STRATEGY FOR RECOVERY

A core area represents the closest approximation of a biologically functioning unit for bull trout. The combination of core habitat (*i.e.*, habitat that could supply all elements for the long-term security of bull trout, including for both spawning and rearing, as well as for foraging, migrating, and overwintering) and a core population (*i.e.*, bull trout inhabiting core habitat) constitutes the basic core area upon which to gauge recovery within a recovery unit. Within a core area, many local populations may exist. Core areas for bull trout recovery in the Klamath River basin occur in three distinct watersheds: the Upper Klamath Lake core area; the Sycan River core area; and the Upper Sprague River core area (Figure 2).

Recovery Goals and Objectives

The goal of the bull trout recovery plan is to **ensure the long-term persistence of self-sustaining, complex interacting groups of bull trout distributed across the species native range, so that the species can be delisted**. To recover bull trout in the Klamath River Recovery Unit, the following objectives need to be met:

- Maintain current distribution of bull trout and restore distribution in previously occupied areas within the Klamath River Recovery Unit, as noted in Appendix A.

- Maintain stable or increasing trends in abundance of bull trout within the Klamath River. This objective includes the expression of all life history strategies, including resident, fluvial, and

  adfluvial forms in the Upper Klamath Lake core area and resident and fluvial forms in the Sycan River and Upper Sprague River core areas.

- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies. Stable or upward trends in habitat quality in core areas and migration corridors are achieved through landscape-

level adjustments in land management strategies designed to maintain and/or enhance structural and functional attributes of upslope, riparian, and fluvial systems.

- Conserve genetic diversity and provide opportunity for interchange of genetic material among appropriate core populations.

Rieman and McIntyre (1993) and Rieman and Allendorf (2001) evaluated the bull trout population numbers and habitat thresholds necessary for long-term viability of the species. They identified four elements, and the characteristics of those elements, to consider when evaluating the viability of bull trout populations. These four elements are (1) number of local populations; (2) adult abundance (defined as the number of spawning fish present in a core area in a given year); (3) productivity, or the reproductive rate of the population (as measured by population trend and variability); and (4) connectivity (as represented by the migratory life history form and functional habitat). For each element, the Klamath River Recovery Unit Team classified bull trout into relative risk categories based on the best available data and the professional judgment of the team.

The Klamath River Recovery Unit Team also evaluated each element under a potential recovered condition to produce recovery criteria. Evaluation of these elements under a recovered condition assumed that actions identified within this chapter had been implemented. Recovery criteria for the Klamath River Recovery Unit reflect (1) the stated objectives for the recovery unit, (2) evaluation of each population element in both current and recovered conditions, and (3) consideration of current and recovered habitat characteristics within the recovery unit. Recovery criteria will probably be revised in the future as more detailed information on bull trout population dynamics becomes available. Given the limited information on bull trout, both the level of adult abundance and the number of local populations needed to lessen the risk of extinction should be viewed as a best estimate.

This approach to developing recovery criteria acknowledges that the status of populations in some core areas may remain short of ideals described by conservation biology theory. Some core areas may be limited by natural attributes or by patch size

and may always remain at a relatively high risk of extinction. Because of limited data within the Klamath River Recovery Unit, the recovery unit team relied heavily on the professional judgment of its members.

Local Populations

Metapopulation theory is important to consider in bull trout recovery. A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994) (see Chapter 1). Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events. In part, distribution of local populations in such a manner is an indicator of a functioning core area. Based in part on guidance from Rieman and McIntyre (1993), bull trout core areas with fewer than 5 local populations are at increased risk, core areas with between 5 and 10 local populations are at intermediate risk, and core areas with more than 10 interconnected local populations are at diminished risk.

Current local populations in the Klamath River Recovery Unit are 1) Upper Klamath Lake core area: Threemile Creek, Sun Creek, and Lost Creek; 2) Sycan River core area: Long Creek and Coyote Creek; 3) Upper Sprague River core area: Deming Creek, Boulder-Dixon Creek, Brownsworth Creek, Leonard Creek, North Fork Sprague River, and Sheepy Creek. Using the above guidance for assessing risk, if all local populations were interconnected, bull trout in the Klamath River Recovery Unit would be at diminished risk. Resident bull trout are known to occur within the recovery unit. However, an accurate description of their current distribution is unknown, and the identification of resident local populations is considered a research need.

