Management Plan

"Management and restoration programs for native salmonids have a fundamental requirement: They must work in concert with the natural strengths of the fishes that compose the native community and the natural processes that form and maintain the habitats required by those communities"

J. Lichatowich et al. 1998. A Conceptual Foundation for the Management of Native Salmonids in the Deschutes River.

The Management Plan consists of five elements described in the Council's program: 1) a vision for the subbasin; 2) biological objectives; 3) strategies; 4) research, monitoring and evaluation; and 5) consistency with the Endangered Species Act and Clean Water Act. In addition, the management plan provides a conceptual foundation for the Deschutes Subbasin. While the vision is a policy choice about how the subbasin will be managed in the future, the conceptual foundation reflects the information provided in the assessment and frames this information to provide an understanding of the ecological conditions in the subbasin that must be considered in the management plan.

The management plan is part of the Deschutes Subbasin Plan, which is a living document. It reflects the current understanding of conditions in the Deschutes watershed. This understanding — as well as the biological objectives, management strategies and actions based on this understanding — will be updated through an adaptive management approach that includes research and evaluation. The management plan will be reviewed and approved by the Northwest Power and Conservation Council, and will act as a draft amendment to the Council's Columbia Basin Fish and Wildlife Program.

1. Vision for Deschutes Subbasin

The Vision describes the desired future condition for the subbasin. Crafted by the Deschutes Coordinating Group, it incorporates the conditions, values and priorities of a wide spectrum of stakeholders in the Deschutes Subbasin. The vision for the Deschutes Subbasin also is consistent with and builds from the vision described in the Northwest Power and Conservation Council's Columbia River Basin 2000 Fish and Wildlife Program.

The Vision for the Deschutes Subbasin is:

> *To promote a healthy, productive watershed that sustains fish, wildlife and plant communities as well as provides economic stability for future generations of people. An inclusive consensus-based process will be used to create a plan for the achievement of sustainable management of*

water quality standards, instream flows, private water rights, fish and wildlife consistent with the customs and quality of life in this basin.

This vision of the Deschutes Subbasin framed the development of the biological objectives and thereby the strategies that are incorporated to change conditions within the subbasin.

2. Conceptual Foundation

Purpose

This Conceptual Foundation summarizes the underlying ecological conditions that define how salmonid and lamprey producing ecosystems in the Deschutes watershed function. A scientific foundation, it sets the stage for identifying key factors that influence fish and wildlife populations in the basin, and for determining appropriate solutions. It recognizes that fish and wildlife are part of the physical and cultural landscape, and that by understanding how ecosystem functions affect the vitality of fish and wildlife populations, we can better define steps needed to sustain a productive ecosystem that will support these populations.

The term conceptual foundation may have best been described by Jim Lichatowich (1998) in his report *A Conceptual Foundation for the Management of Native Salmonids in the Deschutes River*. He compares a conceptual foundation to the picture that comes with a jigsaw puzzle. This picture, usually on the box lid, illustrates what all the pieces will look like when placed in their proper order. Each piece of the puzzle is a small data set containing information, which is interpreted by continually comparing or referencing back to the picture. Assembling the puzzle without the guidance of the picture, or with the wrong picture, would be extremely difficult if not impossible (Lichatowich et al. 1998).

Our foundation builds on the work by Lichatowich (1998). It is also consistent with the foundation and scientific principles for the larger Columbia River Basin as defined in the Northwest Power Planning Council's 2000 Fish and Wildlife Program. Actions taken in the subbasin to fulfill the vision for the Deschutes Subbasin will be consistent with, and based upon, these principles. While the vision is a policy choice about how the subbasin will be managed, the scientific foundation describes our best understanding of the biological realities that will ultimately determine the success of various resource management solutions.

A Conceptual Foundation for the Deschutes Subbasin

The following principles reflect the more detailed description of population and environmental characteristics in the Deschutes Subbasin, as discussed in the subbasin assessment. The descriptions of these characteristics, and the relationships between them, provide the raw material for a conceptual foundation. The guiding principles identified in this section highlight the key elements of a conceptual foundation for the Deschutes ecosystem.

Guiding Scientific Principles

The following principles, and discussion shown in italics under each of the principles, describe our understanding of the Deschutes subbasin ecosystem. These principles

build on the work conducted by Lichatowich et al. (1998). Together, they provide a foundation for identifying effective management strategies needed to reach our objectives for rebuilding fish and wildlife populations in the Deschutes River Subbasin.

1. **Fish and wildlife populations in the Deschutes Subbasin have complex life histories that respond to the subbasin's considerable variation in habitat conditions. Such diversity promotes production and long-term persistence at the species level and must be protected.**

   Aquatic habitats in the Deschutes subbasin vary from small and large runoff streams with extremely dynamic habitat parameters to small and large perennial spring-driven streams. The presence of both natural lakes and man-made reservoirs adds to the diversity. The terrestrial landscape varies from the high cascades above timberline with high precipitation to lower elevation, semi-arid landscapes with high solar input. With different elevations, exposures, slopes, soil types and associated ecotypes, tremendous potential exists. With this diversity, the challenge of resource plans is to allow natural expression of ecosystem potential and allow access for individuals and populations between productive habitat areas.

2. **The Deschutes Subbasin is part of a coevolving natural—cultural system. Suitable ecosystem attributes can be achieved by managing human interference in the natural habitat forming processes.**

   Humans often view themselves as separate and distinct from the natural world. Still, we play an integral role in the shaping of our ecosystem. Our actions have a pervasive impact on the structure and function of ecosystems, while at the same time, our health and well-being are tied to these conditions.

   Human practices in the Deschutes watershed since the mid-1850s have weakened the natural biophysical processes that create and maintain healthy habitats. Today, however, more people are aware of how different land and water management actions influence stream habitats and overall watershed health, and are changing their practices. Increased efforts to restore watershed health and conserve water will allow recovery of natural habitats. Thus, the recovery of fish and wildlife populations in the subbasin depends on the extent to which we chose to control our impacts on natural habitat forming processes.

3. **Productivity of focal fish species requires a network of complex interconnected habitats.**

   Many fish and wildlife populations in the Deschutes subbasin rely on a network of connected habitats during different life stages and times of year. Summer steelhead using eastside habitats — such as in Trout, Bakeoven and Buck Hollow creeks — adjusted to flow and temperature constraints by migrating and spawning earlier than steelhead returning to the lower Deschutes River westside tributaries. Juvenile salmonids in eastside tributaries particularly relied on deep natural pools, pools associated with beaver dams, and other coldwater refuge areas to escape higher summer water temperatures. Good connectivity between different habitat areas also made it possible for fish populations to weather

natural changes in habitat quality, and to escape to more suitable habitat when problems occurred.

In systems such as the Deschutes subbasin, much of the biological diversity within species is expressed at the margins of the habitats for each species. Thus, to maintain this diversity it is extremely important to maintain marginal habitats. The individuals able to persist in these habitats provide a source of strength for the species should these marginal habitats become more widespread with climate change or normal variation.

4. **There is a physical connection between the upper and lower Deschutes Subbasin. Changes in land and water uses in the upper watershed could affect the stability of the lower river environment, and thus the distribution and performance of native salmonids. Potential impacts must be understood and considered.**

   Much is known about the unique hydrological regime that characterizes the Deschutes Subbasin, but there are many questions remaining regarding the relationship between water lost through leakage in upper subbasin irrigation canals and the effects on the lower Deschutes River when new allocations are proposed in conjunction with conservation methods. The reduction in canal leakage will have a complimentary reduction in flow of the springs in the Crooked River and Deschutes Rivers above Lake Billy Chinook. However, the flow below the Pelton Round Butte Complex will only be reduced if new water appropriations are allocated based on those conservation practices. Understanding the effects of present and past impacts of human actions is key to planning and future habitat restoration efforts.

5. **Activities outside the Deschutes Subbasin can have tremendous influence on salmonid production and genetics. Potential impacts of out-of-subbasin programs must be considered and addressed.**

   Development and operation of the Columbia River hydropower system negatively affects salmon and steelhead production and opportunities for recovery in the Deschutes subbasin. The effects of these operations must be recognized, reflected in established subbasin biological objectives, and addressed simultaneously with restoration actions in the subbasin.

   Out-of-basin stray hatchery origin summer steelhead from upper Columbia River hatcheries have out-numbered Deschutes steelhead for more than ten years. The large influx of out-of-subbasin stray summer steelhead may be contributing significant amounts of maladapted genetic material to the wild summer steelhead population in the lower Deschutes River subbasin. The cumulative effect of this genetic introgression may contribute to lowered productive capacity of the wild population as evidenced by low run strength of wild summer steelhead through time.

3. Key Findings, Biological Objectives and Management Strategies

3.1. Overall Planning Direction

During the assessment, it became apparent that it will take several decades to achieve the needed level of habitat recovery in many parts of the Deschutes Subbasin. Because the ecosystem's semi-arid nature, geology and vegetation restrict the pace of habitat restoration, remedial measures implemented to restore vegetative diversity and recovery of stream channel stability and diversity will require many years or decades to achieve the desired objective. Consequently, planners selected a planning horizon of 25 years for meeting subbasin objectives, instead of the horizon of 10 to 15 years suggested by the Council. This extended recovery period is particularly important for potential restoration of riparian and floodplain function, as well as channel aggradations. In some cases, earlier progress toward recovery of focal fish species will be made. Restoration of fish passage at manmade obstructions or unusual debris jams will frequently produce rapid response when fish begin to access historical fish habitat. The time required to implement these remedial fish passage projects could be substantially less than the time required for stream or upland habitat recovery to produce measurable increases in fish production.

3.1.1. Priority Reaches and Project Areas

During the subbasin assessment process, planners and resource managers concluded that for depressed, fragmented or isolated resident focal fish populations the most effective habitat and population restoration strategy would be to begin with recovery of core populations and core habitat. They identified key stream reaches that provide core habitat for focal fish species, including important spawning and rearing habitat, and important habitat for ESA-listed species. These stream reaches, or conservation reaches, were earmarked as high priority reaches during the EDT and QHA analyses (Map 28). The team determined that these stream reaches deserve high priority protection because of their importance in meeting desired biological objectives during the planning horizon. Further, 21 of the high priority protection reaches were identified as high candidates for future monitoring and evaluation (Map 26). These 21 reaches display desired stream habitat conditions for the Deschutes Subbasin and will serve as reference reaches for monitoring and evaluation. These high priority protection reaches and reference reaches are identified and discussed in the Syntheses and Interpretation Section of the Assessment.

The fish technical team also identified stream reaches with high restoration value to focus future habitat restoration. Restoration of these reaches is needed to meet biological objectives within the planning horizon. These determinations reflected historical focal fish species use and potential for increasing focal fish production, distribution and re-establishing population connectivity. Further, the team identified ten high priority fish habitat restoration projects or scenarios that deserve immediate attention. These reaches, which are also identified and discussed in the Syntheses and Interpretation Section of the Assessment, are:

1. Trout Creek Fish Habitat Restoration Project
2. Squaw Creek Instream and Riparian Habitat Restoration Project

3. Middle and Upper Deschutes River Instream and Riparian Habitat Restoration Project
4. Lower Crooked River Instream and Riparian Habitat Restoration Project
5. Lake Creek and Link Creek Fish Passage Improvement Project
6. North Fork Crooked River Instream and Riparian Habitat Restoration Project
7. Beaver Creek Instream and Riparian Habitat Restoration Project
8. Tygh and Badger Creek Habitat Restoration Project
9. Lower Deschutes River Instream and Riparian Habitat Restoration Project
10. Pelton Round Butte Fish Passage Restoration Project

Overall Strategy for Habitat Restoration

Conclusions reached during the assessment formed the bases for an overall strategy to direct habitat restoration work in the subbasin. Under this strategy, habitat restoration will center on improving and expanding conditions for focal species in core habitats. The following direction will focus habitat restorations in the subbasin:

- Core habitats will be expanded downstream to build on the benefits of preceeding restoration work.
- In areas where headwaters are degraded — or where the system is influenced by flashy or uncontrolled stream flows — habitat restoration for focal fish populations will take place progressively from the upper-most degraded reaches downstream, and restoration projects will include upland restoration work to maintain a ridge top-to-ridge top approach.
- Where headwater areas are in good condition, habitat restoration will begin in at the upper end of a degraded priority reach and work progressively downward.
- In areas where the system is hydrologically stable and habitat restoration is not at risk of loss from an uncontrolled flow situation, the most cost effective habitat restoration opportunities for restoring core fish populations may exist in lower watersheds. In such cases, these projects should be pursued, especially when opportunities become available to work with cooperating landowners.

3.1.2. Management Plan Development

During the subbasin planning process, work sessions were held in different parts of the Deschutes Subbasin to develop key sections of the management plan. State and tribal fish managers, natural resource specialists, landowners, irrigation district representatives, city personnel and others — people who were often very familiar with the populations and/or habitat conditions in a particular drainage — participated in these sessions. The purpose of these meetings was to receive feedback on findings generated from the EDT and QHA analyses, and to refine biological and habitat objectives and management strategies for protection and restoration of focal fish and wildlife species.

Before each meeting, members of the subbasin planning team developed a list of potential biological objectives and strategies that would lead to restoration of focal species in particular assessment units. These lists reflected the findings from the EDT and QHA analyses, and were distributed to potential meeting participants before each meeting. The work sessions began with a review of the results from the EDT and QHA analyses, including ratings showing reaches in highest need of restoration or protection. Following this review, the participants refined the draft lists of key findings, biological

objectives and management strategies to best reflect the on-the-ground conditions and needs in particular subbasin drainages. Information received during the work sessions formed the cornerstones for development of biological and habitat objectives and needed management strategies in the different assessment units.

The following lists of key findings, biological objectives and management strategies were generated based on results from the EDT, QHA and IBIS analyses, and information received during the work sessions. They are supported by information presented in the Assessment. Unfortunately, the tight timeline for this subbasin planning process restricted the review and refinement of these lists. It also restricted the participation of some people who wanted to join the work session but had schedule conflicts. Consequently, the direction — while the best available at this time — could be improved with additional review.

Approach for Establishing Plan Objectives

Specific biological objectives for Chinook salmon and steelhead were derived after considering the EDT projections for adult fish production with moderate habitat restoration, review of extensive inventory data and consultation with fishery managers. The objective was a numerical range that typically bracketed the population abundance point value reflecting habitat restoration, provided in the EDT Report 3 – Future Scenario Spawner Population Performance. The fish biological production objective was modified to reflect reality in several areas. For example resource managers agreed that the spring Chinook salmon production potential projected for Shitike Creek was excessively high, based on past population monitoring, high quality habitat conditions and limited opportunities for restoration. The Shitike Creek spring Chinook population objective was revised to more accurately reflect the potential response to habitat modifications.

Summer steelhead run-size objectives were developed by conducting EDT analyses for each demographically independent population and associated habitat identified by the Interior Columbia Basin Technical Recovery Team (TRT). The actual numerical fish population objective is expressed as a range that brackets the EDT estimated adult fish production following habitat restoration.

Salmon and steelhead biological objectives for increased life history diversity, increased population productivity and increased habitat capacity were derived directly from the EDT Report 3 data generated for assessment units, population habitats or major stream systems.

Specific resident redband trout population objectives were generally impossible to develop based on habitat variability within assessment units and lack of sufficient life history data. The one exception was the lower Deschutes River, where ODFW had developed specific biological objectives based on a detailed life history study and years of population monitoring. These objectives were originally included as part of the ODFW - Lower Deschutes River Fish Management Plan (ODFW 1997) and were determined to still be valid.

Restoration of subbasin stream habitat is largely dependent on meaningful recovery of riparian habitat. There are approximately 1,894 miles of stream within the subbasin. Within the 25-year planning horizon, or by 2030, it is assumed that the riparian habitat along one-half of the subbasin streams will be substantially protected or restored. It was

also assumed that the average width of the riparian corridor, including both stream banks, without the stream channel, averages approximately seventy-five feet. A seventy-five foot wide swath of riparian vegetation totals approximately nine acres of riparian habitat per stream mile. Potentially the subbasin stream corridors could have up to 17,046 acres of riparian habitat. The goal of this plan is to protect or restore 8,523 acres of riparian habitat during the 25-year planning horizon. It is unlikely that degraded habitat will be fully restored within this period, but the percentages of recovery are included as assessment unit or habitat complex strategies.

Restoration of a variety of stream habitat attributes would be difficult to quantify without developing specific objectives for each stream reach. This was not a realistic expectation based on the time allotted for this planning process, and the number of stream reaches and attributes involved. Habitat restoration objectives generally reflect a percentage change expressed as the difference between the template and current conditions. The same objective percentage applies to all stream reaches in a habitat complex, but the expected degree of recovery is directly dependent on the current habitat condition. Compliance with the habitat attribute objectives would require considerably more change for a severely degraded stream than a stream in relatively good condition. In most areas, definitive baseline habitat attribute values need to be determined before initiation of any restoration programs if habitat recovery is to be accurately monitored and evaluated.

Potential stream habitat restoration scenarios with low, moderate and high levels of habitat restoration were analyzed by the EDT model to determine potential fish production capabilities. It was determined that for this planning horizon the moderate level of habitat restoration was the most realistic and offered the greatest likelihood for success. The projected percentage of improvement for various habitat attributes included in the moderate habitat restoration scenario has generally been included as specific plan habitat attribute objectives.

This document recognizes that the subbasin planning process is adaptive in nature. As indicated in the findings from the EDT and QHA analyses, in some cases there is not enough information currently available to accurately quantify our biological and habitat objectives, or 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 the water quality goals that are now being produced at the State level. These and other numeric targets will be modified as better information becomes available.

3.2. Lower Westside Deschutes Assessment Unit

Lower Westside Deschutes Assessment unit includes the lower 100 miles of the Deschutes River, the Warm Springs River system, Shitike Creek and the smaller tributaries that enter the lower Deschutes — except Bakeoven, Buck Hollow and Trout creeks.

Key Findings

- The Warm Springs River system, Shitike Creek and the lower 100 miles of the Deschutes River historically supported populations of most subbasin focal species (summer steelhead, Chinook salmon, redband trout, bull trout and Pacific lamprey).
- Miscellaneous, small Deschutes River tributaries generally supported summer steelhead and redband trout populations.
- Today the assessment unit supports spring and fall Chinook salmon, summer steelhead, pacific lamprey, bull trout and resident redband trout. The anadromous salmonid populations have been monitored for up to 25 years.
- Fall Chinook salmon are only found in the Deschutes River.
- Fall chinook production has been on an increasing trend. Spring chinook and steelhead runs have fluctuated and are currently stable.
- Reestablished sockeye and spring Chinook salmon and steelhead runs to the middle subbasin will use the lower Deschutes as a migration corridor and for rearing.
- Indigenous Deschutes stocks have been used for Round Butte Fish Hatchery summer steelhead and spring Chinook salmon production. These fish are released annually into the river as mitigation for lost production upstream of the hydroelectric complex.
- Indigenous Deschutes stock is used to produce hatchery spring Chinook for annual release into Warm Springs River from the Warm Springs National Fish Hatchery.
- Out-of-basin stray hatchery origin summer steelhead from upper Columbia River hatcheries have out-numbered Deschutes steelhead for more than 10 years.
- Out-of-basin hatchery origin fall and spring Chinook stray into the Deschutes River.
- It is unclear how many wild and unmarked out-of-subbasin hatchery strays also stray into the Deschutes River.
- Hatchery rainbow trout have not been released into the lower Deschutes River since 1978.
- Before the early 1990s, hatchery rainbow trout were released by the Confederated Tribes of Warm Springs into Shitike Creek and the Warm Springs River.
- The lower Deschutes has supported an important Tribal subsistence fishery for thousands of years and today supports a world class redband trout and steelhead fishery. The Sherars Falls site remains an important traditional tribal fishing site.
- The Pelton Round Butte Complex, completed in 1964 at river mile 100, is the upstream limit of anadromous fish distribution in the assessment unit.
- The Pelton Round Butte Complex has blocked the natural recruitment of river substrate and large wood since 1957 (completion of Pelton Dam).
- The lower 100 miles of the Deschutes River is an exemplary example of a river fed by significant springs and groundwater with very uniform annual flow.
- Lower Deschutes River tributaries have a more flashy flow regime resulting from intense rain-on-snow or summer convection storms.

