scores. The highest weighted score in either protection or restoration categories is ranked 1 and is formated in red. On the protection side the number 1 rank goes to reaches or attributes that are in the best shape (hence highest protection ranking) whereas for restoration the number 1 rank goes to the reach or attribute that is in the worst condition relative to the reference condition. Remember that scores are weighted by the Habitat Hypothesis and are not strictly a measure of distance from the reference condition.

NPC= Not present currently

Protection Habitat Ranking

Reach Name	Reach Rank	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
Bernard Creek	23	2	8	2	1	2	8	5	5	8	5	11
Big Canyon Creek	35	7	7	3	1	1	7	3	3	10	3	11
Brush Creek	28	2	10	4	1	2	8	4	4	8	4	11
Captain John Creek	29	4	7	1	1	1	10	4	4	7	7	11
Cave Gulch	37	6	9	6	1	2	8	3	3	9	3	11
Corral Creek (N)	40	6	6	6	1	2	9	2	5	9	2	11
Corral Creek (S)	39	6	9	6	1	2	9	3	3	8	3	11
Cottonwood Creek	33	2	9	2	1	2	9	5	5	8	5	11
Divide Creek	41	5	5	5	1	1	10	3	3	5	5	11
Dry Creek	41	6	7	7	1	2	7	3	3	7	3	11
Getta Creek	38	6	6	2	1	2	8	4	4	8	8	11
Granite Creek	1	1	5	1	1	1	5	5	5	5	5	11
Jones Creek	35	2	8	2	1	2	9	5	5	9	5	11
Kirby Creek	31	3	8	3	1	2	8	3	3	8	7	11
Kirkwood Creek	30	4	8	3	1	2	8	6	4	7	10	11
Little Granite Creek	1	1	5	1	1	1	5	5	5	5	5	11
Redbird Creek	34	8	8	2	1	2	8	4	4	4	4	11
Saddle Creek	14	2	5	2	1	2	10	5	5	5	5	11
Sheep Creek	1	1	5	1	1	1	5	5	5	5	5	11
Sluice Creek	14	2	5	2	1	2	10	5	5	5	5	11
Somers Creek	14	1	5	2	2	2	10	5	5	5	5	11
Temperance Creek	4	1	5	3	1	3	10	5	5	5	5	11
West Creek	31	2	8	2	1	2	8	2	2	8	2	11
Wolf Creek	43	4	4	4	4	1	8	2	2	8	8	11
Three Creeks	23	2	8	2	1	2	8	5	5	8	5	11
Cook Creek	4	1	5	3	1	3	10	5	5	5	5	11
Deep Creek	4	1	5	3	1	3	10	5	5	5	5	11
Lookout Creek	4	1	5	3	1	3	10	5	5	5	5	11
Tryon Creek	4	1	5	3	1	3	10	5	5	5	5	11
Pleasant Valley Cr.	14	2	5	2	1	2	10	5	5	5	5	11
Durham Creek	14	2	5	2	1	2	10	5	5	5	5	11
Two Corral Creek	23	1	5	1	1	1	10	5	5	5	5	11
Salt Creek	23	1	5	1	1	1	10	5	5	5	5	11
Sand Creek	23	4	4	2	1	2	10	4	4	4	4	11
Rush Creek	4	1	5	3	1	3	10	5	5	5	5	11

