Supplement
Deschutes Subbasin Management Plan

Introduction

This supplement expands on discussions presented in the Deschutes Subbasin Plan. Building on information presented in the Assessment and Management Plan, it identifies key factors limiting focal species in the subbasin and discusses when and how these limiting factors should be addressed. It defines objectives and strategies for restoring fish and wildlife populations in the subbasin, as well as for improving overall watershed health. It also provides a framework for developing and prioritizing strategies that are consistent with the Northwest Power and Conservation Council's 2000 Fish and Wildlife Program and defined objectives for the recovery of focal fish and wildlife species and populations in the Deschutes Subbasin.

A. Key Factors Limiting the Biological Potential of Focal Species in the Deschutes Subbasin

The Deschutes is a large and complex watershed and, as might be expected, a combination of many factors have created the conditions that now limit natural abundance, productivity and diversity of the subbasin's fish and wildlife populations. As discussed in the Assessment, changes across the landscape — including conversion of native habitats and manipulation of streamflows — caused ecosystems in the subbasin to unravel. Already depressed anadromous fish populations in the middle and upper subbasin were lost completely after construction of the Pelton Round Butte Complex in the 1960s.

The cumulative effects of these changes now limit ecological functions and biological performance of fish and wildlife in the Deschutes Subbasin. Several important changes affecting focal species and populations in the subbasin were identified in the Assessment as components of the working hypotheses for the Deschutes Subbasin, including:

- Reduced historic distribution of fish and wildlife populations
- Reduced connectivity between habitats and populations
- Reduced ability of uplands to retain and slowly release runoff and maintain soil stability
- Loss of riparian and floodplain function reduce habitat complexity and diversity, and contribute to extreme seasonal stream flows and temperatures
- Loss of instream habitat complexity and channel diversity reduce focal fish species carrying capacity and increase susceptibility to predation
- Altered natural stream flow regimes, including flow extremes, create marginal habitats and contribute to degraded water quality

- Interactions with hatchery fish and exotic species increase competition for limited habitat and food, and threaten the genetic integrity of focal species

Assessment and analysis results using Ecosystem Diagnosis Treatment (EDT), Qualitative Habitat Assessment (QHA), Interactive Biodiversity Information System (IBIS) and other tools show that — while the level of impact from different habitat factors often varies dramatically by stream reach and area — certain factors are more limiting for focal fish and wildlife populations, especially during particular life stages. This section summarizes the major limiting factors identified for Deschutes Subbasin focal fish and wildlife species and populations. More detailed discussions on limiting factors at the stream reach and subwatershed levels are provided in Section E tables 3-8 of this Supplement, the Deschutes Subbasin Plan Assessment, Appendices I and II of the Deschutes Subbasin Plan, and on the attached Resource Inventory Reference CD.

A.1. EDT-Based Major Limiting Factors for Summer Steelhead, Redband Trout and Chinook Salmon

Major factors limiting summer steelhead and Chinook salmon, including Interior Columbia River Technical Recovery Team (TRT) summer steelhead populations, during different life stages are summarized in this section. The factors reflect the results of an abbreviated EDT assessment[1] conducted during the planning process.

Steelhead and Redband Trout — Lower Deschutes River Eastside Populations (TRT includes Deschutes River and tributaries downstream from Trout Creek confluence, except Warm Springs River)

Reduced instream and streamside habitat diversity are the primary factors limiting steelhead and redband production on several reaches of the lower Deschutes River below the Trout Creek confluence. The river generally provides favorable rearing habitat for redband trout adults and sub-adults, but important edge habitat for rearing juvenile salmonids is limited. Loss of habitat diversity, including river margin degradation and lack of hiding/escape cover, has the largest impact on 0- to 2-age rearing steelhead and migrants. Channel stability, food production, stream temperatures, flows, predation and competition with hatchery fish also limit production in mainstem reaches.

Reduced habitat diversity is a major factor limiting steelhead/redband trout in lower eastside Deschutes tributaries, especially 0-age rearing to 2-age migrants. Low habitat diversity ranked as extreme or high for many reaches in the Buck Hollow, Bakeoven and Trout creek systems. Other major limiting factors in the systems include: 1) loss of instream habitat complexity and pool habitat for rearing (woody debris and other instream cover and structure); 2) reduced spawning habitat diversity and high temperatures for egg incubation and 0-age rearing; and 3) low flow for 0- to 2-age rearing — including in lower Trout Creek, where low flow rated extreme for 0-age rearing.

[1] The EDT assessment was abbreviated during the subbasin planning process because of time constraints and difficulties with the EDT program and not all of the habitat attributes available were examined.

Major habitat constraints in smaller lower Deschutes River tributaries include sediment during egg incubation (rated extreme for several streams), habitat diversity for spawning and rearing, low flows for 0- to 1-age rearing, channel stability and predation. Degraded rearing habitat conditions in the lower Deschutes River also restrict juveniles produced in these streams. Historically, many juvenile steelhead in these tributaries moved out of the systems when late spring or summer stream flows diminished and temperatures increased; completing their rearing in the Deschutes River.

Steelhead and Redband Trout — Lower Deschutes River Westside Populations (TRT includes Deschutes River from Trout Creek to Pelton Reregulating Dam and tributaries Warm Springs River and Shitike Creek

Lack of habitat diversity and complexity to support 0- to 2-age rearing juvenile steelhead — especially for 0- to 1-age rearing — rated high as limiting factors for the Deschutes River upstream from Trout Creek and for many lower stream reaches in the lower Warm Springs system and Shitike Creek. Competition with hatchery fish rated high as a limiting factor in this reach of the Deschutes River. Reduced stream flows and channel instability also ranked as major problems in some reaches, including for 0- to 2-age rearing and migrants in lower Shitike Creek. Temperatures during egg incubation and lack of habitat complexity are primary factors limiting salmonid production in lower Shitike Creek, Beaver Creek and several other stream reaches.

Summer Steelhead and Redband Trout — Middle Deschutes River Population Tributaries (TRT includes Middle Deschutes River and tributaries from Pelton Reregulating Dam to Big Falls

While habitat in much of the Metolius system remains in good condition, lack of habitat diversity on several reaches ranked as a major factor limiting production of 0- to 2-age rearing and migrant trout, and potentially reintroduced steelhead. Potential competition with hatchery fish (associated with anadromous reintroductions), channel instability, increased fine sediment, reduced flow, low food production and loss of key habitat also limit production. High temperatures and sediment loads during egg incubation arose as major factors limiting trout and potential steelhead production in Squaw Creek. Reduced key habitat quantity, habitat diversity and complexity, channel stability, flow and pathogens also limit production, especially for 0-age rearing trout. In the middle Deschutes River, low habitat diversity/complexity and obstructions (Steelhead Falls) are the primary limiting factors.

Habitat conditions in the lower Crooked River from Lake Billy Chinook to the Highway 97 bridge remain good, but lack of habitat diversity ranked as extreme for 0- to 2-age rearing trout in the area upstream of the Highway 97 bridge, particularly for 0- and 1-age winter rearing. Sediment also ranked as a major factor for this age group. Other major factors for rearing trout include high stream temperatures, low flows, predation, pathogens, potential competition with hatchery fish (associated with proposed anadromous reintroductions), and loss of key habitat quality. Habitat conditions during 0-age active rearing are major factors in many stream reaches. High water temperatures and sediments also restrict egg incubation in several reaches, including in the Crooked River above the North Unit Irrigation District flume and McKay Creek.