- Many of the miscellaneous small lower Deschutes River tributaries are characterized by intermittent or seasonally low flows.
- White River annually contributes glacial silt, sediment and turbidity to the Deschutes River below RM 46.
- Upland watersheds have been degraded by livestock, forestry and agricultural practices, and invasion by western juniper and noxious exotic vegetation.
- Riparian habitat along the Deschutes River is in best condition where protected from livestock use by fencing or in areas with grazing systems designed to protect vegetative diversity.
- Watershed and stream corridor degradation has resulted in low or intermittent flow and higher peak flows in most small miscellaneous streams.
- Channel alterations, flood scouring and loss of riparian vegetation have contributed to the general lack of instream habitat complexity and pool habitat in most small tributary stream reaches.
- Some reaches in the lower Deschutes River is deficient in instream structural habitat diversity.
- Road and railroad construction and maintenance along stream corridors has created some migration barriers and resulted in channel straightening, sediment input and loss of riparian vegetation.
- Livestock grazing, agricultural and forest practices, and recreational use have degraded riparian vegetation along some stream reaches.
- Sediment from uplands, including cropland, rangeland and road system run-off, degrades stream substrate.
- Headwater stream channel scouring has reduced natural water storage and valley water tables, exacerbating low summer stream flows and water temperature extremes in small miscellaneous Deschutes tributary streams.
- Low summer stream flow and high water temperature limit redband trout and summer steelhead distribution and production in most miscellaneous small Deschutes tributary streams.
- Stream habitat restoration projects are underway on a number of stream reaches within the assessment unit.
- Agricultural irrigation return flows entering the Deschutes River and tributaries may pose water quality concerns.
- Over 99,000 acres of grassland wildlife habitat, all the grassland habitat in the AU, have been completely lost in this assessment unit since mid-1800s. Agriculture uses, shrub-steppe, and juniper woodlands have replaced these grasslands.
- 37% of historic ponderosa pine forests have been lost since mid-1800s, amounting to over 85,000 acres of loss. These forests have been replaced by other mixed conifer forests.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes required in 25 years in the Lower Westside Deschutes Assessment Unit to achieve the vision for the Deschutes River Subbasin. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Achieve and maintain a run of 4,500 to 5,500 naturally produced adult summer steelhead into assessment unit streams.
- Increase summer steelhead population life history diversity from 53% to 70% (EDT projection).
- Increase summer steelhead population productivity from 4.2 to 6.0 (EDT projection).
- Increase summer steelhead habitat capacity to produce 5,348 adult fish (EDT projection) with habitat restoration.
- Achieve and maintain an annual run of 2,600 to 2,800 adult spring chinook to the Deschutes River destined for the Lower Westside Deschutes Assessment Unit streams (EDT Projection).
- Achieve a spawning escapement of 2,200 to 2,300 adult wild spring Chinook salmon above the barrier dam at Warm Springs National Fish Hatchery.
- Achieve a spawning escapement of 400 to 500 adult wild spring Chinook salmon into Shitike Creek.
- Increase spring Chinook salmon population life history diversity from 95% to 98% (EDT projection).
- Increase spring Chinook salmon population productivity from 5.4 to 7.0 (EDT projection).
- Increase spring Chinook salmon habitat capacity by the equivalent of 702 adult fish (EDT projection).
- Achieve and maintain an annual run of 13,000 to 16,000 naturally produced adult fall Chinook salmon into the lower Deschutes River.
- Increase fall Chinook salmon population life history diversity from 53% to 60% (EDT projection).
- Increase fall Chinook salmon population productivity from 6.0 to 7.1 (EDT projection).
- Increase fall Chinook salmon habitat capacity to produce 1,549 adult fish (EDT projection).
- Maintain a population of redband trout of 1,500 to 2,500 fish per mile larger than 8 inches in length in the lower Deschutes River from Pelton Reregulating Dam to Sherars Falls.
- Maintain a population of redband trout of 750 to 1,000 fish per mile larger than 8 inches in length in the lower Deschutes River below Sherars Falls.
- Restore and maintain numbers of indigenous bull trout and Pacific Lamprey throughout their historic ranges within the assessment unit.
- 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 Lower Westside Deschutes Assessment Unit.
- Restore beaver colonies to at least 20% of historic habitat areas within 25 years.

Habitat Objectives

- Protect or restore 1,471 acres of riparian habitat along 163 miles of stream in the Lower Westside Deschutes Assessment Unit.
- Protect and restore important wildlife habitats, including backwaters, oxbow sloughs, seeps and springs, and cottonwood groves, willows, and aspen groves.
- Provide efficient fish passage to all historic fish habitat in the assessment unit.

- Increase minimum stream flows in lower Deschutes River tributaries and mainstem Deschutes.
- Restore and maintain upland vegetative conditions to improve overall watershed health.
- Restore and maintain grasslands and ponderosa pine forests (including white oak component) to benefit wildlife populations.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations in the Lower Westside Deschutes Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Lower Westside Deschutes Assessment Unit.

Overall Management Strategies for Assessment Unit

- Protect or restore 1,471 acres of riparian habitat along 163 miles of stream to meet interim habitat attribute criteria described for each assessment unit habitat complex.
- Restore focal fish species distribution and abundance to meet biological and habitat objectives.
- Increase minimum stream flows and channel habitat complexity.
- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Restore water tables under tributary stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage an increase in beaver numbers and distribution through restoration of woody vegetation.

Key Findings and Management Strategies for Individual Habitat Complexes

The following four habitat complexes for the Lower Westside Deschutes Assessment Unit contain connected or similar habitats for focal fish populations.

Lower Deschutes River – mainstem, Pelton Reregulation Dam to mouth
Warm Springs River Habitat Complex
Shitike Creek Habitat
Miscellaneous small Deschutes River Tributary Streams

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.2.1. Lower Deschutes River Mainstem

Key Findings

- Fall Chinook spawn and rear in the lower Deschutes River. Their historical range may have been similar to that seen today.
- Steelhead and resident redband trout spawn and rear throughout the lower Deschutes River. Most steelhead and resident redband trout spawn above the White River confluence.

- Resident redband are less abundant in the Deschutes below Sherars Falls than above, and most abundant from the Pelton Reregulating Dam to Maupin.
- Some spring chinook produced in westside tributaries rear in the lower Deschutes River.
- Some juvenile summer steelhead produced in eastside tributaries rear in the lower Deschutes River.
- The river margin provides important juvenile rearing habitat for salmonids in the lower Deschutes River.
- There is no evidence that wild spring Chinook spawn in either the mainstem lower Deschutes River or tributaries other than the Warm Springs River or Shitike Creek.
- The river from the Pelton Reregulating Dam (RM 100) to Sherars Falls (RM 43) provides foraging habitat for bull trout.
- The river provides rearing habitat for Pacific lamprey.
- Reestablished sockeye and spring Chinook salmon and steelhead runs to the middle subbasin will use the lower Deschutes as a migration corridor.
- The Deschutes River (RM 0 to 100) is designated as a National Wild and Scenic River and State Scenic Waterway.
- Natural recruitment of river substrate and large wood into the lower Deschutes is believed to have been low. All recruitment, however, has been blocked for over fifty years by upriver storage reservoirs.
- River temperatures and dissolved oxygen levels immediately downstream from the Pelton Round Butte Complex do not meet State water quality standards. Mitigation actions associated with hydroelectric complex relicensing will be taken to meet these water quality standards.
- Wild fire and human activities, including livestock grazing and agricultural practices, road and railroad construction and maintenance, and recreational use have contributed to the loss of riparian vegetation along the river.
- Stream turbidity and sedimentation is usually associated with high intensity rain on snow storms with frozen ground, or summer convection storms.
- Conservation practices implemented in recent years on some cropland and upland range have increased water retention and reduced upland erosion.
- Riparian restoration projects in several stream reaches have produced improved habitat conditions, including bank stabilization and channel narrowing.
- Out-of-subbasin summer steelhead have been found with IHN type 2 virus and the causative agent (spores) for whirling disease.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Maintain or increase minimum stream flow in the Deschutes River to correspond to instream water rights.
- Maintain maximum stream temperature at or below the state water quality standard.
- Maintain dissolved oxygen levels at or above water quality standards.
- Increase instream structural habitat complexity by 25%.
- Reduce channel width by 50% in degraded stream reaches.
- Increase tributary primary pool habitat by 20%

- Reduce stream substrate embeddedness between the Pelton Reregulating Dam and the White River confluence by 30%.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Restore diverse riparian vegetative function by 50%.
- Implement upland and riparian grazing systems or exclosures to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources to reduce livestock use of the river's riparian corridor.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Encourage road and railroad maintenance that protects the riparian corridor.
- Manage recreational use to protect riparian values.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and maintain minimum instream flows.
- Improve and protect water quality consistent with State water quality standards.
- Initiate collaborative conservation, restoration and enhancement projects that improve focal fish species habitat.
- Work with the Pelton Round Butte Complex operator to improve river water quality below the hydro complex.
- Work with Columbia Basin co-managers to address genetic and disease concerns from out-of-subbasin strays.

Research and Evaluation Strategies

- Continue monitoring of focal fish species population trends. Determine specific life-history requirements and habitat use for focal species such as lamprey and bull trout.
- Determine lamprey over-wintering areas.
- Continue monitoring incidence of stray anadromous fish in the lower Deschutes River.
- 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.
- Evaluate the effectiveness of riparian restoration projects.
- Monitor water quality and quantity to document changes from restoration projects.
- Evaluate habitat restoration projects with photo points and aerial photograph documentation.
- Monitor harvest of focal species to determine population trends and escapement levels.
- Monitor water quality of irrigation return flow to the assessment unit streams.
- Evaluate the incursion of exotic fish species into assessment unit streams.

3.2.2. Warm Springs River Habitat Complex

Key Findings

- The Warm Springs River system historically supported populations of all focal species, except sockeye and fall Chinook salmon.
- Most spring Chinook spawn in Beaver and Mill creeks and the upper Warm Springs River.
- Spring Chinook rearing occurs throughout the Warm Springs system. Some spring Chinook drop into the Deschutes River to over-winter and rear.
- Most summer steelhead spawn in the middle and upper Warm Springs River, lower Mill Creek and lower Beaver Creek. Rearing occurs throughout the system.
- Bull trout spawn in the upper Warm Springs River above Schoolie.
- Research is underway to determine Pacific lamprey and bull trout abundance, distribution and habitat requirements in the system.
- Severe flooding in the last 40 years eliminated some instream habitat complexity and impacted riparian vegetation.
- The lower reach of the Warm Springs River has been manipulated and confined in some areas.
- Upland watershed conditions, combined with rain on snow and summer convection storms, contribute to the flashy stream flow regime.
- The Quartz and Coyote creek channels are generally incised into highly erodible soils, which results in turbidity and sedimentation in lower Beaver Creek and the Warm Springs River during runoff periods.
- Road systems and upland management practices, including forestry and livestock grazing, contribute silt to a number of streams.
- Some stream reaches, such as Beaver Creek along Highway 26, have been confined or relocated by highway construction.
- Riparian habitat along a number of stream reaches has been degraded by livestock grazing and wild fires.
- Low stream flow and high water temperatures have resulted from the cumulative effects of loss of natural floodplain and riparian function and areas of channel scour and incision.
- Stream habitat restoration projects have been completed on several stream reaches.
- Brook trout introgression may affect long term viability of bull trout populations.
- Brook trout have displaced bull trout in Mill Cr.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flow.
- Reduce stream temperature to meet water quality criteria for salmonid rearing.
- Reduce channel width by 50%.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces per 100 meters of stream channel.
- Reduce substrate fine sediment percentage to less than 10%.
- Increase primary pool habitat by 20%.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Restore diverse riparian vegetative function by 50%.
- Proper construction and maintenance of range and forest roads can reduce sediment delivery to streams.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources to help alleviate livestock concentrations in streams and riparian corridors.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation and reduce stream sedimentation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout and summer steelhead, bull trout, Pacific lamprey and spring Chinook salmon populations.
- Initiate conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Initiate brook trout eradication efforts to increase bull trout rearing habitat.
- Re-establish bull trout in formerly occupied habitat in Mill Cr.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout, summer steelhead, bull trout and Pacific lamprey in the habitat complex.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects.
- Continue annual steelhead, bull trout and spring Chinook spawning surveys.
- Monitor population trends in bull trout and Pacific lamprey populations.
- Determine lamprey spawning distribution in the assessment unit.
- Determine affects of brook trout introgression into bull trout rearing habitat.

3.2.3. Shitike Creek Habitat Complex

Key Findings

- Shitike Creek historically supported populations of all focal species, except sockeye and fall Chinook salmon.

- Spring chinook spawn in Shitike Creek from the mouth upstream to the upper road crossing.
- Bull trout spawn primarily in upper Shitike Creek above Peter's Pasture.
- Shitike Cr. provides spawning and rearing habitat for the majority of bull trout in the lower Deschutes.
- Brook trout are present and hybridizing with bull trout.
- Summer steelhead and redband trout spawn and rear primarily in lower Shitike Creek below the upper road crossing.
- Research is underway to determine Pacific lamprey and bull trout abundance and distribution in the system.
- This watershed contains some high quality fish habitat in the mid and upper reaches. Habitat is pristine above Peter's Pasture.
- The stream has been manipulated and confined in some areas downstream from the old Warm Springs headworks.
- The old Warm Springs headworks has been modified to provide good fish passage.
- Riparian habitat has been degraded in the lower stream reach as a result of urban and industrial development, channel alterations and livestock use.
- Riparian habitat between the old Warm Springs headworks and the upper road crossing has been impacted by livestock grazing.
- Some habitat restoration work has been completed on lower Shitike Creek downstream of the community of Warm Springs in recent years.
- Occasional sewage spills from treatment lagoons at Warm Springs negatively impact stream water quality.
- The Warms Springs Tribes are supplementing Shitike Creek with adult Warm Springs Hatchery spring chinook.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Maintain pristine condition of the stream above Peter's Pasture.
- Maintain or increase stream flow.
- Reduce stream temperature to comply with current water quality standards.
- Increase primary pool habitat by 20% in appropriate stream channel types.
- Restore diverse riparian vegetative corridors to provide 80% stream shading and increase stream bank stability to 80%.
- Reduce channel width-to-depth ratio to less than 10.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large wood per 100 meters of stream channel or other comparable structure.
- Reduce substrate fine sediment percentage to less than 10%.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Proper construction and maintenance of roads can reduce sediment delivery to streams.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.

- Develop upland livestock water sources to help alleviate livestock concentrations in the stream and riparian corridor.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution and population abundance of redband trout, summer steelhead, bull trout, spring Chinook salmon and Pacific lamprey populations.
- Initiate conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Work with the forest and range managers to protect and maintain a healthy riparian stream corridor.
- Initiate brook trout eradication efforts to eliminate interbreeding and increase bull trout rearing habitat.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of focal fish species in the habitat complex.
- Determine the affects of brook trout introgression into bull trout rearing habitat.
- Evaluate the success of adult spring chinook supplementation on increasing natural production.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects.
- Continue annual bull trout, steelhead and spring Chinook spawning surveys.
- Monitor population trends in bull trout and Pacific lamprey populations.
- Determine lamprey spawning distribution in this stream.

3.2.4. Miscellaneous Small Deschutes Tributaries (including lower White River below White River Falls)

Key Findings

- Summer steelhead populations from the small tributaries contribute to life history diversity in the Deschutes system.
- Resident redband are distributed throughout the systems where suitable habitat conditions exist.

- Historically juveniles in these streams may have been able to drop down to rearing habitat in the Deschutes River when tributary habitat conditions became unsuitable.
- Lower White River is designated as a National Wild and Scenic River.
- These systems are generally gravel-rich and provide good spawning habitat for steelhead in areas where flow is adequate for migration and spawning.
- Stream flows generally decrease rapidly and become intermittent in early summer causing fish to become isolated in remaining exposed pools where they are susceptible to predation.
- Changes in land management activities and their affect on overall watershed health have contributed to the flashy stream flow regime.
- Riparian habitat in some reaches is degraded because of channel alteration and livestock grazing.
- Road and railroad crossings hinder upstream fish passage in some streams.
- Low stream flow and high water temperatures result from the cumulative effects of poor watershed health, loss of properly functioning floodplains and riparian function and severe channel scour or incision.
- Loss of riparian stream corridors and severe flooding in the last 40 years has eliminated most instream habitat complexity.
- Fish passage is frequently blocked by intermittent stream flow and high channel width-to-depth ratio.
- Stream sediment loading has originated from cropland and rangeland runoff, and channel erosion.
- Severe stream turbidity and sedimentation is usually associated with high intensity rain on snow storms with frozen ground, or summer convection storms.
- Areas of historic interior grassland wildlife habitat have been lost in some of the stream watersheds.
- Riparian habitat restoration, changes in livestock management and other efforts have improved riparian condition along some stream reaches.
- Conservation practices implemented on some cropland and upland rangeland in recent years have increased water retention and reduced upland erosion by establishing permanent grasslands and minimizing soil tillage.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and/or maintain a continuous stream flow at stream confluences with the Deschutes River.
- Reduce stream temperature to meet State and/or Tribal water quality criteria for salmonid rearing.
- Restore diverse riparian vegetative corridors to provide 80% stream shading and increase stream bank stability to 80%.
- Reduce channel width-to-depth ratio to less than 12.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large wood, or comparable structure, per 100 meters of stream channel.
- Reduce substrate fine sediment percentage to less than 10%.
- Increase primary pool habitat by 20% in reaches with suitable channel types.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas such as aspen groves and cottonwood groves to reduce big game concentrations in riparian corridors.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Manage riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.
- Restore interior grassland habitat in historic grassland areas in upper watersheds.

Operational and Policy Strategies

- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, springs and seeps, and upland habitats to benefit fish and wildlife through restored natural hydrology.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Monitor stream water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout and summer steelhead in these streams.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects.
- Continue or expand annual steelhead spawning surveys.
- Monitor straying of out-of-subbasin steelhead into lower tributary streams.
- Monitor beaver population abundance and distribution.
- Determine if lamprey are present in these tributaries.

3.3. Lower Eastside Deschutes Assessment Unit

Lower Eastside Deschutes Assessment Unit includes four primary stream systems in the lower eastside Deschutes River watershed: Buck Hollow, Bakeoven, Trout and Willow creeks.

Key Findings

- Historically spawning summer steelhead and redband trout were distributed throughout the Buck Hollow, Bakeoven, Trout and Willow creeks systems.
- The Pelton Round Butte Complex and water withdrawals led to the extirpation of Willow Creek steelhead.
- The stream systems may have historically supported bull trout foraging and Pacific lamprey production.
- Current spawning distribution has been reduced by artificial barriers, habitat degradation and reduced stream flow.
- Steelhead spawners in these streams developed the genetic characteristics to survive in the sometimes hostile conditions that occur in this semi-arid environment. Currently, the population has a unique spawning timing and may leave the tributaries to rear in the mainstem when habitat conditions decline.
- The number of out-of-basin stray hatchery origin steelhead spawning with indigenous steelhead in assessment unit streams has increased significantly in the last twenty years.
- Genetic integression could alter the genetic characteristics that now allow the native steelhead to survive. If it alters spawning timing or juvenile migration timing, this could result in substantial mortality.
- The causative agent (spores) for whirling disease have been found in stray fish in the subbasin.
- Hatchery steelhead and rainbow trout have not been released into assessment unit waters.
- Uplands in the watershed are degraded with reduced ability to collect and store runoff and maintain soil stability.
- Historically periodic fires were an important component in maintaining vegetative species diversity, watershed health and native grasslands.
- Several major floods in the last forty years have negatively affected stream channels, riparian vegetation and stream floodplains.
- Watershed and stream corridor degradation has resulted in an altered flow regime with higher peak flows and lower low or intermittent flows in many stream reaches.
- Channel alterations, flood scouring and loss of riparian vegetation have contributed to the general lack of instream habitat complexity and pool habitat in most stream reaches.
- Road construction and location in and along stream corridors has resulted in channel straightening, sediment input and loss of riparian vegetation.
- Livestock grazing, agricultural and forest practices have removed riparian vegetation along some stream reaches.
- Sediment from uplands, including cropland and road system run-off, degrades tributary stream substrate.

- Headwater stream channel incision has reduced natural water storage and valley water tables, exacerbating low summer stream flows and water temperature extremes.
- Low summer stream flow and high water temperature limit redband trout and summer steelhead distribution, connectivity and production in assessment unit streams.
- Stream irrigation diversions and pumping have contributed to extremely low or intermittent flow for much of the year in Trout Creek and Willow Creek systems.
- There is one active water right on Buck Hollow Creek and no consumptive water rights on Bakeoven Creek.
- Stream channel alterations, head cutting and road crossings have blocked fish passage.
- Beaver habitat has been degraded by loss of riparian vegetation, reduced stream flow, loss of riparian vegetation, and loss of oxbow sloughs and backwaters in lower gradient stream reaches.
- A large contiguous area of approximately 370,000 acres of interior grassland wildlife habitat that existed in the Upper Bakeoven, Buck Hollow, and Antelope creeks watersheds historically has been lost to encroachment by other habitats and land uses.
- Stream habitat restoration projects are underway on all four stream systems.
- Screening has been installed to protect fish at most water diversions and pump intakes in the Trout Creek system.
- Fish passage facilities or infiltration galleries have been installed at most water intake sites to facilitate fish passage in the Trout Creek system.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes in the Eastside Assessment Unit needed to achieve the vision for the Deschutes River Subbasin. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Achieve and maintain a long-term average annual run of 2,400 to 2,900 Deschutes natural origin adult summer steelhead (EDT projection) destined for assessment unit streams in 25 years, including the following distribution of fish: Buck Hollow Creek – 800 to 900 adult steelhead, Bakeoven Creek – 600 to 800 adult steelhead and Trout Creek – 1,000 to 1,200 adult steelhead (EDT projections).
- Maintain the life history diversity of the wild redband trout in the Willow Creek system.
- Increase summer steelhead population life history diversity from 18% to +50% (EDT projection).
- Increase summer steelhead population productivity from 1.2 to 2.3 or more (EDT projection).
- Increase the summer steelhead habitat capacity by 425 or more adult fish.
- Provide efficient fish passage to all historic fish habitat in the assessment unit and provide connectivity between spawning and rearing habitats in the tributaries and mainstem Deschutes River.