NPR = Not present in reference condition

Restoration Habitat Ranking

Reach Name	Reach Rank	Riparian Condition	Channel form	Channel Stability	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions
Bernard Creek	27	1	1	1	1	1	1	1	1	1	1	1
Big Canyon Creek	11	1	3	3	1	9	9	3	3	3	3	9
Brush Creek	27	1	1	1	1	1	1	1	1	1	1	1
Captain John Creek	5	1	6	2	2	2	2	9	9	6	6	9
Cave Gulch	9	1	4	1	1	4	10	4	4	4	4	11
Corral Creek (N)	4	2	5	1	2	5	5	5	4	5	5	11
Corral Creek (S)	10	1	4	1	1	10	4	4	4	9	4	10
Cottonwood Creek	8	2	5	2	1	2	5	5	5	10	5	11
Divide Creek	2	1	7	1	1	4	4	7	7	7	4	11
Dry Creek	5	1	6	1	1	1	1	6	6	6	6	11
Getta Creek	3	2	8	2	2	2	2	8	8	2	1	11
Granite Creek	27	1	1	1	1	1	1	1	1	1	1	1
Jones Creek	13	7	7	7	1	7	2	2	2	2	2	7
Kirby Creek	17	3	3	3	1	3	3	3	3	3	1	3
Kirkwood Creek	12	1	5	3	3	8	5	5	8	8	1	8
Little Granite Creek	27	1	1	1	1	1	1	1	1	1	1	1
Redbird Creek	5	1	5	2	2	2	5	5	5	10	5	10
Saddle Creek	17	1	2	2	2	2	2	2	2	2	2	2
Sheep Creek	27	1	1	1	1	1	1	1	1	1	1	1
Sluice Creek	17	1	2	2	2	2	2	2	2	2	2	2
Somers Creek	17	2	2	2	1	2	2	2	2	2	2	2
Temperance Creek	27	1	1	1	1	1	1	1	1	1	1	1
West Creek	27	1	1	1	1	1	1	1	1	1	1	1
Wolf Creek	1	2	8	2	1	5	5	8	8	5	4	11
Three Creeks	27	1	1	1	1	1	1	1	1	1	1	1
Cook Creek	27	1	1	1	1	1	1	1	1	1	1	1
Deep Creek	27	1	1	1	1	1	1	1	1	1	1	1
Lookout Creek	27	1	1	1	1	1	1	1	1	1	1	1
Tryon Creek	27	1	1	1	1	1	1	1	1	1	1	1
Pleasant Valley Cr.	17	1	2	2	2	2	2	2	2	2	2	2
Durham Creek	17	1	2	2	2	2	2	2	2	2	2	2
Two Corral Creek	14	1	3	3	1	3	3	3	3	3	3	3
Salt Creek	14	1	3	3	1	3	3	3	3	3	3	3
Sand Creek	14	1	2	2	2	2	2	2	2	2	2	2
Rush Creek	27	1	1	1	1	1	1	1	1	1	1	1

Confidence Scores:

Current Condition Confidence Scores

Stream Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Confidence
Attribute Confidence	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	
Bernard Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Big Canyon Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Brush Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Captain John Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Cave Gulch	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Corral Creek (N)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Corral Creek (S)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Cottonwood Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Divide Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Dry Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Getta Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Granite Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Jones Creek	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Kirby Creek	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Kirkwood Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Little Granite Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Redbird Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Saddle Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Sheep Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Sluice Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Somers Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Temperance Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
West Creek	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Wolf Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Three Creeks	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Cook Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Deep Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Lookout Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Tryon Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Pleasant Valley Cr.	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Durham Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Two Corral Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Salt Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Sand Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Rush Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Rattlesnake Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Rough Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Wild Sheep Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Bull Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Battle Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
N.Fk. Battle Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Stud Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Hells Canyon Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67