Spring Chinook — Lower Deschutes River Mainstem

Reduced habitat diversity and complexity for 0-age active rearing juveniles and 1-age migrants are the major factors affecting spring Chinook production in the lower mainstem Deschutes below Sherars Falls. Instream and streamside habitat diversity also limits production above Sherars Falls, particularly for winter rearing 0-age juvenile spring Chinook. Other limiting factors for both reaches of the lower Deschutes River include channel stability, predation, reduced key habitat quantity, and food production.

Spring Chinook — Warms Springs River System and Shitike Creek

Reduced habitat diversity is the major factor limiting spring Chinook production in the Warm Springs system and Shitike Creek, primarily for 0-age winter rearing. Flows, sedimentation, channel stability and key habitat quantity also limit juvenile spring Chinook in a number of reaches. Lack of habitat diversity, flow and high water temperatures affect spring Chinook during spawning and pre-spawn holding in some areas. Competition with hatchery fish is also a problem.

Spring Chinook — Metolius River System, Squaw Creek and Middle Deschutes River

Lack of instream and streamside habitat diversity, especially for 0-age summer and winter rearing, limits potential spring Chinook production in the Metolius River system. Several reaches also lack adequate habitat diversity and key habitat for spawning and pre-spawn holding. Other key limiting factors include predation, competition with hatchery fish, flow, channel stability and food production. In Squaw Creek, the best potential spring Chinook habitat exists below Alder Springs, though lack of habitat diversity and complexity is still a major limiting factor. Water temperatures, key habitat quality, habitat diversity, channel stability, flow, sediment loads, obstructions, and predation limit potential production above the springs. In the middle Deschutes River, the lack of spawning habitat below Steelhead Falls and passage obstructions (Steelhead Falls) are primary factors limiting potential production.

Spring Chinook — Lower Crooked River and Tributaries

Reduced habitat conditions to support spawning and egg incubation are key factors facing reintroduction of spring Chinook in the lower Crooked River system. High temperatures and lack of key habitat quantity and habitat diversity ranked as the most limiting factors for potential spring Chinook spawners above the Highway 97 Bridge. Fine sediment, temperature, channel stability and key habitat quantity ranked as primary problems during egg incubation. Reduced habitat diversity and connectivity, flows, temperatures (especially for 0-age active rearing), key habitat quantity, fine sediments and possible predation would limit juvenile rearing.

Fall Chinook — Lower Deschutes River Mainstem

Reduced instream and streamside habitat diversity are major factors limiting fall Chinook production in the lower Deschutes River. Winter habitat conditions are especially limited for 0-age inactive rearing, as fall Chinook emerge and begin rearing in late winter. Habitat diversity and complexity to support pre-spawn holding and spawning are also major limiting factors. Human disturbance or harassment of pre-spawning adults is a moderate concern, since this coincides with some of the most intense recreational use of the lower river.

A.2. QHA-Based Major Limiting Factors for Focal Species and Populations.

Results from the QHA analysis identified the following major limiting factors for focal species and populations that were not rated during the EDT analysis, including bull trout, resident redband trout, sockeye salmon and pacific lamprey. QHA results are qualitative in nature. They show how different environmental attributes affect species survival, but not during different life stages.

Bull Trout — Lower Deschutes Core Area (TRT includes Deschutes River and tributaries from Columbia River to Big Falls)

Several factors restrict bull trout production in this core area. 1) Passage obstructions, including the Pelton Round Butte Complex, isolate populations or reduce fish distribution (Crooked River and Squaw Creek). 2) High stream temperatures, fine sediments, habitat diversity and reduced riparian habitat are major factors limiting the lower Deschutes population below Pelton Reregulating Dam. 3) Obstructions, habitat diversity, fine sediment and high stream temperatures (Lake Creek system) limit Metolius River populations. 4) Reduced habitat diversity, channel stability, high stream temperatures, obstructions and low stream flow limit potential bull trout production in Squaw Creek. 5) Low flow, stream temperatures, habitat diversity, obstructions, channel stability and fine sediment limit bull trout production in the Crooked River system.

Bull Trout – (Extirpated) Upper Deschutes Core Habitat (TRT includes system above Big Falls)

Natural and artificial obstructions, flow and temperature extremes, reduced habitat diversity, channel stability, fine sediment and competition with exotic fish (brown and brook trout) are major factors limiting potential bull trout production in the upper Deschutes River and small tributaries. Reduced habitat diversity, fine sediment and high stream temperatures limit potential production in the Little Deschutes River system.

Bull Trout — Odell Lake Core Area (TRT includes naturally isolated habitat within Odell and Davis lakes and tributaries)

Natural and artificial obstructions, fine sediment, low flow, reduced riparian habitat and high stream temperatures limit production of the Odell Lake bull trout population.

Redband Trout — Upper Deschutes River and Tributaries above Big Falls (RM 132)

Obstructions, high stream temperature, low flow, lack of spawning gravel, and water quality restrict redband production in the river from Bend downstream to Lower Bridge. From Bend upstream to Wickiup Dam, artificial and natural obstructions, seasonal flow and temperature extremes, channel stability, habitat diversity, fine sediment and reduced riparian habitat are most limiting to redband production. Redband production in small tributaries to this reach is primarily limited by artificial and natural obstructions, fine sediment, habitat diversity and reduced riparian habitat. In the Little Deschutes River system habitat diversity, high stream temperature, channel stability, low stream flow and fine sediment restrict redband trout production. Obstructions, fine sediment, habitat diversity, and competition with illegally introduced exotic species limit redband trout production in the system above Wickiup Dam. Seasonal flow and temperature extremes limit production in the short reach from Wickiup Reservoir to Crane Prairie Dam.

Pacific Lamprey

Assumably, several of the habitat factors that are most limiting for anadromous and resident salmonids would also limit Pacific lamprey. However little specific information is available about Deschutes Subbasin lamprey habitat requirements or historic subbasin distribution. Key factors likely limiting current lamprey production include high stream temperatures and reduced habitat diversity in the lower Deschutes River, and low flows, channel stability, habitat diversity and stream temperatures in tributary streams. Key factors limiting potential lamprey production in the Middle Deschutes River (up to Big Falls) and tributaries likely include: obstructions, low stream flow, high stream temperature, reduced habitat diversity and channel stability in the Crooked River system; obstructions (natural and artificial), low or intermittent flow, channel stability and habitat diversity in the Middle Deschutes River and Squaw Creek; and obstructions, low or intermittent flow (some tributaries), and reduced habitat diversity in the Metolius system.

Sockeye Salmon

Habitat factors most limiting to the potential re-establishment of sockeye salmon in the subbasin include obstructions at the Pelton Round Butte Complex and on Metolius River tributaries. Reduced habitat diversity, fine sediments, competition with other fish and predation would also limit production.

A.3. IBIS-Based Major Limiting Factors for Terrestrial Focal Species and Populations

Comparisons of historic and current habitat during the IBIS analysis show that the following factors limit production of the focal wildlife species.

American Beaver

Loss of riparian vegetation and permanent water habitat are key factors limiting beaver production. Beaver numbers and distribution have declined throughout the subbasin, but are particularly low in areas where perennial streams have evolved to intermittent or ephemeral water courses.