Habitat Objectives

- Provide suitable habitat conditions for adult focal fish species spawning, holding and movement, and juvenile summer steelhead life history stages and migratory patterns.
- Provide suitable foraging habitat for sub adult and adult bull trout in the assessment unit.
- Provide suitable habitat conditions for adult and juvenile life history stages and migratory patterns to maintain stable or increasing trends in abundance and adaptiveness of redband trout and Pacific lamprey in Buck Hollow, Bakeoven, and Trout creek systems.
- Increase minimum stream flows by 25%.
- Restore water tables under former wet meadows and stream floodplains.
- Restore and maintain upland vegetative conditions to improve overall watershed health to increase water infiltration, retention and permeability rates, and soil stability.
- Increase riparian function by 50%.
- Maintain existing riparian habitat vegetation and structure and restore degraded riparian habitat to produce suitable beaver habitat in 20% of the stream habitat that was historically inhabited by beaver. Restore 20% of oxbow sloughs and backwaters within lower gradient stream reaches.
- Convert and/or restore 10% of invasive and nonnative upland vegetation to native perennial grasslands to provide wildlife habitat in the upper Bakeoven, Buck Hollow and Antelope creek watershed.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Lower Eastside Assessment Unit by 2030.

Overall Management Strategies

- Protect and restore fish and wildlife habitat, beginning in the headwater areas and progressing downstream to restore fish distribution and abundance to meet biological and habitat objectives.
- Prioritize and plan future habitat restoration to protect or restore habitat for core populations of summer steelhead and/or redband trout populations and expand their range.
- Increase minimum stream flows and channel habitat complexity, and provide fish passage at all artificial barriers to support production of summer steelhead and/or redband trout populations during all life stages and provide connectivity to areas where good riparian and instream habitat currently or historically existed.
- Improve upland management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.

- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation, oxbow sloughs, and backwaters.
- Restore natural permanent grasslands, beginning with areas adjacent to streams in the upper watersheds as the highest priority.
- Work with Columbia Basin co-managers to address genetic and disease concerns from out-of-subbasin steelhead hatchery strays.
- Conduct a genetic study on Deschutes river summer steelhead to examine effects of out-of-subbasin strays.
- Conduct an aggressive monitoring program to determine whether and/or where out-of-subbasin steelhead are spawning with native steelhead. Develop control measures, such as installation of weirs and distinctive marking of hatchery fish, to protect the native stock.
- Work with landowners and land managers to explore the use fire as a tool to restore upland watershed health and native grasslands.

Management Strategies for Habitat Complexes

The following four habitat complexes identified for the Lower Eastside Deschutes Assessment Unit coincide with the primary stream systems.

Buck Hollow Creek Habitat Complex (including Finnegan and Thorn Hollow creeks)
Bakeoven Creek Habitat Complex (including Deep and Cottonwood creeks)
Trout Creek Habitat Complex (including Antelope and Ward creeks)
Willow Creek Habitat Complex

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.3.1. Buck Hollow Creek Habitat Complex

Key Findings

- Redband trout exist throughout the system. During periods of low stream flow, they occupy areas with suitable summer habitat.
- Adult steelhead spawn throughout the system in areas where access and flows are suitable.
- Juvenile steelhead rear throughout the system where suitable summer habitat exist.
- Some juvenile salmonids migrate to rearing habitat in the Deschutes River before stream flow diminishes and water temperatures rise.
- Loss of riparian stream corridors and severe flooding in the last 40 years eliminated most instream habitat complexity.
- Upland watershed conditions contribute to the flashy stream flow regime, which accentuated by the invasion of grassland areas by juniper and shrub habitats, conversion of grasslands to agricultural uses, and loss of near-stream vegetation buffer zones.
- Some riparian areas are degraded because of channel alteration and livestock grazing.

- Low stream flow and high water temperatures result from the cumulative effects of generally rapid runoff from upland dry land fields and rangeland, loss of natural floodplain and riparian function and severe channel scour and incision.
- Fish passage is frequently blocked by intermittent stream flow and high channel width-to-depth ratio, which typically approaches 30.
- Stream sediment loading has originated from soil disturbance by livestock, cropland runoff, and from road drainage on uplands in assessment unit.
- Severe stream turbidity and sedimentation is usually associated with high intensity rain-on-snow events with frozen ground, or summer convection storms.
- Approximately 120,000 acres of interior grassland wildlife habitat have been lost in the upper stream watershed since historic times.
- Conservation practices implemented on some cropland and upland rangelands in recent years have increased water retention and reduce upland erosion by establishing permanent grasslands and minimizing soil tillage.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Establish perennial flow and increase stream flow to a minimum 5 cfs at the stream's confluence with the Deschutes River as an interim step toward achieving the instream water right flow.
- Meet state temperature standards for salmonid spawning and rearing.
- Reduce channel width-to-depth ratio to less than 12.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large wood, or comparable structure, per 100 meters of stream channel.
- Reduce substrate embeddedness to less than 10%.
- Increase primary pool habitat by 20% in reaches with suitable channel types.
- Restore sinuosity to create additional oxbow sloughs, backwaters and floodplain connectivity.
- Provide protective fish screen at the only irrigation water intake.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct, improve and/or maintain farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas such as aspen groves and cottonwood groves to reduce big game concentrations in riparian corridors.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Construct upland water and sediment control basins to retard peak runoff and stream sedimentation.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.

- Restore diverse riparian vegetative corridors to increase riparian function by 50%.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies

- Work with the one water right holder to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from the stream.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, oxbows sloughs and backwaters, springs and seeps, and upland habitats to benefit wildlife habitat, especially beaver habitat, and fisheries habitat through restored natural hydrology.
- Work with Columbia Basin co-managers to address genetic and disease concerns associated with out-of-subbasin hatchery strays.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Evaluate the effectiveness of water and sediment catch basins and their affect on Buck Hollow Creek flow and water quality.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout and summer steelhead in the habitat complex.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects in selected areas.
- Continue annual steelhead spawning surveys.
- Evaluate possible causes and impacts of out-of-subbasin steelhead strays in drainage and determine instream evaluation methods for assessing stray rates.
- Monitor beaver population abundance and distribution.

3.3.2. Bakeoven Creek Habitat Complex

Key Findings

- Redband trout are distributed throughout the system. During periods of low streamflow, they are found in areas with suitable habitat.
- Adult steelhead spawn throughout the system in areas where flows are suitable.
- Juvenile steelhead rear throughout the system in areas with suitable summer habitat.
- Some juveniles likely migrate to rearing habitat in the Deschutes River before flows diminish and water temperatures rise.

- Loss of riparian stream corridors, channel alterations and severe flooding in the last 40 years eliminated most instream habitat complexity.
- Upland watershed conditions contribute to the flashy stream flow regime, which has been accentuated by invasion of grassland areas by juniper and shrub habitats, conversion of grasslands to agricultural uses, and loss of near-stream vegetation buffer zones.
- Stream sediment loading has originated from range and cropland in the upland portions of the assessment unit.
- No surface water is removed from the Bakeoven Creek system for irrigation or other purposes.
- Stream turbidity and sedimentation is usually associated with high intensity rain-on-snow events with frozen ground, or summer convection storms.
- Riparian habitat in some reaches is impacted by livestock grazing.
- Low stream flow and high water temperatures have resulted from the cumulative effects of rapid runoff from upland dry land fields, rangelands, loss of natural floodplain and riparian function, and severe channel scour and/or incision.
- Fish passage is frequently blocked by intermittent stream flow and high channel width to depth ratios.
- Approximately 100,000 acres of former interior grassland wildlife habitat in the upper stream watershed have been lost.
- Conservation practices implemented on some cropland and upland rangelands in recent years have increased water retention and reduced upland erosion.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Establish perennial flow and increase stream flow to a minimum 5 cfs at the stream's confluence with the Deschutes River as an interim flow until the instream water right flow is achieved.
- Meet State water temperature criteria for salmonid spawning and rearing.
- Restore natural upland vegetation, such as permanent grasslands.
- Reduce channel width-to-depth ratio to less than 12.
- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large wood or comparable natural structure per 100 meters of stream channel.
- Reduce substrate embeddedness to less than 10%.
- Increase primary pool habitat by 20% in reaches with suitable habitat types.
- Restore sinuosity to create additional oxbow sloughs, scour pools, backwaters and floodplain connectivity.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct, improve and/or maintain farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas such as aspen groves and cottonwood groves to reduce big game concentrations in riparian corridors.

- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Construct upland water and sediment control basins to retard peak runoff and stream sedimentation.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore diverse riparian vegetative corridors and near-stream aspen and cottonwood groves to increase riparian function by 50%.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout and summer steelhead populations.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Work with Columbia Basin co-managers to address genetic and disease concerns from out-of-subbasin steelhead hatchery strays.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of water and sediment catch basins and their affect on Bakeoven Creek flow and water quality.
- Evaluate the effectiveness of upland watershed treatments, including establishment of permanent grasslands, to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout and summer steelhead in the habitat complex.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects in selected areas.
- Continue annual steelhead spawning surveys.
- Monitor beaver population abundance and distribution.
- Evaluate causes and impacts of out-of-subbasin steelhead strays in drainage, and determine instream evaluation methods for assessing instream stray rates.

3.3.3. Trout Creek Habitat Complex

Key Findings

- The Trout Creek watershed historically supported summer steelhead, Pacific lamprey and resident redband trout.
- Today the system supports remnant redband trout and summer steelhead populations. Most remnant production occurs in upper areas of the watershed where flows and habitat conditions are suitable.
- Steelhead and resident redband trout in the system are particularly adapted to eastside warm water conditions.
- Key fish production areas impacted by reduced flows are the lower portions of Trout Creek, Trout Creek within the Ashwood Valley and Antelope Creek.
- Of the studied stream reaches, upper Trout stream reaches above Ashwood Valley (above Amity Creek confluence) have the best habitat quality and the highest numbers of steelhead and redband trout production and rearing.
- Out-of-subbasin hatchery steelhead have been observed spawning with native fish.
- The watershed retains some high quality fish habitat, but historical and current management impacts have adversely altered watershed processes and habitats.
- Reduced summertime stream flows, “flashy peak flows”, and areas where riparian vegetation and/or upland vegetation are degraded, have reduced the quality and quantity of fish habitat in the Trout Creek Watershed.
- Key factors contributing to seasonally elevated water temperatures include modifications in riparian conditions from land management, low flow conditions, and widening of channels.
- Low summer stream flow conditions, especially in Trout and Antelope Creeks, affect habitat quality by increasing temperatures, reducing pool habitats, reducing or eliminating floodplain connectivity, and limiting fish movement.
- The Trout Creek system is over-appropriated for irrigation water withdrawal.
- The system has lost the ability to “absorb” high flows because of changes in upland plant communities, loss of floodplain connectivity (through channel straightening, and berms) and wetlands, and reduction in channel complexity.
- The natural flow regime has been modified through loss of in channel structure, increased stream gradient, loss of sinuosity, reductions in wetland habitats, increased distribution of western juniper and exotic plants, and altered runoff timing from roads and other upland management practices. This has resulted in higher peak flows and lower summer flows than existed historically.
- The entire length of Trout Creek and a number of tributaries (Auger, Big Log, Bull, Cartwright, Dick, Dutchman and Potlid creeks) are listed as water quality limited because they exceed State criteria for temperature and sedimentation.
- High water temperatures limit fish production throughout the basin.
- Flood control berms along Trout Creek and channelization of other stream reaches have affected areas that once had very productive fish habitat.
- Channel relocation and storage reservoirs have eliminated steelhead access to the Hay Creek system.
- Fish passage barriers affect significant portions of the Mud Springs Creek, Antelope, and Hay Creek systems. Seasonal fish passage barriers associated with intermittent stream flow and irrigation diversions (push up berms for juveniles) affect the quality and quantity of fish habitat.

- The road network, especially dirt or gravel roads, can generate and deliver excess sediment to the streams. The highest density of gravel roads with the potential to deliver sediment is on forested land in the Upper Trout Creek Subbasin.
- Stream restoration projects have increased instream structure and stream bank stability in a number of stream reaches.
- Riparian fencing projects and management have significantly improved riparian conditions in key areas (for example, the upper watershed).
- An estimated 100,000 acres of interior grassland wildlife habitat once existed in the Antelope Creek and Ward Creek watersheds.
- Forest habitat conditions in the watershed have been altered through intensive timber harvest and associated management activities.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large woody debris or comparable natural structure per 100 meters of stream channel.
- Reduce substrate embeddedness to less than 10%.
- Restore sinuosity to create additional oxbow sloughs, backwaters and floodplain connectivity.
- Establish perennial flow and increase stream flow to a minimum 5 cfs above the stream's confluence with Mud Springs Creek as interim flow until instream water right is met.
- Meet State water temperature criteria for salmonid spawning and rearing.
- Reduce channel width-to-depth ratio to less than 12.
- Increase primary pool habitat by 20% in reaches with suitable channel types.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct, improve and/or maintain farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas such as aspen groves and cottonwood groves to reduce big game concentrations in riparian corridors.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Restore diverse riparian vegetative corridors to increase riparian function by 50%.
- Restore natural upland vegetation, such as permanent grasslands.
- Construct upland water and sediment control basins in ephemeral drainages to retard peak runoff and stream sedimentation.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.

- Protect riparian and floodplain areas to encourage development of habitat complexity and native plant species diversity, and restoration of beaver populations.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout, summer steelhead and pacific lamprey populations.
- Work with Columbia Basin co-managers to address genetic and disease concerns from put-of-subbasin steelhead hatchery strays.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish and wildlife habitat and water quality.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and summer water quantity and quality.
- Work with the Ochoco National Forest and private landowners to protect and maintain healthy riparian stream corridors.
- Restore interior grasslands, to improve natural hydrologic regime and wildlife habitat, with the highest priority areas adjacent to streams.

Research and Evaluation Strategies

- Identify key rearing areas for steelhead and redband populations.
- Determine juvenile migration patterns.
- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Identify areas where water conservation could have a significant impact on flows.
- Evaluate the effectiveness of water and sediment catch basins and their affect on Trout Creek flow and water quality.
- Evaluate the effectiveness of upland watershed treatments to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout and summer steelhead in the habitat complex.
- Evaluate possible causes and impacts of out-of-subbasin steelhead strays in drainage and determine instream evaluation methods for assessing stray rates.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects in selected areas.
- Continue annual steelhead spawning surveys and downstream migrant monitoring.
- Monitor beaver population abundance and distribution.

3.3.4. Willow Creek Habitat Complex

Key Findings

- Upland watershed conditions contribute to the flashy stream flow regime, which has been accentuated by invasion of grassland areas by juniper and shrub habitats, conversion of grasslands to agricultural uses, and loss of near-stream vegetation buffer zones.
- All stream flow in the upper reaches is diverted at several locations for irrigation.
- Stream corridor shading averages less than 20%.
- The State water quality criterion for water temperature is exceeded during summer months.
- The stream has been channelized through the City of Madras.
- Sixty percent of the cropland (15,000 acres) is classified as Highly Erodible Land.
- Public lands on the Crooked River National Grasslands are used for livestock grazing and recreation.
- Sections of the channel above Morrow Reservoir have been altered or incised.
- A series of springs in the lower section of the reach from Madras to the mouth at Lake Simtustus provide a substantial base stream flow.
- Stream sediment loading has originated from highly erodible soils, unstable stream banks, agricultural and forest management practices and drainage from the watershed road system. Irrigation tailwater occasionally discharges over the canyon rim and erodes sediment into lower Willow Creek.
- Fish passage is blocked by intermittent stream flows, as well as the Morrow Reservoir Dam and road culverts on Higgins Creek and Willow Creek near the Higgins Creek confluence.
- Riparian habitat has been degraded by flooding, channel scour, channel alteration and livestock grazing.
- A number of riparian and stream channel restoration projects have been implemented from the downstream boundary of the Crooked River National Grasslands to the headwaters.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain a perennial flow with an interim minimum flow of 1 cfs above RM 4.5 until the instream water right is met.
- Meet state temperature standards for salmonid spawning and rearing.
- Reduce channel width to depth ratio to less than 10.
- Reduce channel incision by 50%
- Increase instream habitat complexity by 25%.
- Increase primary pool habitat by 20% in reaches with suitable channel types.
- Reduce substrate fine sediment by 25%.
- Reduce stream substrate embeddedness by 25%.
- Screen all water intakes.
- Provide fish passage at all artificial barriers.

Sub-Watershed Strategies

- Increase riparian function by 50%, including restoration of diverse riparian vegetative corridors.

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct and/or maintain forest, range and farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources, and restoration of grasslands and early-succession shrub lands and cover areas.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources, while protecting natural springs and associated wetlands, to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Increase the quality and quantity of redband trout spawning and rearing habitat and wildlife habitat by restoring stream meander, oxbow sloughs, and backwaters, and restoring beaver populations.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Work with water users to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from the streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, springs and seeps, and upland habitats to benefit wildlife habitat, especially beaver habitat, and fisheries habitat through restored natural hydrology.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout in the habitat complex.
- Evaluate habitat restoration projects with photo points and aerial photograph documentation.
- Monitor beaver population abundance and distribution.
- Determine instream flow needs to meet biological objectives.

3.4. White River Assessment Unit

The White River Assessment unit includes the White River watershed above White River Falls.

Key Findings

- White River Falls (RM 2) isolates the White River system fish population.
- White River contains genetically unique redband trout stocks that have been isolated above White River Falls for thousands of years. These stocks are more similar to isolated populations of redband trout in the Fort Rock Basin than they are to lower Deschutes River redband trout.
- Pure indigenous redband populations are found in several headwater areas.
- Core redband populations are found in Tygh, Jordan and Little Badger creeks above waterfalls and in upper Threemile and Boulder creeks.
- Retention of natural fish passage barriers will help protect genetically unique populations of native redband trout from genetic intergression.
- Hatchery rainbow trout and brook trout have been stocked into waters in the White River drainage. Stocking of rainbow trout is now restricted to lakes and reservoirs. Self-perpetuating brook trout populations are found in several headwater streams.
- There is evidence that genetic intergression between indigenous redband trout and hatchery rainbow trout populations may have occurred in the lower White River, lower Tygh, Jordan and Rock creeks.
- Key fish production areas are found in tributary streams with no glacial influence.
- Loss of riparian vegetation for feeding, loss of oxbow sloughs for habitat, and loss of permanent water for habitat have resulted in low beaver populations.
- Degradation and loss of ungulate winter ranges has resulted in lower mule deer populations.
- Low summer stream flows and high water temperatures limit redband trout production in approximately 40 miles of lower Tygh, Badger, Jordan, Threemile, Rock, Gate, Boulder and Forest creeks.
- Irrigation storage impoundments and/or diversions for irrigation or reservoir storage result in extremely low or intermittent flow for much of the year in lower Gate, Rock and Threemile creeks.
- Irrigation diversions and storage reservoir dams have blocked fish passage and screening to protect fish is generally lacking.
- Channel alterations have reduced instream habitat complexity in lower river tributaries.
- Road culverts have impeded the movement of large wood in streams.
- Livestock grazing, agricultural practices, forest fire and channel manipulation have removed riparian vegetation along some stream reaches.
- The Rocky Forest Fire appreciably impacted the watersheds of upper Gate, Rock and Threemile creeks.
- Seasonally high water turbidity and high silt concentrations in the White River substrate from natural glacial action on Mount Hood limit fish production.
- Sediment from uplands, including cropland and road system run-off degrades tributary stream substrate.
- Sediment from cropland has been significantly reduced by programs such as the Conservation Reserve Program.

- Over 56,000 acres (57%) of the historic ponderosa pine forests have been lost, as well as 26,000 acres (36%) of historic shrub steppe habitat.
- White oak groves and cottonwood groves have been lost since historic times.
- Ungulate winter ranges are being impacted by other uses, reducing the capacity of these ranges to winter deer and elk and other wild ungulates.
- Increased water storage could be gained through promoting good forest management and controlling runoff.
- A thinner forest canopy and less dense understory existed historically. The current forest condition has a much higher danger of catastrophic fire.
- Water may be available in White River tributaries to meet out-of-stream and instream water rights. Currently water use and diversions are monitored infrequently.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes in the White River Assessment Unit needed to achieve the vision for the Deschutes River Subbasin in the next 25 years. These assessment unit objectives are consistent with the vision, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Maintain stable or increasing trends in abundance and adaptiveness of redband trout and mountain whitefish in White River and tributaries above White River Falls.
- Maintain the genetic diversity of the wild indigenous redband trout in the White River watershed.
- Conserve redband trout genetic diversity and provide opportunity for genetic exchange within the watershed above White River Falls.
- Maintain beaver populations in suitable habitat in the mainstem and lower-to-middle tributaries.
- Maintain wild ungulate populations by protecting the quality and acreage of existing winter range.

Habitat Objectives

- Protect, restore and maintain the quality and quantity of aquatic and riparian habitat along ninety-nine miles of stream to meet or exceed habitat attribute objectives discussed in the following habitat complex discussions by 2030.
- Increase minimum stream flows 25% by 2030.
- Protect, restore and maintain suitable habitat conditions for all redband trout life history stages and migratory patterns.
- Restore and maintain upland vegetative conditions to improve overall watershed health, especially Oregon white oak groves, ponderosa pine forests, and shrub steppe that have been lost since historic times.
- Restore and maintain permanent water to provide beaver habitat in those historic areas where this habitat existed.
- Protect ungulate winter ranges from development and other uses and restore the quality of winter ranges.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the White River Assessment Unit by 2030.