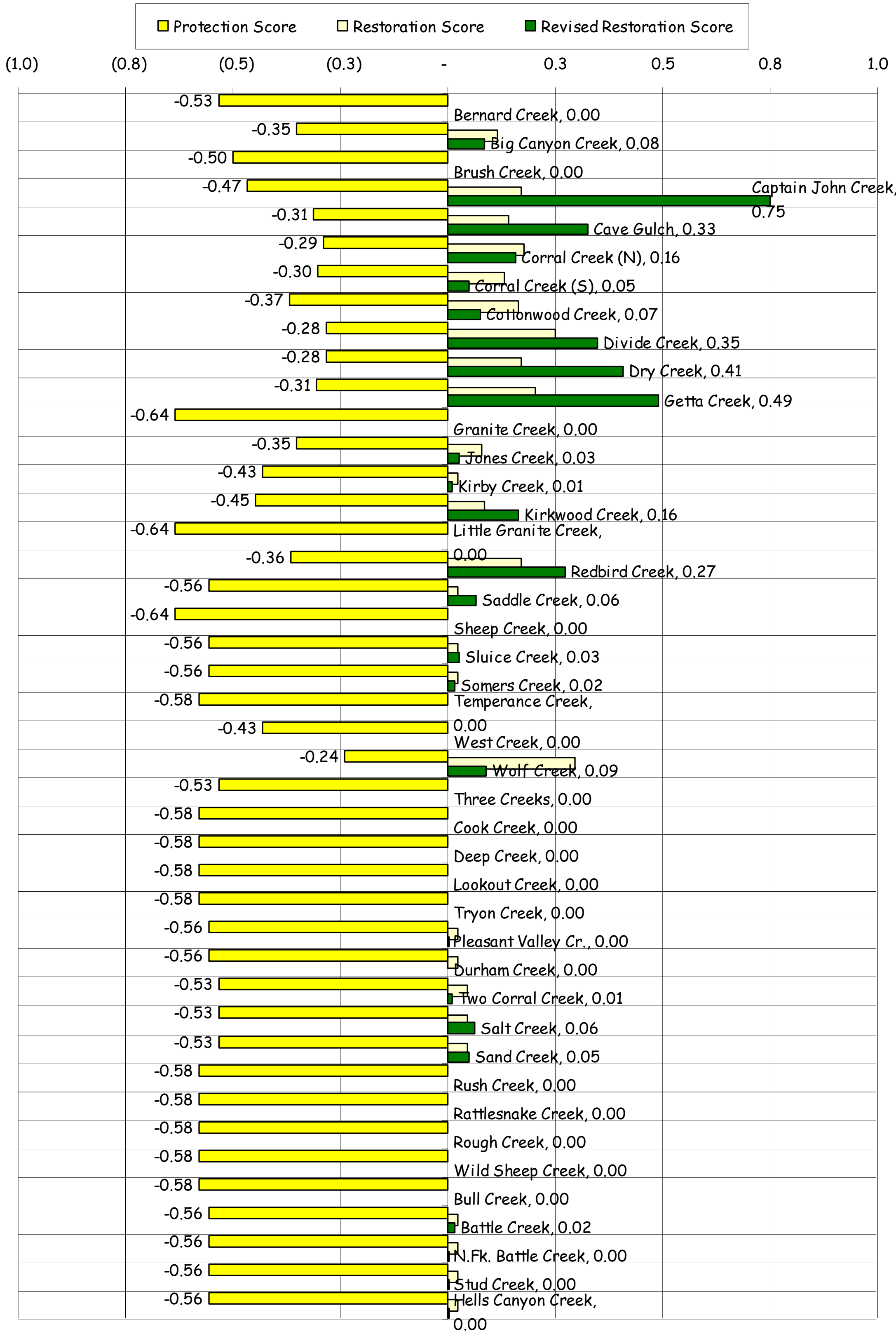
Reference Condition Confidence Scores

Stream Name	Riparian Condition	Channel stability	Habitat Diversity	Fine sediment	High Flow	Low Flow	Oxygen	Low Temperature	High Temperature	Pollutants	Obstructions	Reach Confidence
Attribute Confidence	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	
Bernard Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Big Canyon Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Brush Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Captain John Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Cave Gulch	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Corral Creek (N)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Corral Creek (S)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Cottonwood Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Divide Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Dry Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Getta Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Granite Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Jones Creek	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Kirby Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Kirkwood Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Little Granite Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Redbird Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Saddle Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Sheep Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Sluice Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Somers Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Temperance Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
West Creek	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Wolf Creek	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Three Creeks	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Cook Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Deep Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Lookout Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Tryon Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Pleasant Valley Cr.	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Durham Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Two Corral Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Salt Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Sand Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Rush Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Rattlesnake Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Rough Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Wild Sheep Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Bull Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Battle Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
N.Fk. Battle Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Stud Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
Hells Canyon Creek	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67

Summary of Model Outputs and Revised Restoration Scores:

Reach Name	QHA Protection Score	QHA Restoration Score	Steelhead Habitat miles	Revised (*{miles/2}) Restoration Score
Bernard Creek	-0.53	0.00	1.5	0.00
Big Canyon Creek	-0.35	0.11	1.5	0.08
Brush Creek	-0.50	0.00	0.8	0.00
Captain John Creek	-0.47	0.17	8.8	0.75
Cave Gulch	-0.31	0.14	4.6	0.33
Corral Creek (N)	-0.29	0.18	1.8	0.16
Corral Creek (S)	-0.30	0.13	0.7	0.05
Cottonwood Creek	-0.37	0.16	0.9	0.07
Divide Creek	-0.28	0.25	2.8	0.35
Dry Creek	-0.28	0.17	4.8	0.41
Getta Creek	-0.31	0.20	4.8	0.49
Granite Creek	-0.64	0.00	14.9	0.00
Jones Creek	-0.35	0.08	0.7	0.03
Kirby Creek	-0.43	0.02	1.0	0.01
Kirkwood Creek	-0.45	0.09	3.9	0.16
Little Granite Creek	-0.64	0.00	1.3	0.00
Redbird Creek	-0.36	0.17	3.2	0.27
Saddle Creek	-0.56	0.02	5.7	0.06
Sheep Creek	-0.64	0.00	2.3	0.00
Sluice Creek	-0.56	0.02	2.2	0.03
Somers Creek	-0.56	0.02	1.4	0.02
Temperance Creek	-0.58	0.00	2.5	0.00
West Creek	-0.43	0.00	1.1	0.00
Wolf Creek	-0.24	0.30	0.6	0.09
Three Creeks	-0.53	0.00	Unknown	0.00
Cook Creek	-0.58	0.00	0.6	0.00
Deep Creek	-0.58	0.00	0.5	0.00
Lookout Creek	-0.58	0.00	0.3	0.00
Tryon Creek	-0.58	0.00	0.3	0.00
Pleasant Valley Cr.	-0.56	0.02	0.3	0.00
Durham Creek	-0.56	0.02	0.1	0.00
Two Corral Creek	-0.53	0.05	0.5	0.01
Salt Creek	-0.53	0.05	2.8	0.06
Sand Creek	-0.53	0.05	2.1	0.05
Rush Creek	-0.58	0.00	2.0	0.00
Rattlesnake Creek	-0.58	0.00	0.4	0.00
Rough Creek	-0.58	0.00	0.3	0.00
Wild Sheep Creek	-0.58	0.00	0.3	0.00
Bull Creek	-0.58	0.00	0.3	0.00
Battle Creek	-0.56	0.02	1.5	0.02
N.Fk. Battle Creek	-0.56	0.02	0.3	0.00
Stud Creek	-0.56	0.02	0.3	0.00
Hells Canyon Creek	-0.56	0.02	0.2	0.00

Tornado Diagram:



Appendix I

OCCURRENCE OF NOXIOUS WEED SPECIES IN THE COUNTIES PARTIALLY CONTAINED BY THE SNAKE HELLS CANYON SUBBASIN.

Genus	Species	Common Name	Noxious In	Asotin	Adams	Idaho	Nez Perce	Wallowa
Abutilon	*theophrasti*	velvetleaf	OR,WA			X		
Agropyron	*repens*	quackgrass	OR	X		X	X	
Ambrosia	*artemisiifolia*	common ragweed	OR			X	X	
Anchusa	*officinalis*	common bugloss	WA					X
Arctium	*minus*	common burdock	WY			X	X	
Artemisia	*absinthium*	absinth woodworm	WA	X		X		X
Bryonia	*alba*	white bryony	WA				X	
Cardaria	*draba*	hoary cress	ID,OR,WA	X	X	X	X	X
Carduus	*pycnocephalus*	Italian thistle	OR,WA			X		
Carduus	*nutans*	musk thistle	ID,OR,WA,			X	X	X
Carduus	*acanthoides*	plumeless thistle	WA			X	X	
Cenchrus	*longispinus*	longspine sandbur	WA	X		X	X	X
Centaurea	*macrocephala*	bighead knapweed	OR,WA			X		
Centaurea	*nigra*	black knapweed	WA			X		
Centaurea	*diffusa*	diffuse knapweed	ID,OR,WA	X	X	X	X	X
Centaurea	*calcitrapa*	purple starthistle	OR,WA	X				
Centaurea	*repens*	Russian knapweed	ID,OR,WA,	X	X	X	X	
Centaurea	*maculosa*	spotted knapweed	ID,OR,WA,	X	X	X	X	X
Centaurea	*solstitialis*	yellow starthistle	ID,OR,WA	X	X	X	X	X
Chaenorrhinum	*minus*	dwarf snapdragon	WA			X	X	
Chondrilla	*juncea*	rush skeletonweed	ID,OR,WA	X	X	X	X	X
Chrysanthemum	*leucanthemum*	oxeye daisy	WA	X	X	X	X	X
Cirsium		bull thistle	OR,WA	X	X	X	X	X
Cirsium	*arvense*	Canada thistle	ID,OR,WA	X	X	X	X	X
Conium	*maculatum*	poison hemlock	ID,OR,WA	X		X	X	X
Convolvulus	*arvensis*	field bindweed	ID,OR,WA			X	X	X
Crupina	*vulgaris*	common crupina	ID,OR,WA			X	X	
Cynoglossum	*officinale*	houndstongue	OR,WA	X		X	X	X
Cytisus	*scoparius*	Scotch broom	ID,OR,WA			X		
Daucus	*carota*	wild carrot	WA		X	X		X
Echium	*vulgare*	blueweed	WA			X		
Equisetum	*arvense*	field horsetail	OR	X		X		X
Equisetum	*telmateia*	giant horsetail	OR			X		
Euphorbia	*esula*	leafy spurge	ID,OR,WA	X	X	X	X	X
Euphorbia	*dentata*	toothed spurge	ID			X		
Hieracium	*aurantiacum*	orange hawkweed	ID,WA		X	X		
Hyoscyamus	*niger*	black henbane	ID,WA				X	X
Hypericum	*perforatum*	St. Johnswort	OR,WA	X	X	X	X	X
Hypochaeris	*radicata*	spotted cats ear	WA			X		
Isatis	*tinctoria*	dyer's woad	ID,OR,WA		X	X		
Kochia	*scoparia*	kochia	OR,WA	X				X
Lepidium	*latifolium*	perennial pepperweed	ID,OR,WA	X	X		X	
Lepyrodiclis	*holosteoides*	lepyrodiclis	OR,WA				X	