Columbia Spotted Frog

Loss and fragmentation of riparian and wetland habitats are key factors limiting production of the Columbia and Oregon spotted frogs, particularly the loss of riparian vegetation, oxbows and backwaters, and permanent water habitat. Remnant Columbia spotted frog populations are confined to small, disconnected habitats. Predation by exotic species (exotic bullfrog) contributes to population declines.

White-headed Woodpecker

Loss and fragmentation of ponderosa and lodgepole pine forests, especially the loss of large diameter pine stands (including dead trees and late seral stage), are major factors reducing white-headed woodpecker production in the subbasin.

Mule Deer

Loss, fragmentation and degradation of winter range are key factors limiting production of mule deer and other ungulates. The amount of high quality winter range habitat continues to decline because of reduced quality and quantity of forage and cover, harassment, loss of connectivity between habitat areas, and human disturbance.

Greater Sage Grouse

Loss and disturbance of shrub-steppe habitat, particularly lek sites, combined with livestock grazing and more frequent wild fires are key factors limiting production of greater sage grouse.

Columbian Sharp-tailed Grouse

Loss and/or conversion of much of the interior grassland habitat in the subbasin — through conversion to cropland or the spread of Western juniper woodlands — generally caused the extirpation of the Columbian sharp-tailed grouse in the subbasin.

Golden Eagle

Loss of quality and quantity of canyon land/rimrock habitat, which provides cliff nesting sites, is a key factor limiting golden eagle production. Human development has also reduced forage habitat quantity/quality, and exposed eagles to shooting and harassment.

B. Prioritization Framework for Addressing Major Limiting Factors

Several habitat attributes — including habitat diversity/complexity, connectivity, fine sediments, stream flow and stream temperatures — appeared time and time again during the assessment as key factors limiting focal fish and wildlife populations in the Deschutes subbasin. However, these factors, which were identified based on the EDT, QHA and IBIS analyses, strictly define the habitat conditions limiting fish and wildlife survival and capacity. They do not identify the causes of the conditions. It is these causes of the conditions, not the conditions themselves, which need to be addressed.

Often, adverse habitat conditions are systematic and reflect cumulative problems in a watershed. For example, extreme flow regimes, high stream temperatures and fine sediments often develop because activities in the watershed above the reach disrupt the natural dynamics of a healthy functioning ecosystem. This is true for many stream reaches in the Deschutes Subbasin.

The following are examples of stream reaches or systems that no longer exhibit the characteristics of a healthy, functioning ecosystem.

- Upland watershed modification combined with frequent water withdrawal, stream channel simplification and reduced water quality have fragmented, isolated and extirpated redband trout populations in much of the Crooked River system.

- Extreme seasonal stream flows and temperatures — along with channel instability, artificial obstructions, increased fine sediments, and competition with exotic fish species — have extirpated bull trout and appreciably reduced redband trout populations in the Deschutes River from Lower Bridge to Crane Prairie Dam, and in the Little Deschutes River system.

- Low flows, seasonal temperature extremes, reduced habitat diversity and predation have depressed steelhead and redband trout populations in small lower Deschutes River tributaries. Reduced habitat diversity and flow reductions have limited focal fish species production in the lower Deschutes River and large tributaries (i.e. Warm Springs River and Shitike Creek).

- Artificial obstructions, water storage and withdrawal structures, and associated reductions in stream flow and water quality, have fragmented or isolated genetically unique populations of redband trout in the White River system.

Stopping habitat loss and reversing the decline of subbasin habitats and populations requires use of well-formulated ecosystem approaches. Also, because there is often no single cause responsible for keeping an ecosystem from functioning properly, factors will often need to be addressed in concert. For example, while smaller tributaries may contribute little to the overall abundance of the focal species, such areas may be the source of fine sediments or other problems limiting production in larger downstream areas. Restoring natural processes, functions and dynamics in these smaller reaches may be necessary to address problems that limit fish production in higher ranked reaches. In other areas, restoring instream flows may be necessary before habitat diversity and connectivity can improve.

Because of the size and complexity of the Deschutes Subbasin, it is difficult to prioritize which limiting factors should be addressed first. Instead, the Prioritization Criteria and Considerations identified in Section D of this supplement will be used to prioritize when and how factors limiting focal fish and wildlife populations are addressed. In addition, efforts to address problems for focal fish and wildlife species will focus on restoring the processes that will create and maintain healthy watershed conditions and functions over the short and long term. Well-formulated ecosystem approaches will include actions to restore instream conditions, riparian habitat diversity and complexity, and/or upland watershed health. In some cases, efforts will need to begin with restoration of riparian areas, as riparian habitat is usually the most resilient and responds quicker to restoration measures than restoration of most upland habitats. Such initial efforts will be particularly necessary to retain depressed populations until larger ecosystem processes and functions are restored.

C. Objectives and Strategies

C.1. Aquatic Biological and Habitat Objectives

Biological objectives, as called for by the Northwest Power and Conservation Council, describe physical and biological changes needed to achieve the subbasin vision. Objectives have two components: 1) biological performance, which describes the responses of focal species to habitat conditions in terms of capacity, abundance, productivity, and life history diversity; and 2) environmental characteristics, which describe the environmental conditions needed to achieve the desired biological performance.

The Deschutes Subbasin Management Plan, Section 3, describes the approach for establishing plan objectives, and identifies biological and habitat objectives for focal anadromous fish species in each assessment unit. It provides specific biological objectives for Chinook salmon and summer steelhead in current, historic and potential restored habitats based on results of the EDT analysis, review of extensive inventory, and consultation with fishery managers. The Plan does not provide measurable population performance objectives for resident redband trout, bull trout, sockeye salmon or lamprey populations, except for the lower Deschutes River where it provides redband trout objectives developed by ODFW and determined to be still valid.

C.1.1. Aquatic Biological Objectives

Several qualitative objectives guide management of focal fish populations and other aquatic populations in the Deschutes Subbasin. These objectives overlay the more specific quantitative objectives.

1. Maintain the genetic diversity, adaptiveness, and abundance of the wild indigenous redband trout, steelhead, spring and fall Chinook salmon, bull trout, and Pacific lamprey in the Deschutes Subbasin.
2. Reestablish fish passage at Pelton Round Butte Complex and other artificial barriers.
3. Restore summer steelhead and spring chinook throughout their historic ranges.
4. Restore bull trout to historic habitats by maintaining or increasing the life history diversity of the wild indigenous bull trout and providing connectivity and opportunities for migration between local core populations.
5. Determine the feasibility of re-establishing self-sustaining bull trout populations within historically occupied areas.

6. Restore self-sustaining populations of sockeye salmon in the Metolius/Lake Billy Chinook and Link Creek/Suttle Lake habitat complexes when passage is re-established at the Pelton Round Butte Complex.
7. Restore and maintain numbers of indigenous Pacific Lamprey throughout their historic ranges.

Adult return objectives for Chinook salmon and summer steelhead to the Deschutes Subbasin are provided in Table 1. These numerical objectives are based on results of the EDT analysis, review of extensive inventory, and consultation with fishery managers. Summer steelhead run-size objectives reflect EDT analyses for demographically independent populations and associated habitat identified by the TRT.

Table 1. Biological Objectives for Chinook Salmon and Steelhead in the Deschutes Subbasin.