Overall Management Strategies

- Protect and restore habitat within stronghold areas for redband trout, and work outward from these areas to expand fish distribution and abundance to meet biological and habitat objectives.
- Screening and fish passage is a high priority for fish restoration in the drainage.
- Reconnect redband trout populations across the assessment unit.
- Conserve genetic diversity and restore historic opportunity for genetic exchange.
- Prioritize and plan future habitat restoration projects to protect or restore habitat for redband trout populations and expand their range.
- Increase minimum stream flows, channel habitat complexity, and provide fish passage at all artificial barriers to support production of residual redband trout populations during all life stages.
- Provide connectivity for fish to areas where good riparian habitat currently or historically existed.
- Improve upland watershed health through proper management, including protection of ponderosa pine forest, white oak groves, and shrub steppe habitat.
- Restore ponderosa pine forests, white oak woodlands and native understory in historic areas, to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity, including large wood, gravel and sand bars, oxbow sloughs, and vegetative species diversity.
- Riparian stream corridors should include species that will eventually contribute large wood to the stream channel (i.e. conifer and/or cottonwood trees), to help meet biological objectives.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage an increase in beaver abundance and distribution through restoration of woody vegetation and maintenance of perennial stream flow.
- Analyze water availability in the White River tributaries to determine water use and potential for meeting out-of-stream and instream water rights.

Management Strategies for Habitat Complexes

The following five habitat complexes for the White River Assessment Unit contain connected or similar habitats for focal fish populations.

Tygh Creek Habitat Complex – including Badger and Jordan creeks
Boulder Creek Habitat Complex – including Forest Creek
Clear Creek Habitat Complex – including Frog Creek
Threemile, Gate and Rock Creek Habitat Complex
White River Habitat Complex – including small, upper basin tributaries

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.4.1. Tygh Creek Habitat Complex

Key Findings

- Past channel alterations eliminated most instream habitat complexity in the lower stream reaches.
- Hatchery rainbow trout in Badger Lake need to be separated from native redband trout populations downstream.
- High fuel loads in the wilderness area are causing increased risk of catastrophic fire.
- Ditch failures, including vandalism, have caused substantial sediment input to the stream system.
- Road culverts impede large wood movement in streams.
- Riparian habitat in some reaches is degraded due to channel alteration, agricultural practices and livestock grazing.
- Low stream flow and high water temperatures result from the cumulative effect of multiple irrigation diversions and degraded riparian vegetative stream corridors.
- Fish passage is blocked permanently at several diversion structures or seasonally during the irrigation season at other sites.
- Most diversions or water intakes are unscreened.
- Stream sediment loading originates from uplands and, in particular, cropland in the northern fringe of this watershed.
- Water in excess of instream water rights may be available in the winter for off-channel storage and later use.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25% by 2030.
- Increase large woody debris or comparable natural instream structure by 25% by 2030.
- Reduce maximum stream water temperatures by 25% by 2030.
- Reduce fine sediment in the stream substrate by 25% by 2030.
- Increase primary pool habitat by 20% in reaches with suitable channel types by 2030.
- Reduce stream channel width.
- Restore stream meander and oxbow sloughs.
- Provide fish passage at artificial barriers on natural fish bearing streams, excluding Badger Lake by 2030.
- Provide protective fish screens at water diversions on natural fish bearing streams and at Badger Lake Dam by 2030.

Sub-Watershed Strategies

- Increase riparian function by 50% by restoring and maintaining streambank stability and integrity by restoring vegetation such as willow and cottonwood.

- Improve upland watershed health to increase water infiltration, retention and permeability rates and soil stability.
- Restore ponderosa pine forests, shrub steppe prairies, and white oak and cottonwood groves.
- Reduce the risk of catastrophic fire.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity, such as cottonwood, willow and dead and downed wood.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage an increase in abundance and distribution of beaver.
- Promote off-stream water storage for wildlife habitat and water conservation purposes where water is available beyond existing water rights.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality and quantity.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Monitor water quality to document changes from restoration projects.
- Determine life history characteristics of redband trout in the habitat complex.
- Investigate the need and/or feasibility of screening the outlet at Badger Lake Dam.

3.4.2. Boulder Creek Habitat Complex

Key Findings

- Irrigation water withdrawal results in very low stream flow in lower Boulder and Forest creeks during irrigation season.
- Fish passage conditions at a natural cascade near the mouth of Boulder Creek would improve with increased stream flow.
- Fish passage issues on Forest Creek associated with debris jams would be improved with increased flow.
- Fish passage is blocked at diversion structures and fish screening is lacking on most diversions. A fish screen is being installed in Lost and Boulder Ditch in 2004.
- Stream channels receive fine sediment from upland management activities and road run-off.
- There are multiple miles of low gradient ditch with major water loss in Lost and Boulder irrigation system.
- High fuel loads on forestlands are causing increased risk of catastrophic fire.
- Increased water storage could be gained by promoting good forest management to restore watershed storage and control runoff.

- Boulder Creek joins White River in the Wild and Scenic River section.
- Water may be available over and above existing water rights for off-channel storage and later use.

Management Strategies Specific to Habitat Complex

In Channel Strategies
- Increase minimum stream flows by 25% by 2030, with an ultimate objective of meeting the instream water right flow.
- Reduce fine sediments by 25% by 2030.
- Provide fish passage at artificial barriers on natural fish bearing streams by 2030.
- Provide protective fish screens at water diversions on natural fish bearing streams by 2030.
- Protect and maintain instream habitat structure and complexity.

Sub-Watershed Strategies
- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Reduce the risk of catastrophic fire.
- Protect and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Reduce stream sediment delivery from upland sources.
- Promote off-channel water storage, particularly in winter if there is unallocated water, to increase wildlife habitat and summer stream flows.

Operational and Policy Strategies
- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Work with Mount Hood National Forest to protect and maintain upland watershed health.

Research and Evaluation Strategies
- Identify areas where water conservation could have a significant impact on flows.
- Determine life history characteristics of redband trout in the habitat complex.
- Monitor stream flow and water quality to assess affects of restoration projects.

3.4.3. Clear Creek Habitat Complex

Key Findings
- Clear and Frog creeks have seasonally low stream flow below irrigation diversion structures. There is some flow recovery in the lowest stream reaches.
- Water is diverted from Frog and Clear Creeks year around.
- Clear Creek immediately downstream from Wasco Dam has low winter flow associated with upstream reservoir water storage.

- Warm surface water withdrawn from Clear Lake in mid to late summer elevates stream temperatures between the dam and the Juniper Flat Irrigation District diversion.
- There is significant water loss in Juniper Flat Ditch.
- Elevated stream sediment levels are associated with the altered stream flow regime.
- Road culverts impede large wood movement in streams.
- Irrigation diversions are fish passage barriers and have no protective screening.
- There is no fish passage at Wasco Dam.
- A portion of the tail water from Juniper Flat ditch is diverted to Wapinitia Creek, which flows into the Deschutes River.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25% by 2030, with an ultimate objective of meeting the instream water right flow.
- Reduce fine sediment by 25% by 2030.
- Reduce maximum stream temperatures by 25% by 2030.
- Increase primary pool habitat by 20% in reaches with suitable channel types by 2030.
- Increase large wood by 25% by 2030.
- Provide fish passage at artificial barriers on natural fish bearing streams, except Wasco Dam by 2030.
- Provide protective fish screens at water diversions on natural fish bearing streams, including Wasco Dam by 2030.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Reduce the risk of catastrophic fire.
- Protect and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Reduce stream sediment delivery from road systems, unstable stream banks, and recreational use and forest practices.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Work with the Mount Hood National Forest and others to protect and maintain healthy riparian stream corridors.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Determine life history characteristics of redband trout in the habitat complex.

- Evaluate the effects of the self-perpetuating brook trout populations on the indigenous redband trout populations.
- Investigate the need and/or feasibility of screening the outlet at Clear Lake Dam.

3.4.4. Threemile, Rock and Gate Creek Habitat Complex

Key Findings

- Water withdrawn from Threemile, Rock and Gate creeks for irrigation and water storage in Rock Creek and Pine Hollow reservoirs results in low or intermittent stream flow for much of the year downstream from the diversion sites and reservoirs.
- Water diversions are generally unscreened and there is no upstream fish passage.
- Summer water temperatures in the diversion reaches exceed water quality standards.
- The watersheds and stream corridors associated with the upper reaches of these streams were devastated by the Rocky Forest Fire in the mid-1970s.
- Fine sediments from stream bank erosion, road density and other upland sources impacts stream substrate quality.
- A natural cascade in lower Threemile Creek is a fish passage barrier at most flows.
- Riparian and instream habitat is in generally poor condition in the mid and lower stream reaches.
- Recent implementation of a new community sewer system at Wamic addressed a water quality problem associated with failing septic systems along Threemile Creek.
- Septic systems at Pine Hollow Reservoir may reduce water quality in the lower reaches of Threemile Creek.
- The Pine Hollow drainage was not historically a fish bearing stream, but connects to Threemile Creek which historically was a natural fish bearing stream
- There is a potential impact of pollution in Rock Creek Reservoir and lower Rock Creek from a community septic system at Sportsman Park.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25% by 2030, with a long-term objective to meet the instream water right.
- Improve stream water quality.
- Provide fish passage at artificial barriers on natural fish bearing streams by 2030.
- Provide protective fish screens at water diversions on natural fish bearing streams by 2030.
- Reduce stream sediment loads by 25% by 2030.
- Reduce maximum stream temperatures by 25% by 2030.
- Increase large woody debris or other comparable natural structure by 25% by 2030.
- Increase primary pool habitat by 20% in reaches with suitable channel types by 2030.

Sub-Watershed Strategies

- Increase riparian function by 50% by protecting and maintaining healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Improve upland watershed health, particularly on forest lands, through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Reduce the risk of catastrophic fire associated with lateral fuel buildup.
- Reduce stream sediment delivery from road sources and other upland sources.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and natural connectivity of redband trout populations.
- Work with water right holders to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on stream flow recovery.
- Determine life history characteristics of redband trout in the habitat complex.
- Monitor stream flow and water quality.

3.4.5. White River Habitat Complex

Key Findings

- A series of three natural waterfalls at RM 2 blocks all upstream fish migration.
- The lower reaches of the upper river tributaries are occasionally captured by White River as it migrates across the floodplain.
- Concentrated recreational use at four campgrounds and a road has degraded riparian habitat along sections of Barlow Creek.
- Road culverts impede large wood movement in tributary streams.
- Road run-off and slope failures contribute sediment to tributary streams (Red, Bonney and Barlow creeks).
- The glacial source of the river contributes to naturally high fine sediment loading and seasonally high water turbidity.
- The upper river channel is generally transitory, except where confined by a deep, narrow basalt canyon.
- A seasonal irrigation diversion in White River below Tygh Valley is unscreened.
- The White River from the mouth to the Mt. Hood National forest boundary is a designated Wild and Scenic River. The river is designated as recreational, except for a stretch designated as scenic between the mouths of Deep Creek and Threemile Creek. Increased flow from the tributaries would contribute to flows in this designated reach.
- White River contributes an average flow of 433 cfs to the Deschutes River.
- The stream flow gauge on White River below White River Falls has been out of operation for the past ten years.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Maintain and protect minimum stream flows.
- Maintain and protect natural instream habitat structure and complexity.
- Maintain or restore a diverse riparian corridor.
- Provide protective fish screens at all water diversions.
- Maintain tributary streambank stability and integrity.
- Activate the stream flow gauge on White River below White River Falls to help quantify water conservation.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Reduce the risk of catastrophic fire.
- Protect and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Reduce upland sediment delivery from unstable slopes and road system drainage.

Research and Evaluation Strategies

- Determine life history characteristics of redband trout in the habitat complex.

3.5. Lower Crooked River Assessment Unit

The Lower Crooked River Assessment Unit includes the lower Crooked River drainage below Bowman and Ochoco dams, including lower Ochoco Creek and McKay Creek.

Key Findings

- The lower Crooked River currently supports redband trout. It historically also supported populations of several other focal fish species, including summer steelhead, spring Chinook salmon and Pacific lamprey.
- Core redband trout populations currently exist in the Crooked River in the eight-mile reach below Bowman Dam and from Hwy 97 to Lake Billy Chinook, in Ochoco Creek from Ochoco Dam to confluence with the Crooked River, and in McKay Creek headwaters.
- Historically spawning summer steelhead and redband trout were distributed throughout the stream systems.
- Anadromous fish were extirpated from the assessment unit by construction of Pelton Round Butte Complex dams.
- Ochoco and Bowman dams are the upper limits of this assessment unit and have no provisions for fish passage.
- Re-introduction of anadromous fish species is dependent upon development of effective fish passage at the Pelton Round Butte Complex, as well as at Opal Springs Dam.
- Four permanent and one seasonal irrigation diversion on Crooked River and one on lower Ochoco Creek (Country Club Dam) are fish passage barriers.

- The Crooked River and Ochoco Creek flow regimes have been altered to facilitate irrigation and winter water storage.
- Historically the stream corridors in this assessment unit above the Highway 97 crossing had complex riparian vegetative communities where beaver were abundant.
- Watershed and stream corridor degradation and irrigation withdrawal in the McKay Creek system contribute to flashier flows, and produce low or intermittent seasonal flow in many stream reaches.
- Stream temperatures frequently fail to meet water quality standards during summer months in Crooked River below Prineville, Ochoco Creek and the McKay Creek system.
- Crooked River downstream from Bowman Dam generally does not meet water quality criteria for total dissolved gases during spill and/or periods of substantial discharge.
- A number of springs between Highway 97 and Lake Billy Chinook add more than 1,000 cfs of high quality to lower Crooked River, which has an average flow of 1,562 cfs at its confluence with Lake Billy Chinook.
- Stream channels have been altered throughout the assessment unit.
- Channel alterations, low stream gradient, degraded riparian vegetation and eroding stream banks contribute to high sediment loading throughout the assessment unit.
- Road construction and location in and along stream corridors has resulted in channel straightening, sediment input and loss of riparian vegetation.
- Livestock grazing, agricultural and forest practices have removed riparian vegetation along stream reaches.
- Uplands in the watershed are degraded with reduced ability to collect and store runoff and maintain soil stability.
- Historically periodic fires were an important component in maintaining upland vegetative species diversity, watershed health and native grasslands.
- Western juniper has become invasive in many upland areas as the native vegetation was degraded. The change in upland vegetative types resulted in more flashy stream flow regimes.
- Sediment from uplands, including cropland, rangeland, forests and road system run-off, degrades stream substrate.
- Stream channel scouring has reduced natural water storage and valley water tables, exacerbating low summer stream flows and water temperature extremes.
- Crooked River for eight miles downstream from Bowman Dam and from the National Grasslands Boundary to Opal Springs (river miles 8 to 17.8) are included in the National Wild and Scenic River System.
- Low summer stream flow and high water temperature limit redband trout distribution and production in the assessment unit excluding the National Wild and Scenic River reaches.
- Most of the terrestrial habitat in this assessment unit was historically shrub-steppe and juniper woodlands in about equal acreages amounting to nearly one million acres, and this condition remains currently. However, the plant diversity and growth condition of the shrub-steppe habitat has degraded. Currently, significant areas of grassland (34,000 acres) and lodgepole pine forest (90% of the 84,000 acres) that existed historically in the area are gone. Restoration of grassland areas where this habitat existed historically would benefit grassland wildlife species including greater sage grouse and golden eagle.

- Decadent areas of shrub-steppe need to be rejuvenated through fire or other means to restore sage grouse habitat.
- Aspen groves and cottonwood groves and willow swamps present historically in this assessment unit have been lost, degrading habitat for the Columbia spotted frog and other wildlife.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes required in the Lower Crooked River Assessment Unit by 2030 to achieve the vision for the Deschutes River Subbasin in the next 25 years. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Provide fish passage at Pelton Round Butte Complex and within the assessment unit.
- Provide suitable habitat conditions for adult and juvenile summer steelhead life history stages and migratory patterns to achieve and maintain an annual spawner escapement of 700 to 1,000 naturally produced adult summer steelhead into assessment unit streams.
- Provide suitable habitat capacity for potential production of up to 1,016 summer steelhead adults returning annually to the subbasin.
- Achieve a summer steelhead population productivity of 4.4.
- Provide suitable habitat conditions for adult and juvenile spring chinook life history stages and migratory patterns to achieve and maintain an annual spawner escapement of 750 to 1,000 naturally produced spring Chinook salmon into Crooked River.
- Provide suitable habitat capacity for potential production of up to 1,052 spring Chinook adults returning annually to the subbasin.
- Achieve a spring Chinook population productivity of 5.5.
- Provide suitable habitat conditions for Pacific lamprey.
- Maintain the genetic and life history diversity of the wild indigenous redband trout.
- Maintain existing riparian habitat vegetation and structure and restore degraded riparian and stream habitat, especially backwaters and oxbow sloughs and springs and seeps, to restore beaver populations in 50% of their historical range by 2030.

Habitat Objectives

- Maintain or restore 497 acres of riparian habitat, as described in the following habitat complex discussions, along fifty-five miles of stream.
- Provide suitable habitat conditions for adult and juvenile redband trout life history stages and migratory patterns to maintain stable or increasing trends in abundance and adaptiveness of redband trout in the assessment unit.
- Increase minimum stream flows to provide efficient fish passage to all historic fish habitat in the assessment unit and provide connectivity between spawning and rearing habitats in the assessment unit and Deschutes River.
- Restore and maintain upland vegetative conditions, especially lodgepole pine forests and grasslands where these habitats formerly existed, to improve overall

watershed health to increase water infiltration, retention and permeability rates, and soil stability.
- Restore aspen groves, cottonwood groves, and willow swamps to at least 50% of former areas to restore habitat for the Columbia spotted frog and other wildlife.
- Manage large areas of shrub-steppe to rejuvenate growth stages and restore native forbs to restore sage grouse habitat.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Lower Crooked River Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Protect and restore watershed function, beginning in the headwater areas and progressing downstream to restore fish distribution and abundance to meet biological and habitat objectives.
- Prioritize and plan future habitat restoration to protect or restore core habitat for redband trout populations and expand their distribution and abundance.
- Restore and protect historic habitat for reintroduced populations of summer steelhead, spring Chinook salmon and Pacific lamprey.
- Increase minimum stream flows and channel habitat complexity, and provide fish passage at all artificial barriers to support production of resident and anadromous focal fish species during all life stages and provide connectivity to areas where good riparian and instream habitat currently or historically existed.
- Improve upland management to increase water infiltration, retention and permeability rates and soil stability.
- Improve upland conditions by returning to earlier vegetative successional stages, which will help to rejuvenate springs and increase forbs and grass cover.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and fish and wildlife species diversity to meet biological objectives.
- Restore riparian and floodplain woody vegetative species diversity including willow, cottonwoods and aspen.
- Restore oxbow sloughs, backwaters, springs and seeps to produce areas with good wildlife species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and moderate stream temperature.
- Take appropriate measures to insure that stray, out-of-basin hatchery fish are not introduced if downstream fish passage is developed.

Management Strategies for Habitat Complexes

Three habitat complexes contain connected or similar habitats for focal fish populations in the Lower Crooked River Assessment Unit.

Crooked River mainstem, from Bowman Dam to Lake Billy Chinook
McKay Creek Habitat Complex
Ochoco Creek, from Ochoco Dam to Crooked River mainstem

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.5.1. Crooked River Mainstem (Lake Billy Chinook to Bowman Dam)

Key Findings

- Four permanent dams and one seasonal dam on Crooked River are complete barriers or obstacles to upstream fish passage.
- Some water intakes are unscreened or poorly screened to prevent fish losses.
- Water storage in Prineville Reservoir and downstream flow regulation reverses the historic hydrograph between Bowman Dam and Crooked River Feed Canal (RM 56) in most years.
- Cold water discharge of 180 to 200 cfs from Prineville Reservoir generally keeps summer water temperatures between Bowman Dam and the Crooked River Feed Canal in the 47° F to 50° F range.
- The Lower Crooked River from the National Grasslands boundary to Dry Creek is designated as a National Wild and Scenic River.
- Summer water temperatures in the lower Crooked River from the mouth to Baldwin Dam (RM 0-51) do not meet State water quality criteria. The reach also does not meet criteria for bacteria (summer) and pH (all year).
- The Crooked River from Baldwin Dam to Prineville Reservoir (RM 51-70) generally does not meet water quality criteria for total dissolved gases during periods of reservoir spill and/or substantial discharge.
- Low stream flow, loss of natural floodplain and riparian function contribute to high water temperatures downstream from the Crooked River Feed Canal.
- The Crooked River has also been identified as having the potential for limitations related to dissolved oxygen, total dissolved gas and nutrients.
- Minimum summer flow drops to 10 cfs from the North Unit Irrigation District pump station (RM 28) to Highway 97 (RM 18).
- Springs between Highway 97 and Lake Billy Chinook add more than 1,000 cfs of high quality to the lower Crooked River, which has an average flow of 1,562 cfs at its confluence with Lake Billy Chinook.
- Channel alteration, loss of riparian areas along stream corridors, and the influence of upstream dams eliminated most instream habitat complexity and channel sinuosity, while increasing stream bank erosion and channel sedimentation.
- Riparian habitat in some reaches is degraded because of channel alteration and livestock grazing.
- Stream sediment loading originates from soil disturbance by livestock, tillage of cropland, and from road drainage in the upland portions of the assessment unit.
- Continual stream turbidity is usually associated with colloidal clay that remains in suspension after erosion in the Upper Crooked River Assessment Unit.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Maintain a minimum instream flow of 80 cfs from Bowman Dam to Lake Billy Chinook to support the reestablishment of anadromous populations.
- Meet state temperature standards for salmonid spawning and rearing.