Genus	Species	Common Name	Noxious In	Asotin	Adams	Idaho	Nez Perce	Wallowa
Linaria	*dalmatica*	dalmatian toadflex	ID,OR,WA	X	X	X	X	X
Linaria	*vulgaris*	yellow toadflax	ID,OR,WA		X	X	X	X
Lythrum	*salicaria*	purple loosestrife	ID,OR,WA,		X	X		
Matricaria	*maritima*	scentless chamomile	WA				X	
Milium	*vernale*	spring millet grass	ID			X		
Mirabilis	*nyctaginea*	wild four o'clock	WA				X	
Myriophyllum	*brasiliense*	parrotfeather	WA				X	
Onopordum	*acanthium*	Scotch thistle	ID,OR,WA	X	X	X	X	X
Panicum	*miliaceum*	wild proso millet	OR			X	X	
Phalaris	*arundinacea*	reed canarygrass	WA	X	X	X	X	
Polygonum	*sachalinense*	giant knotweed	OR,WA			X		X
Polygonum	*cuspidatum*	Japanese knotweed	OR,WA			X	X	
Potentilla	*recta*	sulfur cinquefoil	OR,WA			X	X	
Rubus	*discolor*	Himalaya blackberry	OR	X		X	X	X
Salvia	*sclarea*	clary sage	WA		X	X		
Salvia	*pratensis*	meadow sage	WA		X	X		
Salvia	*aethiopis*	Mediterranean sage	OR,WA		X	X		
Secale	*cereale*	cultivated rye	WA			X	X	
Senecio	*jacobaea*	tansy ragwort	ID,OR,WA					X
Silene	*latifolia*	white catchfly	WA	X		X	X	X
Solanum	*rostratum*	buffalobur	ID,OR,WA	X		X	X	X
Solanum	*elaeagnifolium*	silverleaf nightshade	ID,OR,WA	X		X		
Sonchus	*arvensis*	perennial sowthistle	ID,WA					X
Sorghum	*halepense*	Johnsongrass	ID,OR,WA	X		X		
Taeniatherum	*caput-medusae*	medusahead	OR	X			X	X
Tamarix	*spp.*	tamarix complex	WA	X				
Tanacetum	*vulgare*	common tansy	WA	X		X		
Torilis	*arvensis*	field hedge-parsley	WA			X		
Tribulus	*terrestris*	puncturevine	ID,OR,WA	X		X	X	X
Xanthium	*spinosum*	spiny cocklebur	OR,WA	X	X	X	X	

Appendix J

DEFENITIONS OF KEY ENVIRONMENAL CORRELATES (Johnson and O'Neil 2001).

FOREST, SHRUBLAND AND GRASSLAND HABITAT ELEMENTS

Biotic, naturally occurring attributes of forest and shrubland communities and the information that follows are for positive relationships only.

1.1 forest/woodland vegetative elements or substrates - *Biotic components found within a forested context and these are positive influences only.*

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 in-stream 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.

1.1.4.1 shrub size - Refers to shrub height.

1.1.4.2 percent shrub canopy cover - Percent of ground covered by vertical projection of shrub crown diameter.

1.1.4.3 shrub canopy layers - Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies in the forest understory.