Species	Total Return Objective	Natural Component	Hatchery Component	Available For Harvest Component
Spring Chinook				
No passage at Pelton Dam	6,500 – 8,000	2,800 – 3,800[2]	4,000 – 5,000[4]	3,000 – 4,000[5]
Passage at Pelton Dam	?	4,500 – 5,600[3]	?	?
Fall Chinook				
No passage at Pelton Dam	16,000 – 17,800[6]	16,000 – 17,800	0	10,000 – 11,800[8] ?
Passage at Pelton Dam	16,000 – 17,800[7]	16,000 – 17,800	0	10,000 – 11,800 ?
Summer Steelhead				
No passage at Pelton Dam	10,800 – 16,300[9]	6,000 – 8,300[11]	4,800 – 8,000[13]	4,400 – 7,600[14]
Passage at Pelton Dam	?[10]	10,000 – 13,800[12]	?	?

[2] Deschutes Subbasin Plan p 1-8 (EDT production estimate)
[3] Deschutes Subbasin Plan p 1-8 (EDT production estimate)
[4] Assume 0.5% return on annual release of 1,050,000 hatchery smolts. Subbasin Plan p 1-15, 16
[5] Hatchery broodstock needs: RBH - 330, WSNFH – 630. Subbasin Plan p 1-15, 16
[6] Deschutes Subbasin Plan p 1-21 (EDT production estimate)
[7] Deschutes Subbasin Plan p 1-27 (Spawning habitat above RM 100 was eliminated by dam complex.)
[8] Deschutes Subbasin Plan p 1-24 (Minimum 4,000 spawners and 2,000 pre-spawning mortality = 6,000 minimum escapement)
[9] Deschutes Subbasin Plan p 1-36 (EDT production estimate)
[10] No hatchery program has been defined for re-introduction above dam complex
[11] Deschutes Subbasin Plan p 1-36 (EDT production estimate)
[12] Deschutes Subbasin Plan p 1-36 (EDT production estimate)
[13] Assumes 3 – 5% return on annual release of 160,000 steelhead smolts from Round Butte Fish Hatchery
[14] Assumes 400 hatchery adults required for hatchery broodstock.

Role of Artificial Production in the Subbasin

Existing hatchery programs for anadromous fish in the Deschutes Subbasin allow fish managers to provide in-river tribal and sport harvest opportunity while protecting wild population components through more strict regulations. Deschutes hatchery programs also use Deschutes fish stocks in their production programs. These hatchery programs, which are discussed in detail in Appendix 1, are not expected to be expanded to meet biological objectives for salmon and steelhead in their existing range. Objectives for increasing salmon, steelhead and trout populations in the Deschutes Subbasin reflect restored fish passage at the Pelton Round Butte Complex and other artificial barriers, gained instream and streamside habitat diversity and complexity, improved flows and water quality, and other habitat restoration. Hatchery production, however, may be increased to aid the re-introduction of spring Chinook, summer steelhead and, possibly sockeye salmon production in the Middle Deschutes, Metolius River, lower Crooked River and Squaw Creek. To date, no specific hatchery programs have been identified, or quantified, to aid in the re-establishment of salmon and steelhead to their historic range if passage is successfully re-established to areas above the Pelton Round Butte Complex.

C.1.2. Habitat Objectives

As discussed in Section A, results from the Assessment (Sections 4, 7 and 8) show that loss of streamflow, habitat diversity, quantity and connectivity have been major factors limiting some life stages of focal fish and wildlife populations in the Deschutes subbasin. Further analysis of environmental conditions and of environment/population relationships during the subbasin planning process reveals that the processes, functions and dynamics that form and sustain healthy, productive ecosystems are, in many cases, not functioning properly. Consequently, strengthening these ecosystem processes, functions and dynamics forms the core of the Management Plan.

Currently, however, there is not enough information available to accurately quantify the level of habitat modification needed to meet our biological objectives. During the planning process, the EDT analysis was used to link potential gains in stream habitat restoration to potential fish production capabilities for stream reaches that currently, or could potentially, support production of Chinook salmon and summer steelhead. It was determined that the moderate level of habitat restoration was the most realistic and offered the greatest likelihood for success during this 25-year planning horizon. The projected percentages of improvement for various habitat attributes included in the moderate habitat restoration scenario have generally been included as specific plan habitat attribute objectives for assessment unit streams in the Deschutes Subbasin Management Plan ─ though there was not always enough information available to determine if the specific habitat attribute objectives were accurate targets for habitat restoration. For example, it is unclear at this point whether or not the numeric targets for sediment, channel width and pools identified in the management strategies will be consistent with water quality goals now being produced at the state level. These and other targets need to be modified as new information becomes available.

Measurable habitat objectives need to be reviewed and/or identified at an appropriate sub-watershed or stream reach level before restoration programs are initiated. These measurable habitat objectives should identify the levels of habitat restoration needed to restore and connect sustainable, naturally functioning and reproducing biological communities to meet defined biological objectives. Where possible, the measurable objectives should be supported by analysis that models a species or populations response to habitat conditions, such as EDT. Further, habitat objectives should include an upland component. Riparian and instream habitat restoration work will not be effective for the long term unless actions are also taken to improve overall watershed health.

Several qualitative habitat objectives will guide management of habitat for focal species populations and overall watershed health:

1. Provide sustainable, naturally functioning habitat conditions needed for the long-term survival of focal species through their life cycles and under a full range of environmental variation.
2. Provide efficient fish passage to key habitat and provide connectivity between spawning and rearing habitats in tributaries and mainstem Deschutes River.
3. Restore and maintain native upland vegetative conditions to improve overall watershed health.
4. Restore water tables under former wet meadows, stream floodplains and valleys.
5. Protect important habitats, including backwaters, oxbow sloughs, seeps and springs, properly functioning riparian stream corridors, cottonwood galleries, willows, aspen groves, and pine/white oak communities.
6. Restore and maintain native interior grasslands.

C.2. Overall Strategies to meet Aquatic, Terrestrial and Habitat Objectives

The following strategies promote the development of a healthy, productive watershed. They focus on enabling the natural processes, functions and dynamics that will allow ecosystems to repair themselves. Because they are ecosystem-based, they are generally mutually beneficial for fish and wildlife species, and for future generations of people in the Deschutes Subbasin. By restoring ecosystem processes and functions, the combined strategies aim to increase habitat diversity and channel stability, reduce extreme flow fluctuations, improve water quality and regain key habitats for native fish and wildlife.

These overall strategies for the Deschutes Subbasin embody and reflect the more detailed management strategies identified for specific assessment units and habitat complexes in the Management Plan. They are not meant to override the more detailed and area specific strategies, but rather to frame our common approach for improving watershed health. Table 2 identifies how the high priority strategies address major limiting factors.

High Priority Strategies

- **Restore riparian ecosystem habitat complexity and species diversity.**

  Riparian areas are generally very productive and naturally support the greatest biological diversity of any habitat type. They are important to both fish and wildlife species. As the natural buffer between streams and uplands, they also aid in groundwater recharge, filter sediments and pollutants, bind and stabilize *streambanks, provide shade and cover, and perform a number of other ecological functions. In the Deschutes Subbasin, there has been considerable loss of riparian habitats. This has reduced habitat complexity, accelerated erosion, lowered water tables, and contributed to stream flow extremes and reduced water quality. Loss and simplification of these habitats has also adversely affected beaver and many other aquatic and terrestrial populations associated with them.*

Strategy Components

1. Improve extent and composition of riparian areas.
2. Achieve an adequate and sustainable supply of standing and downed dead wood in streamside environments.