- Reduce channel width-to-depth ratio in Prineville Valley reach (RM34-57) to less than 15.
- Increase instream habitat complexity by 25%.
- Reduce substrate embeddedness by 30%.
- Reduce substrate sedimentation by 30%.
- Provide protective fish screens at all water intakes.
- Restore 25% of the historic oxbow sloughs and backwater habitat.

Sub-Watershed Strategies

- Increase riparian function by 50%.
- Restore fish passage at all artificial barriers.
- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct, realign, and/or maintain roads to reduce sediment delivery to streams.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Develop upland livestock water sources, while protecting natural springs, wetlands, and riparian areas to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Restore stream meander, oxbow sloughs, and backwaters to improve wildlife habitat and increase beaver numbers and distribution.

Operational and Policy Strategies

- Work with BOR to allocate unallocated Prineville Reservoir storage to increase minimum stream flow in Crooked River below Bowman Dam.
- 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.
- Work with watershed council and basin stakeholders to initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, oxbows sloughs and backwaters, springs and seeps, and upland habitats to benefit wildlife, especially beaver, and fisheries through restored natural hydrology.
- Work with ODFW, Warm Springs Tribes, NOAA Fisheries, USFWS and Deschutes Valley Water District to re-establish fish passage at Opal Springs Hydroelectric Project.
- Work with other dam owners/operators to provide fish passage in Crooked River below Bowman Dam.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.

- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Implement comprehensive watershed assessment for Prineville Valley reach of Crooked River.
- Monitor water quality and quantity to document changes from restoration projects.
- Evaluate the success of any anadromous fish re-introductions.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects and land management activities.
- Monitor beaver population abundance and distribution.

3.5.2. McKay Creek Habitat Complex

Key Findings

- Degradation of upland watershed conditions has contributed to a more flashy stream flow regime.
- Loss of riparian areas, channel alterations and effects of a more flashy flow regime has eliminated most instream habitat complexity.
- Riparian habitat degradation and stream sediment loading have originated from agricultural and forest management practices, including livestock grazing, and a dense road system.
- Fish passage is frequently blocked by intermittent stream flow and high channel width-to-depth ratio.
- Summer water temperatures in McKay Creek and tributaries do not meet State water quality criteria.
- Severe stream turbidity and sedimentation is usually associated with high intensity rain on snow storms with frozen ground, or summer convection storms.
- Low stream flow and high water temperatures have resulted from the cumulative effects of water withdrawal, loss of natural floodplain and riparian function and severe channel scour and incision.
- Following the 1998 flood, diversion structures were replaced with new structures that provide fish passage and protection screens.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain a perennial flow with a minimum flow of 6 cfs at the stream's confluence with Crooked River. Work toward long-term goal of meeting instream water right flow of 21 cfs measured at the stream's confluence with Crooked River.
- Reduce stream temperatures to meet State water quality standards.
- Reduce channel width-to-depth ratio to less than 10.
- Reduce channel incision by 50%
- Increase instream habitat complexity by 25%.
- Increase primary pool habitat by 20% in reaches with suitable habitat types.
- Reduce substrate fine sediment by 30%.
- Reduce stream substrate embeddedness by 30%.
- Screen all water intakes.

- Provide fish passage at all artificial barriers.

Sub-Watershed Strategies

- Increase riparian function by 50%, including restoration of diverse riparian vegetative corridors.
- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct and/or maintain forest and farm roads to reduce sediment delivery to streams.
- Improve upland wildlife habitat by installation of water guzzlers or other water sources to help alleviate livestock and wild ungulate concentrations in streams and riparian corridors.
- Restore natural grasslands, early-succession shrub lands, and cover areas such as aspen and cottonwood groves to reduce big game concentrations in riparian corridors.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.
- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity, and support restoration of beaver populations.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Restore interior grassland habitat areas in historic grassland areas, with the highest priority areas closely adjacent to streams.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout populations.
- Re-establish summer steelhead and Pacific lamprey into historic habitat.
- Work with water users to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from the streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Improve and restore riparian vegetation, oxbows sloughs and backwaters, springs and seeps, and upland habitats to benefit wildlife habitat, especially beaver habitat, and fisheries habitat through restored natural hydrology.

Research and Evaluation Strategies

- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the effectiveness of upland watershed treatments such as establishing permanent grasslands to reduce rapid runoff and soil erosion.
- Monitor water quality and quantity to document changes from restoration projects.
- Determine life history characteristics of redband trout in the habitat complex.
- Evaluate the success of any anadromous fish re-introductions.

- Evaluate habitat restoration projects with photo points and aerial photograph documentation.
- Monitor beaver population abundance and distribution.

3.5.3. Ochoco Creek (Ochoco Dam to Crooked River)

Key Findings

- Historically the stream corridor was characterized by a complex riparian vegetative community where beaver were abundant.
- Water storage in Ochoco Reservoir and downstream flow regulation has altered the historic hydrograph between Ochoco Dam (RM 11) and Prineville.
- The stream's riparian corridor has been degraded by agricultural practices, channel alteration and urbanization.
- Instream habitat complexity has been lost due to channel alterations, loss of sinuosity and the loss of the riparian corridor.
- Stream substrate sedimentation has been accelerated by erosion of unstable stream banks and a low stream gradient.
- The Country Club Dam is a barrier to fish passage.
- Summer water temperatures in the ten-mile reach of Ochoco Creek below the dam do not meet State water quality criteria.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain a minimum flow of 6.5 cfs at the stream's confluence with Crooked River. Work toward long-term goal of meeting instream water right of 23 cfs.
- Meet State water temperature criterion for salmonid spawning and rearing.
- Maintain the channel width-to-depth ratio to less than 12.
- Reduce channel incision and improve floodplain function.
- Increase instream habitat complexity by 25%.
- Increase primary pool habitat by 20% in reaches with suitable channel types.
- Reduce substrate fine sediment by 30%.
- Reduce stream substrate embeddedness by 30%.
- Screen all water intakes.
- Provide fish passage at all artificial barriers.
- Restore and maintain oxbows, sloughs, backwaters, springs and seeps to benefit fish and wildlife, and encourage an increase in beaver numbers and distribution.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Construct and/or maintain farm roads to reduce sediment delivery to streams.
- Install water guzzlers or other water sources for livestock and wildlife use, while protecting natural springs, riparian areas and associated wetlands.
- Implement upland and riparian grazing systems to increase ground cover and slow runoff and erosion.

- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Increase riparian function by 50%.
- Restore and protect riparian and floodplain habitat complexity.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband trout.
- Re-establish summer steelhead and Pacific lamprey.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Work with City of Prineville, Crook County and other land managers to develop riparian and stream corridor buffers.
- Work with water users to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from the stream.
- Work with the Ochoco Irrigation District, watershed council and others to enhance instream flows through water leases, purchases, transfers and other conservation measures.

Research and Evaluation Strategies

- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects and land management and development activities.
- Determine life history characteristics of redband trout in the habitat complex.
- Evaluate the success of any anadromous fish re-introductions.
- Monitor beaver population abundance and distribution.
- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Investigate opportunities to increase minimum flows through improved water availability predictions that affect upstream reservoir storage and discharge, and through innovative approaches to water distribution and application.

3.6. Upper Crooked River Assessment Unit

The Upper Crooked River Assessment Unit covers the Upper Crooked River drainage above Bowman and Ochoco dams, including upper Ochoco Creek, north and south forks of the Crooked River and Beaver Creek.

Key Findings

- The Crooked River basin historically supported anadromous and resident species.
- Anadromous fish were eliminated from the upper Crooked River and Ochoco Creek watersheds by numerous factors, including construction of major dams in the lower watershed (Pelton Round Butte Project, Bowman and Ochoco).
- Redband trout are the only native game fish and focal fish species left in the Upper Crooked River Assessment Unit, and reside primarily in tributaries on public lands.

- Redband trout abundance varies considerably throughout the drainage, and is highly dependent upon climatic conditions. In some watersheds they have been extirpated.
- Some redband populations are isolated by seasonally dewatering of stream and river reaches, or sections of streams with lethal summer water temperatures.
- Redband trout populations are depressed throughout most of the assessment unit due to the effects of poor watershed health.
- Many riparian areas are degraded due to past and current management practices.
- Riparian area degradation has resulted in losses of oxbow sloughs, backwaters, willow swamps, springs, and seeps, aspen groves, and cottonwood groves.
- Irrigation water withdrawals have changed flow regimes in a number of reaches.
- Low summer flows reduce water quality and block fish passage in several areas.
- Irrigation diversions block passage, fragment and isolate fish populations, and strand individuals.
- Current habitat conditions favor warmwater tolerant fish species over coldwater dependent focal fish species that were historically the dominant species in the assessment unit.
- Soils in many areas are highly susceptible to precipitation driven erosion that has been exacerbated by historic and current land management practices.
- Extensive increases of conifers and western juniper forest habitats, and infestations of exotic grasses and forbs in riparian habitats is negatively impacting riparian vegetative communities and resulting in unstable stream conditions.
- All of the historic lodgepole pine forests in the assessment unit have been lost, amounting to a relatively small area of 17,000 acres
- About 93% of the historic grasslands habitats have been lost, amounting to a area of 56,000 acres.
- About 38 and 35% of the shrub-steppe and ponderosa pine forests, respectively have been lost in the assessment unit, amounting to large areas of 382,000 and 158,000 acres, respectively.
- Most losses in terrestrial habitat types represent large increases in juniper woodland habitat of 401,000 acres, other mixed conifer forest increases of 111,000 acres, and a conversion of 39,000 acres to agricultural uses.
- Aspen groves and cottonwood groves and willow swamps present historically in this assessment unit have been lost, degrading habitat for the Columbia spotted frog and other wildlife.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes needed in the Upper Crooked River Assessment Unit to achieve the vision for the Deschutes River Subbasin in 25 years. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Maintain stable or increasing trends in abundance and adaptiveness of redband trout in the Crooked River and tributaries above Ochoco and Bowman dams.

- Restore native resident fish populations, including redband trout and mountain whitefish, to historic habitats.
- Consider restoring native anadromous fish populations (including steelhead, chinook and Pacific lamprey) upstream of Bowman and Ochoco dams, if passage is achieved at Pelton Round Butte Project, Opal Springs Dam and other artificial barriers downstream from this assessment unit.
- Reconnect core redband trout populations across the assessment unit.
- Conserve genetic diversity of redband trout populations and provide opportunity for genetic exchange.
- Restore beaver colonies to 25% of historic areas.
- Restore Columbia spotted frogs to 25% of historic areas.
- Conserve and restore where possible shrub-steppe habitats to conserve and restore greater sage grouse populations to 75% of former areas.

Habitat Objectives

- Protect, restore and maintain 1,971 acres of riparian habitat along 219 miles of stream.
- Protect, restore and maintain suitable habitat conditions for all redband trout life history stages and migratory patterns.
- Provide efficient fish passage to all historic fish habitat in the assessment unit.
- Increase minimum stream flows.
- Restore and maintain upland vegetative conditions to improve overall watershed health.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the upper Crooked River Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Protect and restore habitat within stronghold areas for redband trout, and work outward from these areas to expand fish distribution and abundance to meet biological and habitat objectives.
- Restore habitat for native anadromous fish populations in the upper Crooked River drainage upstream of Bowman and Ochoco dams, if passage is achieved at Pelton Round Butte Project, Opal Springs Dam and other artificial barriers within and downstream of the assessment unit.
- Reconnect core redband trout populations across the assessment unit.
- Conserve genetic and life history diversity and provide opportunity for genetic exchange.
- Prioritize and plan future habitat restoration projects to protect or restore habitat for remnant redband trout populations and expand their range, rather than beginning work on the most degraded stream reaches where redband trout have been extirpated.
- Increase summer flows and channel habitat complexity, and remove artificial barriers to support production of residual core redband trout populations during all life stages and provide connectivity to areas where good riparian habitat exists now or did historically.

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive conifer, including juniper, populations to improve riparian area and watershed health.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to restore beaver populations and Columbia spotted frog populations through restoration of woody vegetation, oxbow channels, backwaters, and seeps and springs, cottonwood groves, willow swamps, and aspen groves.

Management Strategies for Habitat Complexes

Seven habitat complexes contain connected or similar habitats for focal fish populations in the Upper Crooked River Assessment Unit.

North Fork Crooked River Complex
Beaver Creek Complex
Upper Crooked River, from reservoir to South Fork/Beaver Creek confluence
Ochoco Creek Complex
Upper Crooked River Small Tributaries
South Fork Crooked Complex
Camp Creek Complex

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.6.1. North Fork Crooked River Habitat Complex

Key Findings

- The North Fork complex contains the most widespread, interconnected, redband trout population in the assessment unit.
- Redband trout are self-sustaining in the North Fork Crooked River complex.
- Residual core redband trout populations include the Deep Creek watershed and North Fork canyon above Upper North Fork Falls. Secondary populations are the mainstem and headwater tributaries to the North Fork above Big Summit Prairie.
- This higher elevation area is close to headwater springs and generally has cooler water temperatures and more favorable streamflows relative to other areas in the subbasin. Portions of the North Fork Crooked river canyon are relatively inaccessible and undisturbed compared to other areas in the assessment unit.
- Upper and lower North Fork falls isolate fish populations in the upper watershed from the rest of the assessment unit.
- Redband trout are moderately abundant in streams with good habitat and cool water. Redband trout are depressed in streams with degraded riparian zones, poor fish habitat, and warm water.

- Impoundments, irrigation diversions and channelization have altered historic wetland conditions in Big Summit Prairie and degraded channel conditions in the lower North Fork, isolating some populations of redband trout.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision and reduced quality and quantity of habitat and stream flow.
- The North Fork Crooked River from one mile above the mouth to its source (RM 1-33.3), excluding Big Summit Prairie, is a federally designated Wild and Scenic River. Designations include Wild (11.1 miles), Scenic (9.5 miles) and Recreational (11.7miles). The reaches are managed to protect the outstanding remarkable values associated with their designation.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25%.
- Reduce fine substrate sediment by 25%.
- Reduce maximum stream temperature by 25%.
- Restore and maintain instream habitat complexity.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.
- Increase riparian function by 50% to help restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Remove noxious weeds and reduce invasive conifer, including juniper, populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance, connectivity and number of core redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on stream flows.
- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.
- Determine distribution and connectivity between Columbia spotted frog populations.

3.6.2. Beaver Creek Complex

Key Findings

- Redband trout are self-sustaining in the Beaver Creek Complex.
- Residual core redband trout populations in the Beaver Creek complex include Wolf Creek, North Fork Beaver, South Fork Beaver drainage above Swamp Creek, and Sugar Creek.
- This higher elevation area is close to headwater springs and has cooler water temperatures and more favorable streamflows relative to other areas in the subbasin.
- Much of Beaver Creek and tributaries are unshaded, with streamside vegetation consisting of primarily grasses, some sedge, and an occasional willow or cottonwood.
- Summer flows in Beaver Creek and lower tributaries range from 0 to 5 cfs. Streamflows are over appropriated, with more than 160 cfs of out-of-stream water rights appropriated from Beaver Creek and its tributaries.
- Low instream flows and corresponding high summer water temperatures are the primary limiting factors affecting fish production in the mainstem Beaver Creek.
- Beaver Creek has a relatively low gradient. Much of the stream has a substrate of fine sediments in pools and glides with occasional riffles of cobbles and boulders. Spawning gravel is very limited in much of the mainstem.
- Redband trout are moderately abundant in the core areas. They are depressed in streams with degraded riparian zones, poor fish habitat, and warm water.
- Irrigation diversions and channelization have altered historic wetland conditions and degraded channel conditions in the complex, isolating some populations of redband trout.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision or erosion, and reduced quality and quantity of habitat and stream flow.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows by 25%.

- Reduce maximum stream temperatures by 25%.
- Increase large wood / structure by 25%.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Increase riparian function by 50% and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Remove noxious weeds and reduce invasive conifer, including juniper, populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance, connectivity and number of core redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watershed.
- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.
- Determine distribution and connectivity between Columbia spotted frog populations.

3.6.3. Upper Crooked River, Prineville Reservoir upstream to South Fork/Beaver Creek confluence

Key Findings

- Redband trout are seasonally present and populations are severely depressed in the upper mainstem Crooked River.
- Much of the Crooked River is unshaded, with streamside vegetation generally consisting of grasses, sedge and willow.

- Summer flows in the upper Crooked River range from 0 to 7 cfs. Stream flow in the river is over-appropriated, with numerous temporary irrigation dams. Summer flow is severely reduced and sometimes intermittent, rendering it unsuitable for salmonid production and favorable for competing warmwater tolerant fish species.
- Low instream flows and corresponding high summer water temperatures are the primary limiting factors affecting fish production in the mainstem Crooked River.
- Severely eroded streambanks, with very little riparian vegetation occur along much of the river, and several portions have been channelized.
- Irrigation diversions and channelization have altered historic wetland and riparian conditions and degraded channel conditions in the complex, isolating populations of redband trout in tributaries.
- Poor riparian conditions due to livestock grazing, agricultural practices, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision or erosion, and reduced quality and quantity of habitat and stream flow.
- Poor watershed conditions have predisposed the river to extreme high and low flow events and increased susceptibility to anchor ice.
- Channel incision and separation of stream from its floodplain have increased bank erosion and changed riparian vegetation communities.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase stream flows within this section of the Crooked River.
- Restore and maintain instream habitat throughout the reach.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Restore and increase fish distribution, population abundance, connectivity with adjacent core redband trout populations.

- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watershed.
- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.
- Determine distribution and connectivity between Columbia spotted frog populations.

3.6.4. Ochoco Creek Complex (Upstream from Ochoco Dam)

Key Findings

- Redband trout are self-sustaining in the Upper Ochoco Creek complex.
- Residual core redband trout populations include East Fork Mill Creek and upper Ochoco Creek above the forest service boundary. Secondary populations are found in the mainstem Mill Creek above the mouth of Dry Creek, West Fork Mill Creek, and upper Marks Creek above Mt. Bachelor Pond.
- Portions of redband populations in Ochoco and Mill Creeks have interconnected and adfluvial life histories utilizing Ochoco Reservoir.
- Irrigation withdrawals from the lower reaches of Ochoco, Mill and Marks creeks result in low or intermittent summer stream flow and high water temperatures.
- Fish passage has been interrupted or permanently blocked at temporary or permanent diversion structures.
- The stream substrate has a high concentration of fine sediment originating from bank erosion, upland erosion, road drainage and livestock grazing.
- Higher elevation areas in this complex are close to headwater springs and have cooler water temperatures and more favorable streamflows relative to most other areas in the subbasin.
- Redband trout are moderately abundant in core areas. They are depressed in streams with degraded riparian zones, poor fish habitat, and warm water.
- Impoundments, irrigation diversions and channelization have altered historic wetland condition in the complex and degraded channel conditions, isolating some populations of redband trout.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision and reduced quality and quantity of habitat and stream flow.
- Mercury has been detected in sediments and fish samples from Ochoco Reservoir.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase stream flows, particularly in lower stream reaches.
- Restore and maintain instream habitat.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance, connectivity and number of core redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.
- Determine sources of mercury and level of mercury contamination in Ochoco Reservoir and upstream tributaries.
- Determine distribution and connectivity between Columbia spotted frog populations.

3.6.5. Upper Mainstem Crooked River and Small Tribs above Bowman Dam

Key Findings

- Small tributaries to Crooked River generally originate at lower elevation as small headwater springs on USFS lands and flow through a variety of plant

communities, including wet meadows and forested communities. Lower portions of most tributary streams flow through wider valleys with sagebrush and juniper communities in the uplands, and irrigated meadows and hay fields along the stream bottoms.

- Most redband trout populations are small and isolated from each other by habitat conditions in the mainstem Crooked River, tributary passage barriers, and intermittent stream flow.
- Tributary stream corridors are generally open with little to no shade.
- Some stream reaches are incised in drainages with highly erodible soils susceptible to annual erosion. Instream structure and riparian habitat are generally lacking on most stream reaches.
- Upstream water storage, water withdrawal for irrigation and lowered stream valley water tables result in low or intermittent flow and high water temperatures in many streams. Streamflows are over-appropriated for irrigation and storage.
- Low instream flows and corresponding high summer water temperatures are the primary limiting factors affecting fish production.
- Fish passage is frequently blocked by seasonal or permanent water diversions or storage structures without protective screens on diversions.
- The watershed's reduced ability to retain and slowly release precipitation has produced flashy flow regimes in some streams.
- Stream substrate frequently contains high concentrations of fine sediment.
- Irrigation diversions and channelization have altered historic wetland conditions and degraded channel conditions in the complex, isolating some populations of redband trout.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision and reduced quality and quantity of habitat and stream flow.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum stream flows.
- Restore and maintain instream habitat.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.

- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Protect and increase distribution, population abundance, connectivity and number of redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watersheds.
- Determine redband trout spawning and rearing times of year, and movement between habitat areas during different life stages.

3.6.6. South Fork Crooked River Complex

Key Findings

- The South Fork Crooked River does not appear to support a naturally reproducing stock of redband trout.
- Many streams in the South Fork Basin are intermittent or ephemeral.
- The South Fork Crooked River flows through a mixture of narrow, steep, rim rock canyons and areas of wider rim rock canyons and irrigated hay meadows. The riparian community is dominated by grass and sedge species, with very few willows or other woody species.
- Summer flows ranged from 2 to 9 cfs with numerous irrigation dams diverting much of the flow throughout the private lands. Over 100 cfs of out of stream water rights have been appropriated from the South Fork Crooked River.
- Much of the South Fork has a substrate of fine sediments, occasional riffles of cobbles and boulders, and spawning gravel is very limited.
- A series of springs create a base flow of approximately 25 cfs in the South Fork Crooked upstream from irrigation diversions.
- Base flow, land ownership patterns and watershed topography provide excellent opportunity for reintroduction of native redband trout.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase minimum perennial stream flows.
- Restore and maintain instream habitat.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers.
- Provide protective fish screens at all water diversions.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Restore and then maintain historic distribution, population abundance, connectivity and number of redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions on federally managed lands.

Research and Evaluation Strategies

- Identify areas where water conservation and habitat restoration actions could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watersheds.

3.6.7. Camp Creek Complex

Key Findings

- Desertification of the Camp Creek drainage and the gradual transition to its present day condition of dry canyons and severely eroded streambanks occurred from the mid 1880's to 1905.
- Redband trout have been reported, but not recently observed in Camp Creek.
- Some Camp Creek tributaries begin at lower elevation as small springs on south facing slopes of the Maury Mountains on USFS lands and flow through a variety of plant communities, including forested communities and former wet meadows. Lower portions of tributary streams flow through wider valleys with sagebrush and juniper communities in the uplands and irrigated meadows and hay fields along the stream bottoms. Other tributaries drain the high desert area and generally only contribute flow following high intensity summer storms or during spring snowmelt.
- Tributary streams are generally open with little to no shade.
- Most tributary reaches are incised in drainages with highly erodible soils susceptible to annual erosion. Instream structure and riparian habitat are generally lacking on most stream reaches.

- Where livestock can be managed as planned, BLM managed reaches on the mainstem are heavily vegetated with sedges and other riparian type vegetation, promoting a more desirable channel width-to-depth ratio. In these segments, the channel bottom has deposited sediment and risen over 5 feet within the incised channel.
- Livestock trespass on BLM managed lands within other segments of the mainstem are retarding recovery of riparian vegetation and channel conditions.
- Upstream water storage, water withdrawal for irrigation and lowered stream valley water tables result in low or intermittent flow and high water temperatures in most of these streams. Streamflows are over appropriated.
- Low instream flows and corresponding high summer water temperatures are the primary limiting factors affecting potential reintroduction of redband trout.
- Potential reintroduction of redband trout could be hampered by fish passage obstructions from seasonal or permanent water diversions or storage structures that lack protective screens on diversions.
- The watershed's reduced ability to retain and slowly release precipitation has produced flashy flow regimes in most streams.
- Stream substrate frequently contains high concentrations of fine sediment.
- Irrigation diversions and channelization have altered historic wetland conditions and degraded channel conditions in the complex.
- Poor riparian conditions due to timber harvest, livestock grazing, channel alteration, and road building practices have altered riparian and instream conditions, resulting in channel incision and reduced quality and quantity of habitat and stream flow.
- Historically beaver were an important component of the ecosystem. Beaver dams scattered along stream reaches slowed high flows and promoted natural water storage and development of well vegetated stream corridors.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase or re-establish minimum perennial stream flows.
- Restore and maintain instream habitat.
- Restore and maintain streambank stability and integrity.

Sub-Watershed Strategies

- Improve upland watershed health through proper management to increase water infiltration, retention and permeability rates and soil stability.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Remove noxious weeds and reduce invasive juniper populations to improve riparian area and watershed health.
- Reduce lateral channel scour or channel incision.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and water temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.

Operational and Policy Strategies

- Restore and then maintain historic redband trout distribution and connectivity to existing redband trout populations.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Reevaluate effectiveness of federal management objectives for riparian and channel conditions.

Research and Evaluation Strategies

- Identify areas where water conservation could have a significant impact on flows.
- Develop a better understanding of water use and availability in the watersheds.
- Conduct surveys to verify the status of redband trout in the Camp Creek Complex and identify potential reaches suitable for reintroduction.

3.7. Middle Deschutes River Assessment Unit

The Middle Deschutes River Assessment Unit includes the 32 miles of the Deschutes River from the Reregulating Dam (RM 100) at the lower end of the Pelton Round Butte Complex to Big Falls (RM 132), and the Metolius River and Squaw Creek drainages.

Key Findings

- This reach of the Deschutes River historically supported anadromous fish production, with Big Falls blocking anadromous fish passage to upriver areas. Today, anadromous fish passage is blocked at the Pelton Reregulating Dam.
- Inflow from springs contributes to consistent flows and high water quality in the Deschutes and Metolius rivers and lower Squaw Creek.
- Efforts are underway to restore anadromous fish passage at the Pelton Round Butte Complex. Adequate passage would allow restoration of Pacific lamprey, sockeye and spring Chinook salmon and summer steelhead to their historical range in the middle Deschutes assessment unit, as well as provide connectivity for redband and bull trout populations fragmented by the hydroelectric complex.
- Squaw Creek has been a focal point for flow restoration projects in the basin because of its potential for anadromous production with reintroduction above Pelton Round Butte Complex.
- The 20-mile reach of the Deschutes from the top of Lake Billy Chinook to the Reregulating Dam is constrained by a series of reservoirs and dams that are managed by Portland General Electric and the Confederated Tribes of the Warm Springs Reservation of Oregon for hydroelectric production.
- Cottonwood groves and willow swamps thought to exist historically in the Squaw Creek drainages have been lost, along with beaver populations.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes needed in the Middle Deschutes River Assessment Unit in next 25 years to achieve the vision for the Deschutes River Subbasin. These assessment unit objectives are

consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Provide suitable habitat conditions for adult and juvenile summer steelhead life history stages and migratory patterns to achieve and maintain an annual spawner escapement of 1,600 to 1,850 naturally produced adult summer steelhead (EDT Projection) into assessment unit streams. This population would be distributed to the following stream systems: Metolius River 600 - 700, Squaw Creek 700 – 800 and Middle Deschutes River 300 – 350 fish when passage is established at the Pelton Round Butte and Squaw Creek dams.
- Provide suitable habitat conditions for adult and juvenile spring chinook life history stages and migratory patterns to achieve and maintain an annual spawner escapement of 1,800 to 2,150 naturally produced spring Chinook salmon (EDT Projection) into assessment unit streams by 2030. This population would be distributed to the following stream systems: Metolius River 1,400–1,600, Squaw Creek 250–350 and Middle Deschutes 150-200 fish when passage is established at the Pelton Round Butte and Squaw Creek dams.
- Provide suitable habitat conditions for restored 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.
- Maintain or increase the life history diversity of the wild indigenous bull trout and redband trout in the assessment unit.
- Provide connectivity and opportunities for redband and bull trout migration between local core populations.
- Provide efficient fish passage for focal fish species to all historic fish habitat in the assessment unit and provide connectivity between spawning and rearing habitats in the tributaries and mainstem Deschutes River.

Habitat Objectives

- Provide suitable habitat conditions for adult and juvenile redband and bull trout, and re-established Pacific lamprey, life history stages and migratory patterns to maintain stable or increasing trends in abundance and adaptiveness in the middle Deschutes River, Squaw Creek and Metolius River.
- Restore/maintain upland vegetative conditions to improve overall watershed health to increase water infiltration, retention and permeability rates, and soil stability.
- Maintain or restore 867 acres of riparian habitat along ninety-six miles of stream to meet or exceed the interim habitat attribute objectives discussed in the following habitat complexes.
- Restore degraded riparian habitat to produce suitable beaver habitat in 25% of the historical beaver habitat.
- Restore 20% of oxbow sloughs and backwaters within former beaver habitat areas.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Middle Deschutes River Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Prioritize and plan future habitat restoration to protect or restore habitat for core populations of redband and bull trout and expand their distribution to include historic range.
- Restore historic habitat conditions to support re-introduced Pacific lamprey, spring chinook and sockeye salmon and summer steelhead during all life stages.
- Provide connectivity to areas where good riparian and instream habitat currently or historically existed.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity to meet biological objectives.
- Restore instream habitat complexity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation, oxbow sloughs, and backwaters.
- Insure that out-of-basin stray fish are prevented from entering the assessment unit when anadromous focal fish species are re-introduced.

Management Strategies for Habitat Complexes

Four habitat complexes contain connected or similar habitats for focal fish populations in the Middle Deschutes River Assessment Unit.

Pelton Round Butte Complex, from Reregulating Dam to upper end of Lake Billy Chinook.
Middle Deschutes River Habitat Complex, from Lake Billy Chinook to Big Falls.
Metolius River Habitat Complex, including the Lake Creek system.
Squaw Creek Habitat Complex, including Indian Ford and Snow creeks.

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.7.1. Pelton Round Butte Habitat Complex

Key Findings

- All anadromous fish passage in the Deschutes is currently blocked at the lower end of the Pelton Round Butte Complex (RM 100).
- All anadromous focal fish species were extirpated above the Pelton Round Butte Complex when fish passage failed for downstream migrating smolts.
- Plans are currently underway to re-establish anadromous fish populations above the complex.
- Potential plans for re-introduction of anadromous focal fish species above the Pelton Round Butte Complex call for partial or total transportation of juvenile and adult fish around the three hydro complex dams.
- Because of large water level fluctuations and associated safety issues, no public use is allowed at the reservoir between Pelton Dam and the Reregulating Dam.

Fish routinely enter the reservoir through the Pelton Dam turbines and pass the Reregulating Dam into the lower river.

- Two small tributaries enter the Deschutes River in Lake Simtustus, between Pelton Dam and Round Butte Dam. Seekseequa Creek, a seasonally dry stream, joins the lake from the west and Willow Creek joins it from the east.
- Habitat in Lake Billy Chinook is well-suited for kokanee, which rear in the reservoir and move into the Metolius River to spawn.
- Arms of the Deschutes, Metolius and Crooked rivers support a diverse sport fish community, including kokanee, redband, brown and bull trout. The Metolius River Arm also provides good habitat for juvenile and sub-adult bull trout.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Provide protective fish screens to facilitate anadromous fish passage at the Pelton Round Butte Complex.
- Re-establish passage of anadromous and resident focal fish species.
- Modify reservoir outlet structures to restore historic river water quality downstream of the hydro complex and facilitate juvenile anadromous fish out-migration or collection.

Operational and Policy Strategies

- Modify the Pelton Round Butte operating procedures to restore downstream water quality to meet State and Tribal water quality criteria.
- Take adequate precautions to prevent the passage of out-of-basin stray hatchery fish and fish diseases upstream of the hydro complex.
- Modify the Lake Billy Chinook outlet to facilitate efficient collection of downstream migrant salmonids and lamprey.

Research and Evaluation Strategies

- Evaluate the success of anadromous focal fish species re-introductions above the hydro complex.
- Evaluate the success and efficiency of juvenile downstream passage facilities.

3.7.2. Deschutes River, Lake Billy Chinook (RM 120) to Big Falls (RM 132)

Key Findings

- The Deschutes River from Lake Billy Chinook to Odin Falls is designated as a National Wild and Scenic River.
- The upper end of this reach experiences low summer flows due to upstream irrigation withdrawals. The reach gains a substantial amount of flow from groundwater releases before entering Lake Billy Chinook.
- The Deschutes River from Steelhead Falls to Big Falls exceeds 303(d) temperature criteria for salmonid spawning and rearing, and for pH.
- This reach of the Deschutes River is constrained by steep and moderate v-shaped hill slopes. Streambank stability is excellent and protected by non-erodible substrate and vegetation.
- Instream habitat remains in good condition and structural diversity is primarily provided by large boulders.

- Spawning gravel recruitment is naturally limited and is lacking below Steelhead Falls. Good gravel is found in the Foley waters above Steelhead Falls.
- The reach contains Steelhead Falls, which has the remains of an old fish ladder and is passable for fish at some flows.

Management Strategies Specific to Habitat Complex

In Channel Strategies
- Increase stream flow to meet the instream water right flow.
- Reduce stream temperature to meet State water quality criteria for salmonid spawning and rearing.
- Increase riparian function by 50%.
- Restore and/or maintain instream habitat complexity with a minimum of 20 pieces of large wood or comparable natural structure per 100 meters of stream channel.
- Reduce substrate fine sediment percentage to less than 10%.
- Restore connectivity between spawning and rearing habitats in the tributaries and mainstem Deschutes River.

Sub-Watershed Strategies
- Protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody and herbaceous vegetation.

Operational and Policy Strategies
- Protect and increase distribution, population abundance and connectivity of redband trout and re-establish spring chinook and summer steelhead populations.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.

Research and Evaluation Strategies
- Determine life history characteristics of redband trout in this stream reach.
- Monitor the affects of increased stream flow and/or instream structural complexity.
- Monitor beaver population abundance and distribution.

3.7.3. Metolius River Habitat Complex

Key Findings
- The Metolius River from Lake Billy Chinook to Metolius Springs is designated as a National Wild and Scenic River. The reach from the headwaters to Candle Creek is also a State Scenic Waterway.
- The Metolius River is one of the largest spring-fed streams in Oregon.
- The Metolius system was once the primary producer of spring chinook in the upper subbasin.
- Redband trout are distributed throughout the system. Primary spawning areas are the Metolius River above Allingham Bridge, Abbot Creek and Lake Creek.

- Three bull trout populations exist in Metolius system (Whitewater River, Jefferson/Candle/Abbot complex, and Canyon/Jack/Heising/mainstem Metolius complex).
- Bull trout spawn in Jack, Canyon, Roaring, Candle and Jefferson creeks and in the Whitewater River. They rear in these streams, as well as in First and Brush creeks.
- Sockeye salmon once migrated up the Metolius River and into the Lake Creek-Suttle Lake complex to spawn. The native run of sockeye in Suttle Lake and Link Creek was reported extinct by 1940.
- Major tributaries to the Metolius include Lake, Spring, Jack, Canyon, Abbot, Candle and Jefferson creeks and Whitewater River.
- The spring-fed Metolius River and tributaries have generally consistent flow and high water quality, and stable channels.
- Stable flows within the Metolius River generally promote a healthy riparian corridor along the stream, with undercut banks, except where degraded by past forest fires, forest management and livestock and recreational use.
- Primary sources of sediment in the Metolius system are from landslides, recreational use, and runoff from logged and burned areas and road network.
- Low amounts of instream large woody debris limit fish habitat in the Metolius River and some tributary reaches.
- Cool spring-fed tributaries to the lower Metolius River (Jack, Canyon, Candle and Jefferson creeks and Whitewater River) contain abundant spawning gravel, undercut banks, side channels and wood. They provide high quality bull trout rearing habitat.
- While water quality is generally excellent throughout the Metolius system due to spring releases, temperatures in the lower Metolius River can exceed State water temperature criterion for bull trout during certain seasons of the year. Water temperatures in Lake Creek exceeds State water quality criteria for salmonids.
- Impassable dams are located on Spring Creek and Link Creek at the outlet of Blue Lake.
- An obstruction on Lake Creek just downstream from Suttle Lake is impassable to some life stages at some flows.
- Lake Creek diversions are unscreened. Screens and passage are being provided at the hydro facility on Link Creek.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain instream habitat complexity with a minimum of 20 pieces of large woody debris or comparable natural structure per 100 meters of stream channel.
- Restore and maintain diverse riparian stream corridors by increasing riparian function 50%.
- Reduce stream substrate sedimentation by 30%.
- Reduce stream substrate embeddedness by 30%.
- Reduce non-spring fed (warm water) tributaries maximum stream temperatures by 25% by increasing shade and floodplain function.
- Increase primary pool habitat by 20% in suitable channel types.
- Provide screening at all water intakes.

- Provide fish passage at all artificial barriers.
- Restore oxbow sloughs and backwaters.

Sub-Watershed Strategies

- Restore and protect riparian and floodplain areas to encourage development of good habitat complexity and plant species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and moderate stream flows and temperatures.
- Manage riparian ecosystems to encourage restoration of beaver populations and restore recruitment of large woody debris.
- Stabilize roads, crossings and other sources of sediment delivery.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband and bull trout populations, and re-established Pacific lamprey, summer steelhead, spring Chinook and sockeye salmon populations.
- Work with agencies, watershed councils and basin stakeholders to initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.

Research and Evaluation Strategies

- Initiate an assessment to quantify and evaluate the parameters used in the EDT analysis and determine reference conditions to meet in channel habitat restoration benchmarks for the Metolius River system.
- Evaluate the effectiveness of upland watershed treatments to reduce rapid runoff and soil erosion on tributaries with high adjacent hill slopes.
- Monitor the effects of habitat restoration on fish production.
- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects and land management activities.
- Evaluate the re-introduction of focal fish species.
- Monitor beaver population abundance and distribution.

3.7.4. Squaw Creek Habitat Complex

Key Findings

- Squaw Creek was once the primary producer of summer steelhead in the assessment unit.
- Squaw Creek once also supported spring chinook production.
- Today redband trout exist throughout the watershed. The watershed also provides a primary spawning area for the redband trout population in the Middle Deschutes River.
- Squaw Creek below Alder Springs provides foraging habitat for bull trout. Adult bull trout have been found, but no spawning has been documented.
- Squaw Creek from the gaging station to source is a designated National Wild and Scenic River.
- Higher quality habitat conditions existed in Squaw Creek before the late 1800s when flow allocations for irrigation began. Historically natural flows created an abundance of off-channel habitats in unconfined reaches and provided deeper

pools for fish use during summer months. Diverse riparian vegetation grew along the streambanks and provided shade for off-channel and pool habitat.

- Streamflow in Squaw Creek is "flashy", fluctuating from extremely high flow to low or intermittent flows.
- Flows in Squaw Creek remain generally undisturbed from the headwaters to RM 23.5 where most of the water is diverted for irrigation during summer months. Stream flows are over appropriated to support irrigation.
- The middle reach of Squaw Creek, below the two primary irrigation diversions, has had low to intermittent summer flow.
- Flows in Squaw Creek gradually improve downstream from the City of Sisters with discharge from springs and irrigation return flow. Springs near Camp Polk Road contribute 7 cfs to flows in Squaw Creek. A minimum flow of nearly 100 cfs discharges to the Deschutes River because of Alder Springs and other smaller groundwater springs.
- The stream generally fails to meet water quality criteria for maximum stream temperature between Alder Springs (RM 2) and the Squaw Creek Irrigation District diversion (RM 25).
- There has been extensive channel alteration from the USGS gage (RM 24.7) downstream to the Crooked River National Grasslands boundary (RM 5) resulting in a loss of sinuosity and stream length, with a corresponding increase in gradient.
- The lower half of the stream generally lacks riparian vegetation and instream structural complexity as the result of channel alteration, livestock grazing and development.
- The lower half of the stream has high percentages of fine sediment associated with erosion of unstable stream banks and livestock grazing.
- None of the irrigation diversions are fitted with fish screens and two irrigation diversion dams are fish passage barriers.
- An instream water right exists for Squaw Creek below the mouth of Indian Ford Creek. Flow levels are 50 cfs for March, April and May and 33 cfs for the rest of the year.
- Recent habitat restoration measures completed or underway include acquisition of water rights for conversion to instream rights, and water conservation measures designed to increase minimum summer flow.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase instream minimum flow to meet instream water right of 33 cfs below Indian Ford Creek.
- Restore fish passage to historical habitat in upper Squaw Creek.
- Restore and maintain instream habitat complexity by increasing large wood or other comparable natural structure by 25%.
- Decrease channel width to depth ratio to reference reach condition.
- Decrease channel incision by 50%.
- Increase primary pool habitat by 20%.
- Reduce stream substrate embeddedness by 30%.
- Reduce stream substrate sedimentation by 30%.
- Screen all water diversions to protect fish.

- Restore oxbow sloughs and backwaters.
- Reduce maximum stream temperature by to meet water quality standards.
- Increase riparian function by 50% by restoring diverse riparian vegetative corridors and near-stream alder, aspen and cottonwood groves to provide 50% stream shading and increase stream bank stability to 50%.