Adult Abundance

The recovered abundance levels in the Klamath River Recovery Unit were determined by considering theoretical estimates of effective population size, historical census information, and the professional judgment of recovery team members. In general, effective population size is a theoretical concept that allows us to predict potential future losses of genetic variation within a population due to small population sizes and genetic drift (see Chapter 1). For the purpose of recovery

planning, effective population size is the number of adult bull trout that successfully spawn annually. Based on standardized theoretical equations (Crow and Kimura 1970), guidelines have been established for maintaining minimum effective population sizes for conservation purposes. Effective population sizes of greater than 50 adults are necessary to prevent inbreeding depression and a potential decrease in viability or reproductive fitness of a population (Franklin 1980). To minimize the loss of genetic variation due to genetic drift and to maintain constant genetic variance within a population, an effective population size of at least 500 is recommended (Franklin 1980; Soule 1980; Lande 1988). Effective population sizes required to maintain long-term genetic variation that can serve as a reservoir for future adaptations in response to natural selection and changing environmental conditions are discussed in Chapter 1 of the recovery plan.

For bull trout, Rieman and Allendorf (2001) estimated that a minimum number of 50 to 100 spawners per year is needed to minimize potential inbreeding effects within local populations. In addition, a population size of between 500 and 1,000 adults in a core area is needed to minimize the deleterious effects of genetic variation from drift.

For the purposes of bull trout recovery planning, abundance levels were conservatively evaluated at the local population and core area levels. Local populations containing fewer than 100 spawning adults per year were classified as at risk from inbreeding depression. Bull trout core areas containing fewer than 1,000 spawning adults per year were classified as at risk from genetic drift.

Overall, bull trout in the Klamath River Recovery Unit persist at low numbers in fragmented local populations. Evaluation of genetic risks for local populations and core areas was based on the aforementioned guidance, and available adult abundance estimates (Table 2). In cases where specific adult population estimates were lacking, local populations and core areas were conservatively considered at risk from inbreeding and drift, respectively.

In the Upper Klamath Lake core area, Threemile Creek has an estimated adult abundance of 45 individuals which would place this local population at risk from

inbreeding depression. While Sun Creek represents one of the strongest local populations in the Upper Klamath core area, the lack of recent adult abundance estimates placed precluded the evaluation of inbreeding depression risk for this local population. Similarly, evaluation of genetic risk at the local population level for bull trout in Lost Creek was prevented by a lack of adult abundance information. Based on available information, the Upper Klamath Lake core area may contain less than 1,000 adult bull trout and should be considered at risk from genetic drift.

Within the Sycan River core area, limited data on adult abundance within Coyote Creek conservatively placed this local population at risk from inbreeding. Estimates for adult abundance in Long Creek suggest that this local population may not be at risk from inbreeding depression (Table 2). Overall the Sycan River core area should be considered at risk from the deleterious effects of genetic drift.

Bull trout within the Upper Sprague core area may represent some of the strongest remaining local populations in the Klamath recovery unit. Based on available information, the local populations in Brownsworth, Deming, and Leonard creeks are not at risk from inbreeding depressions. However, local populations within the North Fork Sprague River, Boulder-Dixon and Sheepy creeks are considered to be at risk from inbreeding depression. Overall, if all local populations were connected, the Upper Sprague River core area would not be at risk from genetic drift.

Productivity

A stable or increasing population is a key criterion for recovery under the requirements of the Endangered Species Act. Measures of the trend of a population (the tendency to increase, decrease, or remain stable) include population growth rate or productivity. Estimates of population growth rate (*i.e.*, productivity over the entire life cycle) that indicate a population is consistently failing to replace itself also indicate an increased risk of extinction. Therefore, the reproductive rate should indicate that the population is replacing itself, or growing.