- **Connect favorable habitats.**

  Fish and wildlife populations in the Deschutes subbasin often rely on a network of connected habitats during different life stages and times of year. Good connectivity between different habitats allows fish and wildlife to weather changes in habitat quality and move between favorable habitats to increase productivity. Many productive habitats are now fragmented, and populations are confined to small, disconnected habitats.

Strategy Components

1. Support efforts to reestablish passage at Pelton Round Butte Complex.
2. Provide passage past other artificial structural barriers that fragment populations and historic habitats.
3. Increase low season flows in areas that restrict fish rearing and movement between favorable habitats, or preclude year-round habitat use.
4. Reduce stream temperatures in areas where they create a thermal barrier to fish movement between favorable habitats, or seasonally preclude habitat use.
5. Connect fish to off-channel habitat by reconnecting rivers and floodplains and improving flow management.
6. Retain and re-connect streams to side channels, slough, backwater habitats and wetlands.
7. Restore native, permanent grasslands, beginning with areas adjacent to streams in upper watersheds.

- **Reduce extreme streamflow fluctuations caused by artificial water withdrawals, storage and releases.**

  Stream flow is one of the basic elements needed for the development of healthy, productive ecosystems. It plays an important role in nearly every aspect of how an ecosystem functions, including habitat formation and maintenance, water quality, and the make up of biological communities. Currently, extreme streamflow fluctuations caused by water withdrawals, storage and releases limit fish and wildlife production in many streams within the Deschutes Subbasin.

Strategy Components

1. Protect and enhance base streamflows.
2. Work with water users to increase the efficiency of water delivery and use to reduce the quantity of water removed from streams.
3. Work with irrigation districts and individual water users to enhance instream flows by seeking opportunities such as water leases, water purchases, water transfers, or other conservation measures.
4. Manage water releases from dams to create more floodplain-connecting flows.

- **Increase interaction of rivers and floodplains**.

  Natural flow regimes, functioning riparian areas, and instream structural complexity — including large wood, boulders, and emergent or aquatic vegetation — create biologically diverse and productive floodplain dynamics. They allow formation and maintenance of pools, braided channels and backwaters that provide important habitats and allow systems to withstand and benefit from periodic flooding. They also regulate streamflows and water temperatures, as well as the transport of sediment, gravel and other organic matter. Many stream reaches in the Deschutes Subbasin are now disconnected from their floodplains.

Strategy Components

1. Move toward more natural hydrologic patterns and restoration of natural stream hydrographs.
2. Increase supply and recruitment of large wood by improving riparian function, composition, diversity and extent, and providing flows to capture wood.
3. Improve low season flows.
4. Remove or alter selected revetments and blockage to off-channel areas.
5. Retain and reconnect side channels, slough, backwater habitats and wetlands.

- **Increase instream habitat complexity.**

  Instream structural habitat complexity, which may include large wood, boulders or vegetation, is important for formation and maintenance of pools, braided channels and backwaters. It also regulates the transport of sediment, gravel and organic matter. Loss of instream habitat complexity has reduced focal fish and aquatic species carrying capacity during all freshwater life stages.

Strategy Components

1. Add large wood or other instream structure to provide habitat complexity until natural processes are sufficiently restored to contribute regular structure.
2. Work toward properly functioning stream channels by reducing width-to-depth ratios.

- **Increase water infiltration, retention and soil stability, and native vegetation on uplands.**

  Natural water storage and native vegetative conditions on uplands play critical roles in providing healthy habitats for focal fish and wildlife populations. Healthy ecosystem dynamics stabilize flows and water quality by increasing the watershed's ability to capture, store and slowly release runoff and maintain soil stability. Conversion of native upland vegetation, including the introduction of exotic plant species and invasion of western juniper, has reduced the watershed's ability to perform this important function. Actions on uplands have also reduced and fragmented native habitats — including large blocks of interior grassland, ponderosa pine, lodgepole pine and shrub-steppe habitats — and caused terrestrial species associated with them to decline.

  <u>Strategy Components</u>

  1. Reduce impervious surfaces within urban growth boundaries to increase natural soil moisture absorption and subsurface storage.
  2. Restore more natural fire regimes where feasible and consistent with the protection of life and property.
  3. Improve land use and forest practices.
  4. Protect lands by providing landowner conservation incentives and through agreements with willing landowners and communities.
  5. Control or reduce invading or noxious exotic vegetation.
  6. Restore diverse vegetative ground cover.
  7. Protect natural springs and associated wetlands, including development of upland livestock water sources.
  8. Restore native grassland habitat, particularly near stream corridors.

- **Reduce Interactions with Hatchery and Exotic Populations**

  Interactions between Deschutes focal fish species and stray hatchery fish from the upper Columbia River basin pose serious genetic risks to wild populations. They also increase exposure to pathogens found in other subbasin. Out-of-basin stray hatchery origin summer steelhead from upper Columbia River hatcheries have out-numbered Deschutes steelhead annually for more than 10 years. Preliminary study results indicate that fall Chinook hatchery strays may also pose genetic risks to the subbasin population. Indigenous focal fish and wildlife species are also negatively impacted by a variety of exotic species. Non-native brook trout, for example, compete for food and space with native redband trout and bull trout and hybridize with bull trout. The exotic bullfrog competes with the native Columbia spotted frog.

  <u>Strategy Components</u>
  1. Continue monitoring incidences of stray anadromous fish in the lower Deschutes.
  2. Evaluate possible causes and impacts of out-of-subbasin strays in the drainage and determine most effective instream evaluation methods for assessing numbers of stray fish.

3. Work with Columbia Basin fish managers to reduce interactions between native fish and out-of-subbasin strays through broodstock selection, fish culture practices, marking and release strategies.
4. Evaluate potential measures to control, confine or reduce exotic species posing genetic risk or competition to focal fish and wildlife populations.

Table 2. How High Priority Strategies Address Major Limiting Factors.

Strategy	Restore Riparian Ecosystems	Increase River/floodplain Interactions	Connect Favorable Habitats	Reduce Extreme Flows	Restore Instream Complexity	Restore Upland Functions	Reduce Interactions w Non-natives
Limiting Factors Addressed	Streamflow	Streamflow	Habitat quantity	Streamflow	Habitat diversity	Streamflow	Competition
	Water quality	Water quality	Habitat diversity	Water quality	Predation	Water quality	Genetic Risk
	Fine sediments	Fine sediment	Connectivity	Habitat diversity	Harassment	Fine sediment	Hybridization
	Habitat diversity	Habitat Diversity	Habitat quantity	Habitat quantity	Fine sediment	Channel stability	Pathogens
	Channel stability	Connectivity	Predation	Connectivity	Water quality	Pathogens	
	Predation	Channel stability		Predation			
	Harassment	Food production		Harassment			
	Connectivity	Predation		Channel stability			
	Food production	Habitat quantity					
	Pathogens						

D. Prioritization Framework

Achieving the objectives in the Deschutes Subbasin Management Plan is not solely the responsibility of the Bonneville Power Administration, as guided by the Northwest Power Act and the Council's 2000 Fish and Wildlife Program. Restoring watershed health and fish and wildlife populations in the subbasin requires a coordinated effort involving natural resource managers, landowners, conservation groups and others.