Sub-Watershed Strategies

- Improve upland watershed health through effective management by restoring grasslands and near-water vegetation to increase water infiltration, retention and permeability rates and soil stability.
- Implement riparian grazing systems to increase ground cover and slow runoff and erosion.
- Re-vegetate and protect riparian and floodplain areas to restore shade and canopy, riparian cover and native vegetation along Squaw Creek and tributaries.
- Encourage beaver restoration.
- Arrest stream channel incision and restore natural sinuosity and gradient.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and stream temperature moderation.
- Restore fish passage to historical habitat and screen all water intakes.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of redband and bull trout populations and re-introduced Pacific lamprey, spring chinook and summer steelhead populations.
- 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.
- Work with agencies, watershed council and basin stakeholders to initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality, and provide connectivity.
- Work with irrigators to increase the efficiency of water delivery and use to reduce the quantity of water withdrawn from streams.
- Work with the Deschutes National Forest and private landowners to protect and maintain healthy riparian stream corridors.
- Increase the numbers and distribution of beaver.

Research and Evaluation Strategies

- Determine reference conditions to meet in channel habitat restoration benchmarks for the Squaw Creek system.
- Identify areas and management actions to increase natural water storage to improve stream flow and stream temperature moderation.
- Evaluate the opportunities for restoring natural stream channel sinuosity and gradient.
- Evaluate the re-introduction of focal fish species.
- Evaluate the distribution of exotic fish species and potential affects on re-introduction of focal fish species.
- Monitor the effects of habitat restoration on fish production.

- Monitor changes in morphology, vegetation, water quality and quantity from habitat restoration projects and land management activities.
- Determine life history characteristics of redband and bull trout in the habitat complex.
- Monitor beaver population abundance and distribution.

3.8. Upper Deschutes River Assessment Unit

Upper Deschutes River Assessment unit covers the Deschutes River drainage from Big Falls (RM 132) to Wickiup Dam (RM 222), including Little Deschutes River, Fall River, Spring River and Tumalo Creek.

Key Findings

- Historically, bull trout, redband trout, and whitefish were the indigenous salmonids in this segment of the Deschutes River.
- Wild fish species currently present are redband trout and mountain whitefish.
- Historically, the upper Deschutes provided suitable and plentiful habitat for widespread bull trout populations.
- Drastic alteration of the natural river flow regime caused by irrigation diversions, and the associated effects to aquatic and terrestrial habitat resulted in the extirpation of bull trout and has appreciably reduced the redband trout population.
- All of an estimated 37,000 acres of grassland wildlife habitat has been lost since historic times in this assessment unit.
- Fifty percent of lodgepole pine forests, amounting to 179,000 acres, have been lost since the mid-1800s.
- Fifty-seven percent, or 29,000 acres, of shrub-steppe habitat has also been lost since the mid-1800s.
- Fluctuations in water levels in the Deschutes River, resulting from changes in the outflow at Wickiup Dam that do not match natural seasonal flows, may preclude beaver colonies in this river channel and destroy aquatic habitat for other wildlife in backwaters and oxbow channels.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes in the Upper Deschutes River Assessment Unit needed in the next 25 years to achieve the vision for the Deschutes River Subbasin. These assessment unit objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Maintain stable or increasing trends in abundance and adaptiveness of redband trout and mountain whitefish.
- Conserve redband trout genetic diversity and provide opportunity for genetic exchange.
- Determine the feasibility of re-establishing a self-sustaining bull trout population within historic habitat.
- Restore beaver colonies to at least 20% of their historic habitat.

Habitat Objectives

- Protect, restore and maintain suitable habitat conditions for all redband trout life history stages and strategies.
- Improve the quality and quantity of aquatic and riparian habitat.
- Conserve or restore 1,406 acres of riparian habitat along 156 miles of stream.
- Restore and protect important wildlife habitats, including backwaters, oxbow sloughs, seeps and springs, and cottonwood groves, willows, and aspen groves for focal wildlife species.
- Conserve and restore grasslands, lodgepole pine forests, and shrub-steppe habitats to conserve and restore the wildlife species such as mule deer and golden eagle.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Upper Deschutes River Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Protect and restore core areas for redband trout, and work outward from these areas to expand distribution and abundance to meet biological and habitat objectives. Multi-species benefits would have priority.
- Conserve redband genetic diversity and provide opportunity for genetic exchange.
- Prioritize and plan future habitat restoration projects to protect or restore habitat for small or remnant redband trout populations and expand their range, rather than beginning work on the most degraded stream reaches.
- Restore spawning habitat in the mainstem between Wickiup Dam and Pringle Falls. Priority efforts include improving winter flows, restoring channel structure and selectively increasing spawning gravel availability.
- Restore juvenile rearing habitat within the mainstem by stabilizing flows and improving instream structure. Priority mainstem reaches include from Wickiup Dam to Pringle Falls, and near the mouths of Fall, Spring and Little Deschutes Rivers and Tumalo Creek.
- Protect and enhance spawning and rearing areas in tributary reaches and provide connectivity to mainstem.
- Protect and restore riparian habitat complexity, building on existing areas of good riparian habitats. Priority efforts should include restoration in areas where structural upgrade will encourage natural vegetative recovery. Native plant species should be used for riparian area re-vegetation, not exotic plant species.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage restoration of beaver populations through restoration of woody vegetation.
- Set operational and policy standards at levels to meet biological objectives.

Management Strategies for Habitat Complexes

Four habitat complexes contain connected or similar habitats for focal fish populations in the Upper Deschutes River Assessment Unit.

Deschutes River Habitat Complex, from Big Falls to North Canal Dam
Tumalo Creek Habitat Complex
Deschutes River and tributaries from North Canal Dam to Wickiup Dam, except the Little Deschutes River
Little Deschutes River Habitat Complex

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.8.1. Deschutes River from Big Falls to North Canal Dam

Key Findings

- Low summer flows reduce water quality and aquatic habitat conditions in the Deschutes River from North Canal Dam to Big Falls.
- Fish habitat quality and successful fish spawning between North Canal Dam and Big Falls have been severely reduced by irrigation water withdrawals from the river above North Canal Dam.
- No known core redband trout populations are present in this reach of the Deschutes River. Populations in the reach are highly variable due to fragmentation from barriers, low summer flows and high summer water temperatures. When flows are adequate below North Canal Dam notable increases in redband production are observed.
- The reach of the Deschutes River near the mouth of Tumalo Creek is a priority area for habitat restoration.
- Habitat effects due to flow alterations in the Deschutes River may be the most critical limiting factors in natural production of trout and whitefish in this section.
- The Deschutes River from Lake Billy Chinook to Odin Falls (RM 120-140) is a designated National Wild and Scenic River. Reaches from Sawyer Park to Tumalo Park and from Deschutes Market Road to Lake Billy Chinook are also designated as State Scenic Waterways.
- Modification of the flow regime and improvement of habitat is necessary to sustain healthy populations of trout and whitefish. This includes but is not limited to higher minimum flows, seasonal flow stabilization, screening of water intakes, and habitat restoration.
- Awbrey and Odin Falls are natural obstacles to upstream movement of fish.
- Big Falls is a complete barrier to upstream fish passage.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain instream habitat.
- Improve the river's flow regime by increasing the minimum summer flow to meet instream water rights.
- Prevent the loss of fish at unscreened intakes.

Sub-Watershed Strategies

- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Remove noxious weeds and reduce invasive juniper populations to improve watershed health.

Operational and Policy Strategies

- Improve the river's flow regime to achieve aquatic resource and fish population objectives.
- Support current and future methods to improve water conservation and efficiency of water delivery systems to meet instream flow objectives.

Research and Evaluation Strategies

- Complete inventory an evaluation of current conditions of wetlands to restore and enhance water quality.
- Determine impacts of seasonally low stream flow combined with urban and rural run-off.
- Document life history characteristics and monitor population trends of trout and whitefish.

3.8.2. Tumalo Creek Habitat Complex

Key Findings

- Tumalo Creek once provided spawning and rearing habitat for a core redband trout population that migrated from the Deschutes River.
- Currently, fish passage from the Deschutes River to potential spawning and refuge areas in Tumalo Creek is restricted at the Tumalo Feed Canal diversion.
- Small populations of redband trout occur throughout the Tumalo drainage.
- A large portion of the summer flow is diverted for irrigation at RM 2.5, reducing trout production and raising water temperatures in the lower stream reach.
- Bridge Creek, a tributary to Tumalo Creek, provides about 50 percent of the total volume of water used by the City of Bend in a given year. During the summer peak demand times, deep wells provide most of the water needed to meet customer demand.
- There is a lack of pool habitat in reaches below Tumalo Feed Canal and in area burned by Bridge Creek Fire.
- Several stream sections lack trout cover (large wood) for rearing and feeding.
- Irrigation diversions are unscreened.
- During severe winters, anchor ice forms resulting in stream bottom scouring as the ice breaks up and moves downstream.
- Increased summer flows in the lower reach below Tumalo Feed Canal have improved summer water temperatures.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase instream structural habitat complexity in deficient reaches.
- Provide fish passage at all artificial structures and barriers.
- Install protective fish screening at water intakes.

Sub-Watershed Strategies

- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity, particularly in the Bridge Creek Burn area.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage increased number and distribution of beaver.

Operational and Policy Strategies

- Increase the minimum summer flow.
- Develop a coordinated water policy to secure and protect instream flow enhancements from conservation, leases, transfers and acquisitions.

Research and Evaluation Strategies

- Compare the condition of Tumalo Creek channel before and after the Bridge Creek Fire and determine management activity needed to restore habitat quality.
- Evaluate impacts of the Tumalo Irrigation Distirct diversion dam on bedload movement and determine appropriate actions to maintain channel function and improve fish spawning and rearing habitat.

3.8.3. Deschutes River and Tributaries from North Canal Dam to Wickiup Dam, except the Little Deschutes River

Key Findings

- The core redband trout population for this habitat complex exists in the Deschutes River from Benham Falls to Bend.
- The redband trout numbers between Benham Falls and Wickiup Dam are highly variable depending on the availability of adequate winter flows in consecutive years.
- Redband trout indigenous to the upper Deschutes River and tributaries have been identified as an inland redband trout and are listed as a provisional wild fish population and a state sensitive species.
- Redband trout above and below Benham Falls comprise one population.
- Priority reaches include the Deschutes River from Wickiup Dam to Pringle Falls, and near the mouths of Fall, Spring and Little Deschutes rivers.
- Nonnative brown and brook trout compete with redband trout for food and space.
- Several reaches in this habitat complex are federally designated and managed as Wild and Scenic Rivers: The Deschutes River from the Bend UGB to Lava Island Camp (172-175) as recreational; from Lava Island Camp to Sunriver (RM 175-186.2) as scenic; and from Sunriver to Wickiup Dam (RM186.2 to 226.7) as recreational. Reaches from the gage to General Patch Bridge and from Harper Bridge to the Bend Urban Growth Boundary are also State Scenic Waterways.
- Artificially high summer river flows and low winter flows produced by the water release schedule at Wickiup Reservoir accelerate soil erosion from sensitive river banks on the Upper Deschutes River above the City of Bend.
- Riparian and instream habitat is very difficult to restore on the Upper Deschutes between Wickiup Reservoir and the City of Bend due to current managed flow regime that has significantly altered the natural hydrograph.

- Modification of Deschutes River hydrology from Wickiup Dam to Benham Falls has resulted in wide variations in flows in what was once a relatively stable river, causing loss of habitat (spawning, rearing, and holding) which supported natural production of redband and bull trout in significant numbers.
- Modification of the current timing and distribution of flows in Deschutes River downstream of Wickiup Dam and habitat improvement is needed to sustain healthy trout and whitefish populations. This includes, but is not limited to, higher minimum flows, seasonal flow stabilization, screening of water intakes and habitat restoration.
- Modification of the current timing and distribution of flows in the upper Deschutes Subbasin, and implemention of water conservation actions will potentially change the timing of flows in the lower Deschutes River.
- The Deschutes River is confined to a series of reservoirs in the Bend area by four dams; North Canal Dam, Stiedel Dam, Pacific Power and Light Dam, and Colorado Street Dam.
- Habitat effects due to extreme high summer flows and extreme low winter flows in the Deschutes River above Benham Falls may be the most critical limiting factors in natural production of redband trout in this reach.
- In Fall and Spring Rivers (which are unaffected by irrigation diversions) the lack of abundant natural spawning gravel, instream woody structure, and pool habitat currently limits natural production of trout.
- Degradation of riparian and wetland habitat has contributed to a loss of habitat for Oregon spotted frog and other wildlife.

Management Strategies Specific to Habitat Complex

In-Channel Strategies

- Increase the quality and quantity of spawning habitat.
- Increase minimum stream flow in the Deschutes River to meet instream water right.
- Improve the quantity and diversity of instream habitat complexity.
- Provide fish passage and protective screening at river dams.
- Modify dams to provide fish passage.

Sub-watershed Strategies

- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Assist landowners with projects that replace non-native vegetation with native riparian plants.

Operational and Policy Strategies

- Improve the river's flow regime by increasing the minimum winter flow and reducing the summer peak flow.
- Initiate programs to meet minimum winter flow levels as identified by State instream water rights in Upper Deschutes River from Wickiup reservoir to North Canal Dam.

- Decrease sedimentation and turbidity levels in sections of upper Deschutes River from Wickiup Reservoir to North Canal Dam.
- Reduce erosion by implementing spring ramping rates (0.1 ft/ 4 hrs rising).
- Support programs that raise awareness of the valuable role wetlands play within the watershed.
- Initiate collaborative and interagency conservation, restoration and enhancement projects that improve native fish habitat and water quality.
- Support efforts to reduce river contaminants in storm water runoff.
- Support education and community awareness/outreach programs to increase public awareness of the unique nature of the Deschutes Subbasin and the positive effects of projects that conserve water and increase irrigation efficiency.

Research and Evaluation Strategies

- Monitor the trout and aquatic invertebrate populations in the Deschutes, Fall and Spring rivers.
- Monitor and evaluate the adequacy of existing down-ramping rates to minimize loss of fish and macroinvertebrates.
- Research and model the potential success of fish populations between Wickiup Reservoir and the North Canal Dam with stable annual water levels.
- Evaluate sources and effects of spikes in turbidity on fish habitat and populations.
- Evaluate impacts of urban and rural runoff and effects on fish populations and water quality.
- Support water quality monitoring between Wickiup Dam and North Canal Dam in order to evaluate the successes of management strategies.
- Conduct a redband trout life history study to identify spawning and rearing areas and better define population characteristics including distribution, size and age at maturity, spawning frequency, abundance and migration patterns.
- Monitor population trends of fishes in the Deschutes River and tributaries.
- Complete an inventory and evaluate of current conditions of wetlands and their ability to restore and enhance water quality.
- Evaluate the distribution and connectivity between Oregon spotted frog populations.

3.8.4. Little Deschutes River

Key Findings

- No known core redband trout populations exist in the Little Deschutes system.
- Remnant redband trout populations are found in the section of the Little Deschutes below Gilchrist Mill Pond and in Crescent Creek from the Crescent Cut-off Road to Hwy 58.
- Nonnative brown and brook trout compete with redband trout for food and space.
- Several reaches in the Little Deschutes drainage are federally designated as Wild and Scenic Rivers, including the Little Deschutes River from Hemlock Creek to the headwaters (RM 84-97), Crescent Creek from the County Road to Crescent Lake Dam (RM 18.5-30), and Marsh Creek from the mouth to headwaters (RM 0-15).

- The combination of an altered flow regime, historic grazing practices, and more recently urbanization of the river corridor has had the greatest impact on aquatic habitat conditions.
- Low summer flow compounds temperature problems in the lower river.
- Several reaches in this habitat complex exceed State water quality criteria: Little Deschutes for temperature (both spawning and rearing) from Crescent Creek to Hemlock Creek and for dissolved oxygen (both spawning and rearing) from mouth to Crescent Creek; Crescent Creek for summer temperature (mouth to RM 26.1) and Paulina Creek (RM 0-13.2). More data is needed for the Little Deschutes River from the mouth to Crescent Creek to determine if temperatures exceed criteria, and examine bacteria, nutrients and sediments. Crown Pacific holds an industrial NPDES permit to discharge cooling water and process wastewater into the Little Deschutes at the town of Gilchrist.
- Cover in the lower reach of the Little Deschutes is lacking. The combination of low flows, erosion, and degraded riparian condition have eliminated or substantially reduced those features that would normally provide stream cover.
- Groundwater levels are very high near the Little Deschutes River and increase in depth at higher land elevations.
- The majority of riparian/wetland habitat in the drainage is privately owned.
- Fire suppression may be the most important factor influencing vegetation patterns in the Little Deschutes drainage.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Restore and maintain instream habitat complexity and cover.
- Restore and maintain streambank stability and integrity.
- Provide fish passage at all artificial barriers and provide fish protection screens at water diversions.
- Increase minimum stream flow.
- Meet State water quality criteria for salmonid spawning and rearing.

Sub-watershed Strategies

- Reduce grazing impacts on riparian stream corridors.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Restore water tables under former wet meadows and stream floodplains to provide natural sub-irrigation and stream flow and temperature moderation.
- Manage riparian ecosystems to encourage increased number and distribution of beaver.

Operational and Policy Strategies

- Protect and increase distribution, population abundance and connectivity of remnant redband populations. Restore core redband trout populations where possible.
- Work with water users to increase the efficiency of water delivery and management practices to increase the minimum summer stream flow.
- Initiate collaborative conservation, restoration and enhancement projects that improve native fish habitat and water quality.

Research and Evaluation Strategies

- Determine life history characteristics of redband trout in the habitat complex, including distribution, abundance, seasonal habitat preferences, timing of spawning, spawning migrations or concentrations, key spawning habitat, movement within and between habitat areas and assessment units, and inter and intra-specific competition.

3.9. Cascade Highlands Assessment Unit

Cascade Highlands Assessment Unit includes the Cascade Lakes and upper Deschutes River drainage above Wickiup Dam.

Key Findings

- Redband and bull trout were endemic to this assessment unit.
- Bull trout have been extirpated from all but the Odell Creek / Odell Lake habitat complex.
- Bull trout were last seen in Wickiup Reservoir in 1954.
- The remnant population of bull trout in the Odell Creek/ Odell Lake complex is the only resident, non-reservoir, adfluvial population remaining in Oregon.
- The goal of the USFWS recovery plan for bull trout in the Deschutes Recovery Unit is to ensure the log-term persistence of self-sustaining complex interacting groups of bull trout distributed throughout the species native range.
- Tributaries to Crane Prairie Reservoir provide about 13.5 miles of stream habitat for redband trout, over three quarters of which is in the upper most reach of the Deschutes River. One quarter of the habitat is in Deschutes River tributaries.
- The Deschutes River between Wickiup Reservoir and Crane Prairie Dam is approximately two miles in length and impacted by flow manipulation.
- Habitat restoration/enhancement opportunities exist in most streams.
- Ponderosa pine and lodgepole pine forests have been reduced by 80% since mid-1800s, and have been replaced by other mixed conifer type forests.
- High fluctuations in reservoir water levels leave large areas of aquatic habitat unsuitable for beaver and other wildlife, including lower sections of tributary streams and the Deschutes River between the reservoirs.

Objectives for Planning Horizon

The following biological and habitat objectives describe physical and biological changes needed in the Cascade Highlands Assessment Unit to achieve the vision for the Deschutes River Subbasin within the 25-year planning horizon. These objectives are consistent with the visions, objectives, and strategies adopted for the Columbia River Basin in the Northwest Power and Conservation Council program.

Biological Objectives

- Maintain current distribution of bull trout in Odell Lake Recovery Unit and determine the feasibility of re-establishing self-sustaining bull trout populations within historically occupied areas.
- Maintain stable or increasing trends in abundance of adult redband and bull trout.
- Conserve genetic diversity and provide opportunity for genetic exchange.

- Restore beaver colonies in tributaries above the influence of fluctuating reservoir water levels.

Habitat Objectives

- Maintain or restore 63 acres of riparian habitat along fourteen miles of stream.
- Protect, restore and maintain suitable habitat conditions for all redband and bull trout life history stages and strategies.
- Retain existing lodgepole pine and ponderosa pine forests, and restore these forests to historic areas wherever possible to benefit focal wildlife species, including white-headed woodpecker and mule deer.

Management Strategies for Protection and Restoration of Focal Fish and Wildlife Populations throughout Assessment Unit

Implementation of the management strategies identified below is needed to achieve the biological objectives for the Cascade HIghlands Assessment Unit by 2030.

Overall Management Strategy for Assessment Unit

- Protect and restore habitat within stronghold areas for redband trout, and work outward from these areas to expand fish distribution and abundance to meet biological and habitat objectives.
- Expand core bull population and reconnect redband trout populations across the assessment unit.
- Conserve genetic diversity and provide opportunity for genetic exchange.
- Restore riparian habitat complexity, preferably to build on, or extend, areas where good riparian habitat exists now or did historically.
- Priority actions include restoration in areas where structural upgrade will raise the water table to maintain instream flows, and encourage natural vegetative recovery.
- Native plant species should be used for riparian area re-vegetation, not exotic plant species.
- Restoration projects should increase range and abundance of existing native redband and bull trout populations. Multi-species benefits would have priority.

Management Strategies for Habitat Complexes

Two habitat complexes contain connected or similar habitats for focal fish populations in the Cascade Highlands Assessment Unit.

Deschutes River and tributaries above Wickiup Dam
Odell Creek Complex

Key findings and management strategies for protection and restoration of focal fish and wildlife populations in specific habitat complexes are identified below.