Since estimates of the total population size are rarely available, the productivity or population growth rate is usually estimated from temporal trends in

indices of abundance at a particular life stage. For example, redd counts are often used as an index of a spawning adult population. The direction and magnitude of a trend in the index can be used as a surrogate for the growth rate of the entire population. For instance, a downward trend in an abundance indicator may signal the need for increased protection, regardless of the actual size of the population. A population that is below recovered abundance levels, but that is moving toward recovery, would be expected to exhibit an increasing trend in the indicator.

The population growth rate is an indicator of probability of extinction. This probability cannot be measured directly, but it can be estimated as the consequence of the population growth rate and the variability in that rate. For a population to be considered viable, its natural productivity should be sufficient for the population to replace itself from generation to generation. Evaluations of population status will also have to take into account uncertainty in estimates of population growth rate or productivity. For a population to contribute to recovery, its growth rate must indicate that the population is stable or increasing for a period of time. Due to the overall lack of long-term population census information in the Klamath River Recovery Unit, the recovery unit team believes bull trout to be at increased risk.

Connectivity

The presence of the migratory life history form within the Klamath River Recovery Unit was used as an indicator of the functional connectivity of the recovery unit. If the migratory life form was absent, or if the migratory form is present but local populations lack connectivity, the core area was considered to be at increased risk. If the migratory life form persists in at least some local populations, with partial ability to connect with other local populations, the core area was judged to be at intermediate risk. Finally, if the migratory life form was present in all or nearly all local populations, and had the ability to connect with other local populations, the core area was considered to be at diminished risk. Lack of passage within the Klamath River Recovery Unit has fragmented bull trout populations and prevented migration to foraging and overwintering habitat. Lack of passage and the low abundance of migratory life history strategy also limit the possibility for genetic exchange and refounding of local populations.

Recovery Criteria

Recovery criteria for bull trout in the Klamath River Recovery Unit are the following:

1. **Maintain current distribution of bull trout in the 12 local populations that have been identified and expand distribution by establishing bull trout in areas identified as suitable for potential local populations.** The number of existing local populations by core area are: Upper Klamath Lake, 3; Sycan River, 2; and Upper Sprague River, 7 (Table 5).

Table 5. Summary of recovery criteria for the Klamath River Recovery Unit. Potential number of local populations, potential abundance, and future trend reflect minimum standards under recovered conditions.

Core Area	Current number of local populations	Current estimated abundance	Potential number of local populations	Potential abundance	Future trend
Upper Klamath Lake	3	324	5 to 7 of 17	500 to 5,000	stable to increasing
Sycan River	2	842	5 to 7 of 15	500 to 5,000	stable to increasing
Upper Sprague River	7	3,310	10 to 12 of 24	500 to 5,000	stable to increasing
3 Core Areas	12	4,476	20 to 26 of 56	8,250	stable to increasing

Table 6 presents specific local populations and areas identified as potential local populations. Achieving criterion 1 entails maintaining existing local populations and establishing additional potential local populations of all core areas in

the recovery unit to achieve the maintenance of both current and recovered distribution. To achieve criterion 1 and to ensure a core area population of no fewer than 100 adult bull trout, establishing at least 5 to 7 local populations in the Klamath Lake core area among 15 potential local populations (2 to 4 new local populations), at least 5 to 7 local populations in the Sycan River core area from among 15 potential

Table 6. List of existing and proposed local populations by core area in the Klamath River Recovery Unit.

Recovery Unit	Core Area	Local Populations[a]
Klamath River	Upper Klamath Lake	Annie Creek, Cherry Creek Crooked Creek, Fort Creek, Fourmile Creek drainage, Jackson Creek, **Lost Creek** Munson Creek Nannie Creek Rock Creek Sand Creek, Scott Creek, Sevenmile Creek, Spring Creek **Sun Creek**, **Threemile Creek** Wheeler Creek
	Sycan River	Boulder Creek, Calahan Creek, Chocktoot Creek, **Coyote Creek**, Crazy Creek, Cummins Creek, Currier Creek, **Long Creek** Paradise Creek, Rifle Creek, Rock Creek, Skull Creek, South Fork Sycan River, Sycan River, Watson Creek

Table 6. List of existing and proposed local populations by core area in the Klamath River Recovery Unit.