The people of the Deschutes Subbasin — those who are most familiar with its natural resources, limitations and potential — can often develop the most appropriate solutions to localized problems. Consequently, the strategies identified in the Management Plan are offered to assist local efforts in developing the most effective and cost-efficient approaches for habitat restoration. Projects proposed for BPA funding through the Northwest Power and Conservation Council must meet the prioritization criteria to be considered further. For best results, local citizens pursuing a project should consult with local biologists, watershed councils, conservation groups and stakeholders to insure that their proposed projects identify an effective approach for meeting defined biological and habitat recovery targets during the planning horizon.

D.1. Prioritization Criteria and Considerations

The following criteria and considerations will be used to prioritize the implementation of strategies for recovery of focal species in the Deschutes Subbasin.

Tier I (Coarse-scale) Prioritization Criteria and Considerations

The following criteria ensure that all proposed projects and measures address BPA's responsibilities under the Northwest Power Act.

1. The project protects, mitigates or enhances fish and wildlife affected by hydropower development within the Columbia River Basin (Section 4(h)(5).
2. The project complements the activities of federal, state and Tribal fish and wildlife managers (Section 4(h)(6)(A) and is consistent with the objectives and strategies in the Deschutes Subbasin Plan.
3. The project is based on and supported by the best available scientific knowledge (Section 4(h)(6)(B).
4. The project is consistent with the legal rights of Indian Tribes (Section 4(h)(6)(D).

Once Tier I criteria above are met, the highest priority will be completion of on-going projects that address urgent and high priority objectives in the Deschutes Subbasin Plan, consistent with the objectives in the Council's 2000 Fish and Wildlife Program.

Tier II (Subbasin Scale) Prioritization Criteria and Considerations

If all Tier I criteria are met, the following prioritization criteria will be used to guide BPA funding in the Deschutes Subbasin:

1. Projects that protect and restore the highest quality habitats for core focal fish and wildlife populations will be given highest priority.
   - 1.1. Among focal species, give priority status first to existing populations that are federally listed and second to existing populations with other strong cultural and ecological value, or to species that are currently extirpated from portions or all of the subbasin, but for which recovery is feasible.
   - 1.2. Give high priority status to remaining pine/white oak communities, cottonwood galleries and native interior grasslands that provide important wildlife habitat for focal wildlife species.

2. Projects will be given higher priority that
   - 2.1. Employ multi-species approaches, i.e. which address factors that limit multiple focal species — fish and wildlife — or have other beneficial ecological implications in the watershed.
   - 2.2. Expand habitat for existing core populations to increase survival, connectivity and reproductive success of native populations.

2.3. Provide high quality habitat, and that are contiguous with core habitat or along migratory routes to high quality habitat.

2.4. Restore low quality habitat or sections that fragment productive habitats and/or restrict distribution of populations.

2.5. Provide long-term (rather than short-term) protection for habitats and populations.

2.6. Make significant (rather than marginal) contributions toward measurable fish and wildlife objectives.

3. Other things being equal, projects that demonstrate the following will be given higher priority.

3.1. Projects that address sources of degradation (rather than impacts).

3.2. Projects where landowners are willing participants or supporters.

3.3. Projects where opportunity for success is high (rather than those of limited feasibility).

3.4. Projects that are complementary to other subbasin land management, water quality, environmental management and recreational objectives as specified in fish management, conservation, recovery or other plans developed with and supported by subbasin stakeholders (rather than those that are isolated, stand-alone efforts).

3.6. Projects that demonstrate cost effectiveness relative to alternative means of achieving the same ends in the same location or of achieving similar progress in other locations.

3.7. Projects that bring additional funding (including in-kind) to the subbasin for the realization of the restoration/conservation objectives.

E. How Limiting Factors Affect Focal Species during Different Life Stages.

Subbasin planners used two tools, EDT and QHA, during the planning assessment to identify limiting factors for focal fish species in various stream reaches of the Deschutes subbasin. The EDT analysis ranked how key environmental attributes affect summer steelhead and Chinook salmon performance during different life stages. The QHA analysis provided more qualitative information on major limiting factors for focal fish species and populations not rated during the EDT analysis. Information gained from these analyses is shown in Tables 3 through 8, which expand on previous discussions presented in Section A. The tables identify Key Environmental Correlates (KECs), or habitat needs, for the different species and populations by life stage, as well as the major factors limiting production during the different stages.

Table 3. Limiting Factors for Summer Steelhead/Redband Trout during Different Life Stages.

Summer Steelhead/Redband Trout — Deschutes Subbasin							
Fish Habitat Requirements		**Major Limiting Factors by Area (Prioritized)**					
Life Stage	**Key Habitat Needs (KECs)**	**L. Deschutes River**	**Lower Westside Tribs.**	**Lower Eastside Tribs.**	**Middle Deschutes River, Squaw Creek , Metolius River System**	**Upper Deschutes River and tributaries (Redband Trout only)**	**Lower Crooked System**
Spawning	Suitable substrate, flow, temperature, habitat diversity/complexity. Minimal predation.	Habitat diversity, predation, key habitat quantity	Habitat diversity, water temperature	Fine sediments, habitat diversity, predation, flows	Habitat diversity, potential harassment, water temperature extremes, predation	Habitat diversity, potential harassment and predation, fine sediment	Habitat diversity, predation, water temperature, substrate sediments, key habitat quantity
Egg Incubation	Suitable substrate quality, flow, temperature, channel stability	Channel stability (cementing, armoring), flow, key habitat quantity	Channel stability, key habitat quantity/quality (spawning gravel), water temperature, flow	Channel stability, water temperatures, sediment levels	Fine sediments, channel stability, flow reductions, water temperatures, key habitat quantity	Channel stability, fine sediment, key habitat quantity	Fine sediments, channel stability, flow, temperatures, key habitat quantity
0-age rearing	Suitable habitat diversity, flow, temperature, channel stability, and food production; minimal predation and pathogen levels; minimal substrate sediment	Instream and streamside habitat diversity, competition, channel stability, food production, predation	Summer/fall flow, competition with hatchery fish, instream habitat diversity, key habitat quantity, water temperatures, channel stability, food production, predation, pathogens	Summer/fall flows, instream habitat diversity, seasonal water temperature extremes, channel stability, food production, pathogens, predation and sediment loading	Habitat diversity and complexity, flow and temperature variation, potential competition with hatchery fish, channel stability, food production, pathogens, predation	Flow and temperature extremes, channel stability, fine sediment, habitat diversity and complexity, predation, competition with other fish species, food production	Competition with hatchery fish, summer/fall flow, habitat diversity, seasonal water temperature extremes, channel stability, food production, pathogens, predation, sediment loading
0, 1-age inactive (winter inactivity)	Suitable stream flow, habitat diversity, stream temperature, channel stability and food production	Winter flows, instream habitat complexity, stream bank erosion	Winter flows, instream habitat complexity, stream channel and bank erosion, predation, key habitat quantity	Winter flows, instream habitat complexity, channel stability, food production	Substrate fine sediment, instream habitat diversity/complexity, channel stability, flows, food production, predation.	Seasonal flow and temperature extremes, channel stability, instream habitat diversity and complexity, key habitat quantity, food production, predation	Instream habitat diversity and complexity, substrate sediments, key habitat quantity, flow, food production, predation.
1,2+-age rearing	Adequate habitat complexity/cover for protection from predators. Suitable stream temperatures, flow, channel stability and food production	Habitat complexity and channel stability, predation, stream temperatures, summer and fall flow, food production, competition from hatchery fish	Competition with hatchery fish, habitat complexity and channel stability, predation, water temperatures, summer/fall flow and food production.	Habitat complexity and channel stability, predation, seasonal stream temperature and flow extremes, food production	Potential competition with hatchery fish, habitat diversity and complexity, channel stability, predation, pathogens, water temperatures, flows, food production	Seasonal flow and temperature extremes, channel stability, habitat diversity and complexity, food production, key habitat quantity, predation	Potential competition with hatchery fish, habitat diversity, channel stability, predation, pathogens, stream temperatures, summer/fall flow, food production, key habitat quantity
1,2+-age migrant	Adequate habitat complexity/cover for protection from predators. Suitable water temperature/clarity	Habitat complexity, predation, key habitat quantity	Habitat diversity and complexity, predation	Habitat diversity and complexity, predation, stream temperatures, sediment levels	Habitat complexity and diversity, predation, key habitat quantity, flow, water temperatures, sediment	NA	Habitat complexity/diversity, predation, key habitat quantity, flow, water temperatures, fine sediment
Pre-spawning mortality	Adequate habitat diversity and complexity/cover for protection from predators, harassment.	Habitat diversity and complexity, harassment	Habitat diversity and complexity, predation, key habitat quantity	Habitat complexity, predation, harassment and poaching	Access to habitat, habitat complexity, potential harassment, flow, temperature	Passage and habitat accessibility, key habitat quantity, habitat complexity, predation	Access to habitat, predation vulnerability, key habitat quantity, habitat complexity, water temperatures
Pre-spawning holding	Adequate habitat diversity and complexity/cover for protection from predators and harassment. Suitable quantity of key habitat	Habitat diversity and complexity, harassment	Habitat diversity and complexity, predation, key habitat quantity	Habitat diversity and complexity, predation, harassment and poaching, key habitat quantity	Habitat diversity, potential harassment, predation, key habitat quantity, flows, water temperatures	Habitat diversity and complexity, key habitat quantity, predation and fine sediment	Habitat diversity/complexity, predation, key habitat quantity