3.9.1. Deschutes River and Tributaries above Wickiup Dam

Key Findings

- Core redband populations are found in Wickiup and Crane Prairie reservoir complexes. These populations adapted an adfluvial life history following reservoir construction. They spawn in the tributaries and rear in the reservoirs.
- The Deschutes River between Little Lava Lake and Crane Prairie Reservoir is the most important redband trout spawning area.
- Rainbow trout indigenous to the Upper Deschutes River and tributaries are considered an inland redband trout and are listed as a sensitive species.
- Loss of habitat complexity increases rainbow trout and whitefish vulnerability to predation, but the impact on abundance is unknown.
- Self-sustaining exotic fish populations are present and may affect indigenous fish populations.
- The Deschutes River from Lava Lake to Crane Prairie Reservoir is designated as a State Scenic Waterway.
- Altered flows from water storage and seasonal releases reduce fish habitat quality and use in the Deschutes from Crane Prairie Dam to Wickiup Reservoir.
- High summer water temperatures associated with surface reservoir releases reduce water quality in reach between Crane Prairie Dam and Wickiup Reservoir.

Management Strategies Specific to Habitat Complex

In Channel Strategies

- Increase the quality, quantity and distribution of salmonid spawning habitat.
- Increase instream structural habitat complexity by 25%.
- Maintain protective fish screens at water intakes.
- Provide upstream and downstream passage for fish at road culverts and artificial obstructions in streams above Crane Prairie Reservoir.

Reservoir Strategies

- Maintain large wood structure/cover in Crane Prairie Reservoir.
- Reduce/manage seasonal reservoir pool fluctuation.

Sub-watershed Strategies

- Restore and maintain riparian habitat along stream and reservoir margins.
- Reduce concentrated recreation and other impacts on riparian stream corridors.

Operational and Policy Strategies

- Reduce seasonal flow fluctuations in the river between Wickiup Reservoir and Crane Prairie Dam.
- Identify optimal ramping rates for flows in area between Wickiup reservoir and Crane Prairie.
- Investigate feasibility of providing upstream and downstream passage at Wickiup and Crane Prairie dams.
- Coordinate with irrigation districts to assure fish protection screens are installed and maintained at the Crane Prairie and Wickiup intakes.

Research and Evaluation Strategies

- Identify impacts of barriers and sites of entrainment for redband and bull trout populations.
- Conduct periodic stream surveys to determine fish distribution and population status.
- Develop and conduct research and monitoring studies to determine movement of focal fish species and seasonal use of different habitat areas.
- Evaluate interactions and competition between native trout populations and exotic species.
- Evaluate the timing and effects of flow management strategies on water quality, quantity.
- Investigate with the USFS, BOR, and irrigation districts the possibility of plugging subterranean water leaks in Crane Prairie Reservoir to better manage reservoir storage and outflow to enhance aquatic habitats.

3.9.2 Odell Creek Complex

Key Findings

- The Odell Lake Complex is recognized as a core area for bull trout.
- Trapper Creek provides the only known bull trout spawning area in the Upper Deschutes watershed.
- Increased bull trout abundance could potentially come from expansion of spawning and juvenile rearing habitat in Trapper, Maklaks and Odell Creeks and/or use of historic habitat in Crystal Creek and other areas.
- Core redband trout populations exist in Odell and Davis lakes and use Odell Creek for spawning.
- Summer water temperatures and pH levels in Odell Creek exceed State water quality standards.
- High fine sediments in tributaries may limit salmonid spawning potential.
- Minimum flows in Odell Creek are typically in September with maximums in June. Mean monthly flows measured between 1970 and 1992 were 158 cfs for June and 79 cfs for September.
- The aquatic insect community sampled in and analyzed from Odell Creek in 1991, indicated that the stream has reduced habitat complexity and moderate to high embeddedness.
- Self-sustaining exotic fish populations are present and may affect indigenous fish populations.

Management Strategies Specific to Habitat Complex

In-Channel Strategies

- Increase instream structural habitat complexity by 25%.
- Maintain of improve water quality in the bull trout core area or potential core areas.
- Maintain or restore habitat in and adjacent to Trapper Creek to benefit spawning bull trout.
- Restore impaired stream channel areas.
- Provide fish passage at artificial obstructions and eliminate entrainment.

Sub-Watershed Strategies

- Reduce sediment sources through road stabilization and improved drainage systems, etc.
- Restore and maintain healthy riparian and floodplain areas with good habitat complexity and species diversity.
- Improve upland watershed health through effective management to increase water infiltration, retention and permeability rates and soil stability.

Operational and Policy Strategies

- Increase angler education to prevent over-harvest and incidental angling mortality of bull trout.
- Develop, implement fish stocking polices to reduce stocking of non-native fishes that affect bull trout.
- Address the issues of fish passage and flow maintenance at the barrier dam at the Odell Lake outlet.
- Initiate partnerships and collaborative processes to protect, maintain and restore functioning core areas for bull trout and redband trout.

Research and Evaluation Strategies

- Analyze interactions among aquatic species in Odell Recovery Unit, including competition between bull and lake trout in Odell Lake, and competition and hybridization between bull and brook trout in Trapper Creek.
- Assess feasibility of re-establishing bull trout in Crystal Creek and Odell Creek.
- Monitor for fish pathogens.
- Assess water quality in Odell Lake complex and identify sources of water quality impacts.
- Quantify and evaluate sources of fine sediments in tributary stream substrates and impacts on native fish populations.
- Identify barriers or sites of entrainment for bull and redband trout.
- Continue research to determine bull trout presence/absence, timing and abundance in habitat areas.

4. Cookbook of Potential Actions

Actions taken on individual watershed to achieve the management strategies and meet the biological objectives with vary depending on the restraints and opportunities that are unique to a particular situation. The following list of actions and activities describe many of the possible approaches available for habitat restoration in the subbasin.

Category of Action and/or Activity

1. Water Conservation / Stream Flow Recovery

Convert water conveyances from open ditch to pipe or lined canal
Convert delivery system to sprinkler or drip
Convert from instream diversion to groundwater wells
Convert point of withdrawal from gravity to pump
Convert water right to instream right thru lease, purchase, agreement
Consolidate or improve irrigation diversion dams

2. Restore riparian stream corridor / floodplain function

Protect the stream corridor and floodplain from livestock grazing and soil and vegetative disturbances.
Provide upland water sources for livestock
Provide controlled stream access points with hardened banks, fords
Plant or seed native species
Implement stream bank stabilization measures

3. Restore instream habitat complexity

Protect riparian stream corridors for future large woody debris supply
Install habitat forming materials such as large wood and/or boulders in the channel
Maintain existing instream structure
Restore overhanging vegetation
Encourage the establishment of beaver populations
Restore oxbow sloughs and backwaters
Protect springs and seeps

4. Reduce instream sedimentation

Re-establish a functional riparian vegetative corridor and floodplain
Harden livestock stream crossings or controlled access points
Stabilize stream banks with bio-engineering or other techniques
Implement upland conservation buffers
Implement upland conservation farm plans and cropping methods
Control invasive and noxious vegetation and re-establish native plants in riparian and upland areas
Implement erosion control practices
Relocate or decommission roads
Reduce road runoff into streams

5. Restore fish passage at artificial obstructions

Restore perennial stream flow
Modify, breach or remove obstructions
Install and maintain fully functional fish ladders
Install and maintain fully functional fish screens
Bridge, culvert and road ford maintenance, removal or replacement.
Increase minimum stream flow
Reduce maximum stream water temperature

6. Reduce stream channel scour or incision

Protect the stream corridor and floodplain to restore riparian vegetation
Install streambank protection, i.e. bio-engineering
Install instream structures (rock and large wood)

7. Reduce maximum stream temperatures

Restore riparian and floodplain function
Reduce stream channel width
Restore floodplain water table with increased channel elevation
Restore or increase minimum perennial stream flow
Implement water conservation measures
Re-establish and maintain beaver populations

8. Reduce stream channel width

Protect or re-establish diverse riparian vegetation
Restore floodplain function
Install interim sediment collection traps within the floodway
Restore instream structure
Install streambank protection, i.e. bio-engineering

9. Improve upland watershed health

Restore native grasslands
Implement upland grazing systems to reduce runoff and erosion
Implement erosion control practices
Implement upland conservation buffers
Develop upland water sources for livestock and wildlife
Protect riparian habitat associated with upland springs and seeps

5. Consistency with ESA/CWA Requirements

Endangered Species Act Compliance

Many of the larger issues regarding impacts to listed species that are concerns at the scale of the Columbia Basin are not concerns in the Deschutes Subbasin. Wild summer steelhead are caught incidentally in the Deschutes River hatchery steelhead fishery and the Sherars Falls tribal and sport fisheries, but must be released unharmed. The only harvest of bull trout occurs in Lake Billy Chinook under very restrictive regulations. Hatchery summer steelhead are produced at Round Butte Fish Hatchery under the guidance of the Round Butte Fish Hatchery Genetic Management Plan. Only Deschutes stock summer steelhead are cultured at the hatchery. Actions that are comtemplated in this plan are consistent with information the Deschutes Subbasin planning team has received from NOAA Fisheries' Technical Recovery Team to protect existing healthy populations of summer steelhead, improve the health of the populations that have low productivity or are in low abundance and to seek ways to increase the production of summer steelhead in historic habitat in the Middle Deschutes Subbasin. In addition, recommendations from the draft Recovery Plan for the Middle Columbia ESU Recovery Unit were incorporated into the Subbasin Plan where such recommendations were consistent with the plan scope and Technical Guide for Subbasin Planners. Like the Subbasin Plan, the FCRPS BiOp, and other fishery conservation management plans within the Columbia River Basin, recovery plans should be based on the principles of adaptive management for those factors for decline that are not completely understood, or for which strategies for conservation are not well defined. The Subbasin Plan strengthens this approach by recognizing factors for decline that can be reversed or reduced, and those factors for decline that are at this point not completely understood..

Clean Water Act Compliance

In the Deschutes Subbasin, the Federal Clean Water Act is implemented in large part through the State's preparation of water quality standards, Total Maximum Daily Loads (TMDLs) and TMDL implementation processes of designated management agencies. The Oregon Department of Environmental Quality (ODEQ) has identified streams throughout the subbasin as water quality limited for temperature, dissolved oxygen, pH, fecal coli form bacteria, sedimentation, turbidity, and/or total dissolved gas. ODEQ's data collection for TMDLs is underway and is expected to be completed in 2005. Completion of TMDLs is slated for the end of 2006. Once the TMDL modeling process begins, it is likely that it will produce goals specific to attainment of water quality criteria throughout the Subbasin. It is unclear at this point whether or not these goals, such as specific numeric targets necessary for attainment, will be consistent with the management strategies outlined in this Plan. This document recognizes that both the subbasin planning and TMDL processes are adaptive in nature. Once TMDLs are established for the subbasin planning area, the plan will be re-evaluated on some designated time-frame to incorporate new findings and ensure consistency with TMDLs and/or new 303(d) listings. It should also be noted that the findings of the subbasin planning process will be utilized in the TMDL process.

Achievement of the TMDL, in part, occurs through implementation of nonpoint source management plans: the Agricultural Water Quality Management Area Plans (SB 1010), the Oregon Forest Practices Act, County Comprehensive plans, and Federal

policies/plans on Forest Service lands. These plans vary from voluntary to proscriptive (though all should have reasonable assurance of implementation), and management oversight is normally conducted through the local, state or federal land use authority. Achievement of the TMDL also occurs through implementation of NPDES permits regulated by ODEQ. Initiative-based restoration/protection and public funding dovetails with TMDL implementation and is an important implementing mechanism. Subbasin Planning is recognized as a key effort that supports TMDL implementation, and will be recognized in the TMDL water quality management planning process.

6. Research, Monitoring and Evaluation

Research and monitoring programs have been on-going in some areas of the Deschutes Subbasin for many years. Biologists have collected anadromous fish data from the lower one hundred miles of the Deschutes River to estimate run size, in-river harvest and escapement for nearly forty years. This data collection includes statistical sport and tribal fish harvest monitoring, mark and recovery (modified Schnabel) population and escapement estimates and annual steelhead and Chinook spawning surveys. Life history studies have been completed on lower Deschutes summer steelhead, spring and fall Chinook and redband trout. A redband trout assessment was recently completed for the Crooked River drainage. There are ongoing studies on fall Chinook, bull trout and Pacific lamprey within the upper and lower subbasin. All of this existing data provided some general insight into how changes in habitat may have affected various focal fish populations. Some research, monitoring and evaluation of habitat changes — particularly those associated with recent habitat restoration projects — also provided important information that helps planners evaluate, focus and adjust restoration strategies.

During the assessments, however, biologist and planners often found that a lack of information about biological and environmental conditions in some individual watersheds hampered their efforts to clearly, and confidently, define environment/population relationships and identify needed restoration actions. In some cases, such as in some reaches of the upper Little Deschutes River drainage, little was known about the presence, distribution and life histories of redband trout populations. In other cases, not enough information was available about different habitat attributes to confidently rate their quality and assess potential gains in fish and wildlife production through habitat restoration. In many areas, little monitoring has occurred to accurately identify streamflow, water temperature and dissolved oxygen levels and fluctuation.

Many of these limitations are identified as key findings and addressed as research and evaluation management strategies at the assessment unit and habitat complex levels in the previous section. General research and monitoring and evaluation needs in the Deschutes Subbasin are also identified in Tables MP-1 and MP-2.

Table MP-1. Deschutes Subbasin Research Needs.

Research Need	Methods	Tools/Techniques
Focal Fish Life history Redband trout in middle and upper subbasin, Bull trout and Pacific lamprey in Lower Westside AU	Population status/distribution Habitat use and preference Interspecific relationships with exotic species (i.e. brook and Brown trout, three-spine stickleback, bass, Tui chub) Migration patterns/timing	Population sampling, tagging Radio telemetry Population sampling, telemetry
Stray out-of-basin hatchery fish	Enumerate stray summer steelhead and Chinook salmon in the subbasin by species and origin Estimate number of stray steelhead spawning in subbasin Evaluate disease risks	Count at Sherars Falls, Pelton and Warm Springs Hatchery traps and potentially tributary weirs (Buck Hollow, Bakeoven and Trout creeks) Spawning surveys, trapping, tagging Collect random samples from stray steelhead and Chinook salmon
Habitat restoration treatments	Evaluate past projects affect on habitat restoration/recovery Evaluate different treatments for same habitat deficiency Evaluate best opportunities for natural water storage/retention and flow augmentation Evaluate most effective techniques or treatments for water temperature moderation Evaluate the opportunities for restoring natural stream channel sinuosity and gradient.	Recover project documentation and evaluation data, if available Conduct extensive literature review Review past or ongoing projects Establish control and reference plots Geologic and groundwater investigations Establish control and reference streams and reaches. Consult historic photos, maps, topography. Conduct surveys. Consult with landowner/manager

Table MP-2. Deschutes Subbasin Monitoring and Evaluation Needs.

Monitoring Need	Methods	Tools/Techniques
Population status & trends – focal fish	Estimate in-basin harvest	Continue statistical sampling programs
	Estimate annual population (run) size	Continue tag/recapture/population estimates Continue counts at Pelton/Warm Springs Install tributary weirs Continue and expand spawning surveys
	Estimate population productivity	Sample spawners for age, sex, and size
	Estimate number of out-of-subbasin stray steelhead and Chinook salmon	Record mark/tag info in creel and traps Continue tag/recapture/population estimates Seek 100% mark of all Basin hatchery fish Tributary weir monitoring
	Determine seasonal focal fish distribution	Continue and expand spawning surveys Presence/absence surveys
	Estimate juvenile/smolt production	Tributary enumeration, trapping
Stream Habitat Attribute baseline	Determine % riparian function by stream	Conduct AIP-type surveys
	Determine % fine sediments (embeddedness and intragravel)	Conduct AIP-type surveys
	Determine existing water quality (DO, Temperature, pH, pollutants, turbidity, etc)	Conduct AIP-type surveys
	Determine quantity/quality/distribution of instream structure	Conduct AIP-type surveys
	Determine instream habitat diversity (habitat types)	Conduct AIP-type surveys
	Determine channel/bank stability Record current stream flow	Conduct AIP-type surveys
Restoration Treatments	Determine effectiveness/response	Photo points and attribute monitoring as appropriate for the type of treatment
	Determine changes in: morphology, vegetation, water quality and quantity	Water quality monitoring Stream/Riparian/Floodplain Transects Upland watershed transects/photo points Utilize continuous recording flow gauge and temperature recorder.
Exotic fish	Determine affect on focal fish	Fish population monitoring Presence/absence surveys
Beaver	Determine changes in abundance and distribution	Population/presence absence surveys

Coordination with Pacific Northwest Aquatic Monitoring Partnerships

This planning document recognizes the need for a disciplined, and well coordinated, monitoring and evaluation program to help confirm scientific assumptions, resolve key uncertainties and provide the basis for performance tracking and adaptive management. Collecting monitoring data in a way that data can be "rolled-up" to larger scales is essential for information gathered at the scale of watersheds or subbasins to support evaluations at larger geographic scales, such as province or Evolutionarily Significant Unit. The Warm Springs Tribes and ODFW currently follow monitoring protocols developed for the Oregon Plan for Salmon and Watersheds. These protocols are standardized and are being coordinated with regional standards through Pacific Northwest Aquatic Monitoring Partnerships (PNAMP) discussions.

The PNAMP provided "Considerations for monitoring in subbasin plans" on May 4, 2004. We generally agree with and support the intent and direction of these guidelines. However, key elements of the Partnership's recommendations have yet to be developed (e.g. the Strategic Monitoring Framework, a data management plan, etc.). For this reason and due to the extremely short time available to respond to these suggestions, we have been unable to incorporate specifically the Partnership's monitoring recommendations. Rather, we offer here some perspectives on how parties to the Deschutes Subbasin Plan can integrate their monitoring efforts into a regionally consistent framework. This is a forward-looking effort and, although it is to a degree a "plan to develop a plan", that cannot entirely be avoided since so many critical elements are yet to be developed at a regional level.

The PNAMP guidance includes recommended principles for coordinated monitoring. These principles are organized into four issue areas. This subbasin plan incorporates those principles as follows.

1. Principles for Resource Policy and Management

Discussions by the Deschutes Coordinating Group and with natural resource managers in the subbasin have consistently identified answers to the following questions as central to having a successful fish and wildlife restoration program.

a. What are the trends over time in the productivity, abundance and distribution of focal species identified in this plan?
b. What are the trends over time in the amount, quality, and distribution of the habitats upon which these focal species depend?
c. Considering the subbasin as a whole, are habitat conditions showing a net improvement or a net degradation?
d. Which habitat restoration strategies are most effective and most cost-effective (not necessarily the same thing) at i) improving habitat conditions and ii) affecting the performance of focal species populations?

The Deschutes Coordinating Group will work with ODFW, the Warm Springs Tribes, the U.S. Forest Service, and other natural resource agencies to establish a monitoring and evaluation technical team by August 31. The technical team will evaluate how present monitoring efforts in the subbasin address policy questions, identify gaps in existing efforts, and suggest how the efforts could be improved. The team will report its findings and recommendations to the Deschutes Coordinating

Group by January 31, 2005. The Deschutes Coordinating Group will then sponsor an M&E workshop by 4/31/05 to review and refine recommendations in the report and identify changes (including additional effort needed) to be proposed and implemented in FY06. This additional information will be formally incorporated into the subbasin plan during the Council's subsequent rolling review period.

2. Principles for Efficiency and Effectiveness

The report and workshop described above will identify opportunities for agencies to coordinate monitoring efforts to address policy questions. The seven specific PNAMP principles in this category will be part of the workshop agenda also. Recommendations that are possible within existing programs and budgets will begin being officially coordinated in FY06.

Local agency offices within the Deschutes Subbasin do not have the staff and other resources to participate directly in PNAMP. Rather, they will rely on the federal, state, and tribal representatives who do participate in PNAMP to disseminate relevant material and provide local support for regional monitoring needs and coordination. This is a function the PNAMP Steering Committee could likely provide.

3. Principles for Scientific Soundness

Some of the seven principles in this category (e.g. integrated monitoring and shared goals and objectives) will be wholly or partially met as described above when addressing other principles. Other principles (e.g. regional consensus on status and trend monitoring, guidelines on multiple spatial and temporal scales) will be developed by others at a regional level. We intend to incorporate these when they become available and within the rolling review process of the Power and Conservation Council.

Still other principles in this category (e.g. statistically precise monitoring designs) will require expertise not normally available locally. Perhaps these technical resources can be provided by a state or regional group dedicated to working with local subbasin groups to translate regional agreements into effective implementation by local programs and projects. The TOAST model is an example of the type of technical support we feel would be effective.

4. Principles for Sharing Information

The five information sharing principles in this category are largely beyond the resources of local agency and tribal offices. We have neither the necessary skills locally, nor a budget able to provide those skills.

Our immediate information sharing strategy is to call upon existing regional information management projects to provide the expertise and guidance to meet these principles. We will begin this process by using the StreamNet system to archive the technical work done for this plan. This will consist of the GIS and tabular data files used in the assessment. These reach-specific files will form the basis of future monitoring efforts.

We will look to the Northwest Environmental Database Network to develop regional strategies and standards for information sharing. That project has the breadth of concept and technical expertise to effectively integrate monitoring information into a broader fish and wildlife data management system.