Recovery Unit	Core Area	Local Populations[a]
	Upper Sprague River	Alder Creek, **Boulder-Dixon Creek**, **Brownsworth Creek**, Buckboard Creek, Camp Creek, Cold Creek, Corral Creek, Dead Cow Creek, **Deming Creek**, Gearhart Creek, Gold Creek, Hammond Creek, Hole Creek, Jack Creek, Jade Creek, **LeonardCreek**, Mud Creek, **North Fork Sprague River**, Nottin Creek, Pothole Creek, School Creek, **Sheepy Creek** South Fork Sprague River, Whitworth Creek

[a] Existing local populations of bull trout, or areas used seasonally by bull trout, are indicated in bold.

local populations (3 to 5 new local populations), and at least 10 to 12 local populations in the Upper Sprague River core area from among 25 potential local populations (3 to 5 new local populations) is necessary.

2. **Estimated abundance of adult bull trout is at least 8,250 individuals distributed among the Upper Klamath Lake, Sycan River, and Upper Sprague River core areas, based on 10 years of monitoring data.**

3. **Adult bull trout exhibit stable or increasing trends in abundance in the Upper Klamath Lake, Sycan River, and Upper Sprague River core areas, based on at least 2 generations (10 years) of monitoring data.**

4. **Specific barriers to bull trout migration in the Klamath River Recovery Unit are addressed.** In the Klamath River Recovery Unit, this objective means addressing passage: (1) existing culverts that impede passage should be replaced, including those on Threemile Creek at U.S. Forest Service Road 110 crossing, Brownsworth Creek at U.S. Forest Service Road 34 crossing, and Brownsworth Creek both 0.75 mile and 1.25 miles above U.S. Forest Service Road 34; the culvert 0.25 mile below U.S. Forest Service Road 34 (to prevent repeated washout); the large-diameter culvert at the Boulder Creek road crossing; culverts in the upper Sycan River watershed that are identified in the Fremont National Forest inventory; and several in the North Fork Sprague River drainage, namely, on North Fork Sprague River (2), Boulder Creek (1), Dead Cow Creek (1), and Sheepy Creek (1); (2) fish passage structures should be installed at water diversions on bull trout streams, and barriers should be removed, including on Cherry, Sevenmile, Sun, and Threemile Creeks; (3) fish screens should be installed to prevent fish from entering diversion canals or pipes, including on Long, Deming, Threemile, Sun, Sevenmile, and Cherry Creeks; 4) manmade barriers and entrainment should be evaluated and remedied to promote migratory bull trout; priority watersheds include Threemile, Long, Deming, Sevenmile, Cherry, Sun, and Long Creeks.

Recovery criteria for the Klamath River Recovery Unit were established to assess whether recovery actions are resulting in the recovery of bull trout. The Klamath River Recovery Unit Team expects that the recovery process will be dynamic and will be refined as more information becomes available. While removal of bull trout as a species under the Endangered Species Act (*i.e.*, delisting) can only occur for the entity that was listed (Columbia River distinct population segment), the criteria listed above will be used to determine when the Klamath River Recovery Unit

is fully contributing to recovery of the population segment. A summary of recovery criteria standards is presented in Table 5.

Research Needs

Many uncertainties exist regarding bull trout population abundance and distribution. If effective management and recovery based on the best scientific information available are to occur, the recovery plan for the Klamath River Recovery Unit must be treated as a "living" document—it must be updated as new information becomes available. As part of an adaptive approach to management, the Klamath River Recovery Unit Team has identified a number essential research needs within the recovery unit.

Distribution

It is important to understand the current and future role of the Sycan Marsh in the persistence and recovery of bull trout. Migratory bull trout appear to use portions of the marsh at least seasonally and probably on a year-round basis. It is also essential to establish with greater certainty the current distribution and seasonal use areas of remnant migratory bull trout within the mainstem rivers within the Klamath River Recovery Unit. To this end, the recovery unit team recommends developing and applying a statistically rigorous, standardized protocol for determining distribution of bull trout. Application of such a protocol will improve the team's ability to modify existing or identify new core areas.