Table 4. Major Limiting Factors for Spring Chinook during Different Life Stages.

Spring Chinook — Deschutes Subbasin				
Fish Habitat Requirements		**Major Limiting Factors by Area (Prioritized)**		
Life Stage	**Key Habitat Needs (KECs)**	**Lower Deschutes R., Warms Springs R. and Shitike Cr.**	**Middle Deschutes River, Squaw Creek, Metolius River and Tribs.**	**Crooked River and Tribs. (below Bowman Dam)**
Spawning	Suitable or preferred water temperature; adequate instream and streamside habitat diversity and complexity; low pathogen levels; low levels of fine substrate sediment; and suitable quantities of preferred habitat	(Warm Springs River and Shitike Creek only) Habitat diversity and complexity, water temperature, key habitat quantity	Habitat diversity, key habitat quantity, flow, water temperature	Stream temperatures, habitat diversity and complexity, fine sediment, pathogens, key habitat quantity
Egg Incubation	Suitable water temperature, stream channel stability, suitable substrate quality and quantity; suitable key habitat	Channel stability, fine sediment, water temperature, key habitat quantity.	Channel stability, fine sediment, key habitat quantity	Stream temperatures, channel stability, fine sediment, key habitat quantity
0-age rearing	Suitable habitat diversity or complexity, stream flow and temperature; suitable quantities of key habitat; minimal competition from hatchery fish; minimal predation; low pathogen levels; channel stability; suitable food production; and low sediment level.	Instream and streamside habitat diversity, predation, competition with hatchery fish, water temperature, key habitat quantity	Potential competition with hatchery fish, flow, instream and streamside habitat diversity, predation, food production, key habitat quantity	Potential competition with hatchery fish, flow, instream and streamside habitat diversity, channel stability, fine sediments, stream temperature, predation, pathogens, food production, key habitat quantity
0-age inactive (winter inactivity)	Suitable habitat diversity; channel stability; sufficient minimum flows, food production; minimal predation; and suitable key habitat quantity; suitable food production; and low sediment level.	Instream and streamside habitat diversity, channel stability, flow, predation, food production, key habitat quantity	Instream and streamside habitat diversity, channel stability, flow, predation, food production, key habitat quantity	Habitat diversity, channel stability, fine sediments, flow, predation, food production, key habitat quantity
1+-age migrant	Suitable habitat diversity; upstream and downstream passage; sufficient key habitat; and minimal predation	Instream and streamside habitat diversity and complexity, vulnerability to predation	Passage, instream and streamside habitat diversity, vulnerability to predation, key habitat quantity	Passage, instream and streamside habitat diversity, vulnerability to predation, key habitat quantity
Pre-spawning mortality	Efficient passage at artificial barriers; adequate stream flow; suitable habitat diversity and complexity; suitable water temperature and quantities of key habitat.	Habitat diversity and complexity, water temperature, key habitat quantity	Artificial passage barriers, flow, habitat diversity and complexity, key habitat quantity	Artificial passage barriers, flow, habitat diversity and complexity, stream temperature, key habitat quantity
Pre-spawning holding	Adequate stream flow; suitable habitat diversity and complexity; suitable water temperature; and suitable quantities of key habitat. Reduced levels of pathogens and sediment.	Flow, habitat diversity and complexity, water temperatures, key habitat quantity	Flow, habitat diversity and complexity, key habitat quantity, flow, water temperature	Stream flow, habitat diversity and complexity, stream temperatures, key habitat quantity, sediments, pathogens

Table 5. Major Limiting Factors for Bull Trout during Different Life Stages.