1.1.5 moss - Large group of green plants without flowers but with small leafy stems growing in clumps.

1.1.6 flowers - A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.

1.1.7 lichens - Any of a various complex of lower plants made up of an alga and a fungus growing as a unit on a solid surface.

1.1.8 forbs - Broad-leaved herbaceous plants. Does not include: grasses, sedges or rushes.

1.1.9 cactus - Any of a large group of drought-resistant plants with fleshy, usually jointed stems and leaves replaced by scales or prickles.

1.1.10 fungi - Mushrooms, molds, yeasts, rusts, etc.

1.1.11 roots, tubers, underground plant parts - Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.

1.1.12 ferns - Any of a group of flowerless, seedless vascular green plants.

1.1.13 herbaceous layer - Understory non-woody vegetation layer beneath shrub layer (forest context). May include forbs, grasses, ferns.

1.1.14 trees - Includes both coniferous and hardwood species.

1.1.14.1 snags - Standing dead trees.

1.1.14.1.1 decay class - A system by which snags are classified based on their deterioration.

1.1.14.1.1.1 hard - Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown (1985).

1.1.14.1.1.2 moderate - Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown (1985).

1.1.14.1.1.3 soft - Well decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown (1985).

1.1.14.2 snag size - Measured in diameter at breast height, (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.

1.1.14.2.1 seedling <1" dbh
1.1.14.2.2 sapling/pole 1"-9" dbh
1.1.14.2.3 small tree 10"-14" dbh
1.1.14.2.4 medium tree 15"-19" dbh
1.1.14.2.5 large tree 20"-29" dbh
1.1.14.2.6 giant tree >= 30" dbh

1.1.14.3 tree size - Measured in diameter at breast height, (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.

1.1.14.3.1 seedling <1" dbh
1.1.14.3.2 sapling/pole 1"-9" dbh
1.1.14.3.3 small tree 10"-14" dbh
1.1.14.3.4 medium tree 15"-19" dbh

1.1.14.3.5 large tree 20"-29" dbh
1.1.14.3.6 giant tree >= 30" dbh

1.1.14.4 mistletoe brooms/witches brooms - Dense masses of deformed branches caused by any type of broom-forming parasite (fungal or plant).

1.1.14.5 dead parts of live tree - Portions of live trees with rot; can include broken tops; branches with decay; tree base with rot.

1.1.14.6 hollow living trees (chimney trees) - Tree bole with large hollow chambers.

1.1.14.7 tree cavities - Smaller chamber in a tree; can be in bole, limbs, or forks of live or dead trees. May be excavated or result from decay or damage.

1.1.14.8 bark - Includes crevices/fissures, and loose or exfoliating bark.

1.1.14.9 live remnant/legacy trees - A live mature or old-growth tree remaining from the previous stand. Context is remnant trees in recently harvested or burned stands up through young forested stands. See dead parts of live trees, hollow living trees, tree cavities, and bark to see which species benefit from remnant trees with these attributes.

1.1.14.10 large live tree branches - Large branches often growing horizontally out from the tree bole.

1.1.14.11 tree canopy layer - Refers to the strata occupied by tree crowns.

1.1.14.11.1 sub-canopy - The space below the predominant tree crowns.

1.1.14.11.2 above canopy - The space above the predominant tree crowns

1.1.14.11.3 tree bole - The tree trunk.

1.1.14.11.4 canopy - The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.

1.1.15 fruits/seeds/nuts - Plant reproductive bodies that are used by animals.

1.1.16 edges - The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together.

1.2 shrubland/grassland vegetative elements or substrates - *Biotic components found within a shrubland or grassland context and these are positive influences only.*

1.2.1 herbaceous layer - Zone of understory non-woody vegetation beneath shrub layer (non-forest 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 prickles.

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 less than 16 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 <20"
1.2.6.1.2 medium 20"- 6.5'
1.2.6.1.3 large 6.6' – 16.5'

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 sub-canopy - 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 - Non-vascular plants that grow on the soil surface. Primarily lichens, mosses and algae. Often found in arid or semi-arid 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 as described in Brown (1985).

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 (dbh) - Measured in diameter at breast height, (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.