Specific waters mentioned in anecdotal reports of bull trout should be targeted for surveys to clarify bull trout distribution within the recovery unit. These areas include the Sycan River watershed, both above and below the Sycan Marsh, and the upper reaches of the North and South Forks of the Sprague River. Also, unoccupied habitat that has the potential to be restored and to have bull trout reestablished needs to be identified.

Pathogens

The extent of threats to Klamath River basin bull trout from pathogens and parasites is unknown. One species of myxosporean parasite, *Ceratomyxa shasta*, has

been found in Klamath River drainages (Wales and Wolf 1955) and lower elevation tributaries to Klamath Lake (R. Smith, pers. comm., 2000). The distribution of *C. shasta* within the Klamath River basin is unknown. Although there is evidence to suggest that some strains of salmonids may be resistant to *C. shasta* (Schafer 1967; R. Smith, pers. comm., 2000), whether Klamath River bull trout are resistent is unknown. If bull trout are susceptible to *C. shasta*, recovery of the char beyond colder natal and mainstem drainages could be difficult. Among topics needing research are distribution of the parasite in the Klamath River basin; the degree of resistance that bull trout may posses; vectors of disease transmission; intermediate hosts, if any; and methods to control the disease.

ACTIONS NEEDED

Recovery Measures Narrative

In this chapter and all other chapters of the bull trout recovery plan, the recovery measures narrative consists of a hierarchical listing of actions that follows a standard template. The first-tier entries are identical in all chapters and represent general recovery tasks under which specific (*e.g.*, third-tier) tasks appear when appropriate. Second-tier entries also represent general recovery tasks under which specific tasks appear. Second-tier tasks that do not include specific third-tier actions are usually programmatic activities that are applicable across the species' range; they appear in *italic type*. These tasks may or may not have third-tier tasks associated with them; see Chapter 1 for more explanation. Some second-tier tasks may not be sufficiently developed to apply to the recovery unit at this time; they appear in *a shaded italic type (as seen here)*. These tasks are included to preserve consistency in numbering tasks among recovery unit chapters and intended to assist in generating information during the comment period for the draft recovery plan, a period when additional tasks may be developed. Third-tier entries are tasks specific to the Klamath River Recovery Unit. They appear in the implementation schedule that follows this section and are identified by three numerals separated by periods.

The Klamath River Recovery Unit chapter should be updated as recovery tasks are accomplished or revised as environmental conditions change and monitoring results or additional information becomes available. The Klamath River Recovery Unit Team should meet annually to review annual monitoring reports and summaries and make recommendations to the U.S. Fish and Wildlife Service.

1 Protect, restore, and maintain suitable habitat conditions for bull trout.

1.1 Maintain or improve water quality in bull trout core areas or potential core habitat.

1.1.1 Conduct watershed assessments. The U.S. Forest Service (USFS), National Park Service (NPS), Bureau of Land

Management (BLM), Oregon Department of Forestry (ODF), U.S. Timberlands (UST), and The Nature Conservancy (TNC) should conduct thorough surveys of sediment sources and channel stability (watershed analysis) in all bull trout watersheds within their respective areas of responsibility. If a watershed contains lands under the responsibility of more than one entity, all parties should jointly conduct the watershed analysis. The watershed analysis should include a reassessment of previous road closures and treatments for their effectiveness; identification of skid trails, roads, and landings that are no longer needed; an evaluation of hydrographic regime; and a review of land and resource management activities and their impacts on watershed function. Roads that need to be hydrologically improved and/or decommissioned should also be identified (*e.g.*, Deming Creek and Threemile Creek).

1.1.2 Monitor sediment loading in current and potential bull trout habitat. Because these creeks either currently support bull trout or have a high probability of supporting them following the implementation of restoration and

conservation measures, the land use management agencies should routinely monitor sediment loading to minimize potential for adverse impacts to bull trout.

1.1.3 Reduce general sediment sources. All roads, crossings, and other sources of sediment delivery should be stabilized. Potential sites include U.S. Forest Service Road 3413 along Threemile Creek; U.S. Forest Service Road 103 adjacent to Brownsworth Creek; U.S. Forest Service Road 400 along Long Creek; roads and sediment sources on Calahan, Coyote, Deming, Boulder, Leonard, and Cherry Creeks; and bank

stability along Paradise and Watson Creeks and the lower Sycan River.