Bull Trout — Deschutes Subbasin				
Fish Habitat Requirements		**Major Limiting Factor (Prioritized)**		
Life Stage	**Key Habitat Needs (KECs)**	**Lower Deschutes Population (TRT)**	**Upper Deschutes Population (extirpated)**	**Odell Lake Population**
Spawning	Suitable gravel/cobble substrate, flow and temperature, minimal predation and suitable habitat diversity/complexity	(Warm Springs River and Shitike Creek only) Fine sediment, flows, habitat diversity, vulnerability to predation, in-breeding with brook trout	Key spawning habitat inundated by reservoirs; fine sediment; flow fluctuations; habitat diversity; vulnerability to predation, hybridization	Key spawning habitat quantity, fine sediment, water temperatures, habitat diversity, competition with exotic fish species, vulnerability to predation
Egg Incubation	Suitable substrate quality, flow, temperature, channel stability	Channel stability, flow, stream temperatures, sediment levels	Channel stability, flow fluctuations, fall/winter flow, stream temperatures, sediment levels	Channel stability, sediment levels
0-age rearing	Suitable habitat diversity, stream flow and temperature; channel stability; suitable food production; minimal predation and competition; minimal substrate sediment	Summer/fall stream flow, instream habitat diversity, flow fluctuations, water temperature extremes, channel stability, food production, competition/hybridization with brook trout, predation, sediment	Seasonal flow extremes, instream habitat diversity, flow fluctuations, stream temperatures, channel stability; food production, competition with brook trout, sediment loading	Instream habitat diversity, seasonal water temperature variation, channel stability, food production, competition with exotic trout, sediment loading
0-age inactive (winter inactivity)	Suitable stream flow, habitat diversity, stream temperature, channel stability and food production	Winter flows, channel stability, temperature extremes, sediment loading, instream habitat complexity, food production	Winter flows, channel stability, stream temperatures, sediment loading, instream habitat complexity, food production	Winter flows, channel stability, temperature extremes, sediment loading, instream habitat complexity, food production
1+-age rearing	Suitable habitat diversity, stream flow and temperature; channel stability; suitable food production; minimal predation and competition; minimal substrate sediment	Instream habitat diversity, flow fluctuations, water temperature extremes, channel stability, food production, competition with brook trout, sediment loading	Instream habitat diversity, flow fluctuations, water temperature extremes, channel stability, food production, competition with exotic fish, sediment loading	Instream habitat diversity, flow fluctuations, water temperature variation, channel stability, food production, competition with exotic trout, sediment loading
2 and 3-age migrant (Fluvial and Adfluvial)	Suitable fish passage, adequate habitat complexity/cover for protection from predators, and stream temperatures	Passage obstructions/fragmentation, habitat diversity and complexity, predation, stream temperatures, sediment	Obstructions/fragmentation, habitat diversity and complexity, predation, stream temperature extremes, sediment loading	structures obstruct/delay passage; key habitat quantity; habitat diversity and complexity; predation; stream/lake temperature variation; sediment level
Pre-spawning mortality	Unobstructed upstream passage, adequate stream flow, suitable water quality, adequate habitat diversity and complexity/cover for protection from predators and harassment	Upstream passage obstructions, habitat complexity, flow, water temperatures, harassment, predation	Upstream passage obstructions, temperature and flow extremes, habitat complexity, harassment, predation	Structures obstruct/delay upstream passage; seasonal temperature and flow variation; habitat complexity; harassment; predation
Pre-spawning holding	Adequate habitat diversity and complexity/cover for protection from predators and harassment, suitable stream flow and water quality, suitable quantity of key habitat	Habitat diversity and complexity, water temperatures, predation, harassment, key habitat quantity	Upstream passage obstructions, temperature and flow extremes, habitat complexity, harassment, predation	Habitat diversity and complexity, water temperatures, flow, predation, harassment, key habitat quantity

Table 6. Major Limiting Factors for Fall Chinook Salmon during Different Life Stages.

Fall Chinook Salmon — Deschutes Subbasin (Lower Deschutes River Mainstem Only)		
Life Stage	**Key Habitat Needs (KECs)**	**Major Limiting Factor (Prioritized)**
Spawning	Adequate habitat diversity and complexity; minimal harassment and predation; suitable water temperatures	Habitat diversity and complexity, water temperature, harassment/, predation
Egg Incubation	Suitable substrate, flow, and channel stability	Channel stability (cementing or armoring, conversion to rooted vegetation), substrate sediment, flow
0-age rearing	Suitable habitat diversity or complexity; channel stability; minimal competition from hatchery fish; minimal predation; suitable food production; and low pathogen levels	Instream and streamside habitat diversity, channel stability, food production, predation, pathogens, competition with hatchery fish
0-age inactive (winter inactivity)	Suitable habitat diversity, channel stability, minimum flows, minimal predation: and suitable food production	Instream and streamside habitat diversity, channel stability, stream flow, predation, food production
0-age migrant	Adequate habitat diversity or complexity; minimal predation; and sufficient quantities of key habitat	Instream and streamside habitat diversity and complexity, predation (reduced cover), key habitat quantity (majority migrate as age-0 smolts)
Pre-spawning mortality	Adequate river flow, suitable habitat diversity and complexity/cover for protection from harassment, suitable water temperature	Habitat diversity and complexity, potential harassment, water temperature, pathogens
Pre-spawning holding	Habitat diversity and complexity/cover for protection from harassment; and suitable water temperature	Habitat diversity and complexity, harassment, water temperatures, pathogens

Table 7. Major Limiting Factors for Pacific Lamprey during Different Life Stages.

Pacific Lamprey – Deschutes Subbasin (Lower and Middle Deschutes River and tributaries)		
Life Stage	**Key Habitat Needs (KECs)**	**Major Limiting Factor (Prioritized)**
Spawning	Suitable gravel/cobble substrate, flow and temperature, minimal predation and suitable habitat diversity/complexity	Fine sediment, flow, habitat diversity, vulnerability to predation
Egg Incubation	Suitable substrate quality, flow, temperature, channel stability	Channel stability, fluctuating and low flow, stream temperatures, sediment levels
0 to 6+-age rearing	Suitable habitat diversity, stream flow and temperature; channel stability, suitable food production; minimal predation and; minimal substrate fine sediment	Summer/fall stream flow, instream habitat diversity, flow fluctuations, water temperature extremes, channel stability, food production, sediment loading, predation
0 to 6+-age inactive (winter inactivity)	Suitable stream flow, habitat diversity, stream temperature, channel stability and food production	Winter flows, channel stability, sediment loading, instream habitat complexity, food production
1 to 6+-age migrant	Adequate habitat complexity/cover for protection from predators, suitable substrate quality, stream temperatures and water clarity	Habitat diversity/complexity, predation, stream temperatures, sediment level
Pre-spawning mortality	Unobstructed upstream passage, adequate stream flow, suitable water quality, adequate habitat diversity and complexity/cover to protect from predators, harassment	Upstream passage obstructions; habitat complexity; reduced, fluctuating or intermittent flow; water temperature; harassment and harvest; predation
Pre-spawning holding	Habitat diversity and complexity/cover for protection from predators and harassment, suitable stream flow and water quality, suitable quantity of key habitat	Habitat diversity and complexity; predation; harassment; key habitat quantity

Table 8. Major Limiting Factors for Sockeye Salmon during Different Life Stages.

Sockeye Salmon – Deschutes Subbasin, Deschutes Population (extirpated)		
Life Stage	**Key Habitat Needs (KECs)**	**Major Limiting Factor (Prioritized)**
Spawning	Suitable gravel/cobble substrate, flow and temperature, minimal predation, a stable stream channel and suitable habitat diversity/complexity	Fine sediment, channel stability, habitat diversity/complexity, vulnerability to predation
Egg Incubation	Suitable substrate quality, flow, temperature, channel stability	Channel stability, stream temperatures, fine sediment levels
0-age migration	Suitable flow, temperature, no passage obstructions, minimal predation	Artificial obstructions (dams and diversions), habitat diversity and complexity, vulnerability to predation
0 to 1+-age rearing	Suitable lake habitat; suitable food production; minimal predation and competition	Variations in lake productivity/food production, inter and intra-specific competition, predation.
1+-age migrant (ocean migration)	Suitable fish passage, adequate habitat complexity/cover for protection from predators, and suitable stream temperatures	Obstructions extirpated population; habitat diversity and complexity; predation; stream temperatures
Pre-spawning mortality	Unobstructed upstream passage, adequate stream flow, suitable water quality, adequate habitat diversity and complexity/cover for protection from predators and harassment	Upstream passage obstructions, habitat complexity, flow, water temperature, harassment, predation
Pre-spawning holding	Adequate habitat diversity and complexity/cover for protection from predators and harassment, suitable stream flow and water quality, suitable quantity of key habitat	Habitat diversity and complexity, water temperatures, predation, harassment, key habitat quantity