1.2.12.2.1 shrub/seedling <1" dbh
1.2.12.2.2 sapling/pole 1"-9" dbh
1.2.12.2.3 small tree 10"-14" dbh

1.2.12.2.4 medium tree 15"-19" dbh
1.2.12.2.5 large tree 20"-29" dbh
1.2.12.2.6 giant tree >= 30" dbh

1.2.12.3 tree size - Measured in diameter at breast height (dbh) the standard measurement for standing trees taken at 4.5 feet above the ground.

1.2.12.3.1 shrub/seedling <1" dbh
1.2.12.3.2 sapling/pole 1"-9" dbh
1.2.12.3.3 small tree 10"-14" dbh
1.2.12.3.4 medium tree 15"-19" dbh
1.2.12.3.5 large tree 20"-29" dbh
1.2.12.3.6 giant tree >= 30" dbh

1.2.13 edges - The place where plant communities meet or where successional stages or vegetative conditions within plant communities come togethe

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2) ECOLOGICAL HABITAT ELEMENTS

Selected interspecies relationships within the biotic community, and they include both positive and negative influences.

2.1 exotic species - Exotic species are defined as any non-native 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 (not used by panelists).

2.2 insect population irruptions - The species directly benefits from insect population eruptions (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 eruptions.

2.2.3 gypsy moth - The species directly benefits from gypsy moth eruptions.

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) <u>NON-VEGETATIVE, ABIOTIC, TERRESTRIAL HABITAT ELEMENTS</u>

Non-living 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 0.2 - 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 - 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 and/or vine maple).

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.

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4) FRESHWATER RIPARIAN AND AQUATIC BODIES HABITAT ELEMENTS

Includes selected forms and characteristics of any body of freshwater.

4.1 water characteristics - *Includes various 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, is in the comments field.

4.1.6 water velocity - Speed or momentum of water flow.

4.1.7 water turbidity - Refers to the 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 & 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 which contain non-tidal 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 one meter 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 > 256 mm (10") in diameter.

4.2.4.2 cobble/gravel - Rocks or pebbles, 4-256 mm in diameter (10), substrata may consist of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.

4.2.4.3 sand/mud - Fine substrata < 4 mm 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 - Un-rooted 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 < 1 meter above the water surface.

4.2.11 waterfalls - Steep decent 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 > 256 mm (10 inches) in diameter.

4.6.2.2 cobble/gravel - Rocks or pebbles, 4-256 mm in diameter, substrata may consist of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.

4.6.2.3 sand/mud - Fine substrata < 4 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 - <2ha

4.6.4.2 lakes - >=2ha

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 non-forest - 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.

5.1 zone - System of marine classification based on 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 20 meter isobath, typically within 1 kilometer of shore.

5.1.4 shelf - The area between the 20 and 200 meter isobath, typically within 60 kilometers of shore.

5.1.5 oceanic - The zone that extends seaward from the 200 meter isobath.

5.2 substrates - The bottom materials in a body of water.

5.2.1 bedrock - The solid rock underlying surface materials.

5.2.2 boulders - Large, worn, rocks > 256 mm (10 inches) 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 which sloughs frequently.

5.2.4 cobble - Rocks or pebbles, 64-256 mm in diameter, may be a mix of cobbles, gravel, shells, and sand, with no one type exceeding 70 percent cover.

5.2.5 mixed-coarse - Substrata consisting of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.

5.2.6 gravel - Small rocks or pebbles, 4-64 mm in diameter.

5.2.7 sand - Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.

5.2.8 mixed-fine - Mixture of sand and mud particles < 4 mm in diameter, little gravel present.

5.2.9 mud - Fine substrata < 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 moderated 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's 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. Positive or negative influences were noted.

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 off-shore islands/rocks/sea stacks/off-shore cliffs - 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 20 degrees usually formed by erosional processes 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 which is periodically inundated by tidal brackish or salt water and which supports significant (15% cover) non-woody 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 (less than 5 degrees) 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.

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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.

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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 Element's 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 - Roads that are 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 fencelines and field borders.

8.14 sewage treatment ponds - Settling ponds associated with sewage treatment plants.

8.15 repellents - Various methods purposely used against 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 - Non-chemical 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

8.19.2 sewage

8.19.3 water

8.20. piers

8.21 mooring piles, dolphins, buoys

8.22 bulkheads, seawalls, revetment

8.23 jetties, groins, breakwaters

8.24 water diversion structures

8.25 log boom

8.26 boats/ships

8.27 dredge spoil islands

8.28 hatchery facilities and fish