1.1.4 Modify roads and trails to allow natural drainage patterns. Trails that channel water or block side channels should be modified in all watersheds by the respective land use management entity.

1.1.5 Conduct limiting factors analysis for impact of roads. Identify roads that are susceptible to mass wasting and bank failures, intercept surface or ground water, negatively impact riparian areas, and inhibit connectivity and natural stream function. Implement corrective actions where appropriate. Road density in bull trout watersheds should be reduced to less than 1.0 mile per square mile with few roads in valley bottoms.

Prospective road candidates include approximately 100 miles of roads within the Fremont National Forest within the upper Sycan River drainage that have hydrological connection or are within riparian areas, as well as U.S. Forest Service Road 3413, from 3413-110 to its connection with U.S. Forest Service Road 3449, on the Winema National Forest along Threemile Creek. A 50 percent reduction in road density within the Threemile Creek and Sevenmile Creek watersheds should be achieved. The 3208-105 spur should be permanently closed and rehabilitated. Alternatives to retaining the Sevenmile Creek trailhead and campground should be developed and implemented. The campground and road are immediately adjacent to the stream channel, and both contribute sediment directly into the creek. Supports for the washed-out bridge are still within the stream channel and should be removed.

1.1.6 Monitor baseline instream habitat and watershed conditions. On a regular schedule, instream habitat and watershed

conditions should be monitored and resulting recommendations implemented through adaptive management to reduce impacts from land and resource management actions.

1.1.7 Assess nutrient input from forestry and agriculture. The effects of nutrient enrichment from forestry and agriculture should be addressed by all land managers within their respective areas of responsibilities.

1.1.8 Implement measures to reduce nutrient input. Measures to reduce the introduction of nutrient enrichment that is identified through assessment of forestry and agriculture practices should be implemented as soon as possible. Some of these measures are limiting or removing agriculture and livestock grazing immediately adjacent to streams and waterways, establishing buffer zones between waterways and agriculture and grazing, and restoring natural streamside and riparian plant communities.

1.1.9 Implement water quality regulations. Encourage rapid implementation of total maximum daily load (known as TMDL) standards for current and potential bull trout waters included in the 303(d) list of impaired water bodies. These include currently occupied reaches of Threemile Creek (listed for habitat) and Deming, Boulder, Leonard, Brownsworth, Long, and Sun Creeks (listed for temperature).

1.1.10 Increase water quality monitoring. A detailed water quality monitoring plan developed by the respective land use entity, with oversight from the Klamath Basin Bull Trout Working Group, should be implemented for all watersheds having known populations of bull trout and in streams considered potential local populations (Table 5) to refine the water quality

requirements for bull trout and to provide corrective action, should it be necessary, as soon as possible.

1.1.11 Increase enforcement of water quality standards. In all streams with known bull trout populations and in all streams considered potential local populations (Table 5), all land use managers should ensure that water quality standards are being met within their areas of responsibility, and the Oregon Department of Environmental Quality should enforce all water quality standards, including newly completed total maximum daily loads (TMDLs).

1.2 Identify barriers or sites of entrainment for bull trout and implement tasks to provide passage and eliminate entrainment.

1.2.1 Investigate methods to improve instream flows. Land use managers should investigate methods to increase water retention and slow runoff in watersheds exhibiting low or intermittent stream flows in streams like Rock, Cherry, Threemile, Boulder, and Hammond Creeks.

1.2.2 Implement measures to improve instream flows. Land use managers should implement measures to increase water retention and slow runoff in watersheds exhibiting low or intermittent stream flows in streams like Rock, Cherry, Threemile, Boulder, and Hammond Creeks.

1.2.3 Monitor all road crossings. All road crossings should be routinely monitored by respective land use managers to identify blockages to upstream passage.

1.2.4 Eliminate culvert barriers. Existing culverts that impede passage should be replaced immediately. Examples of culverts that have been identified as barriers include Threemile Creek

at U.S. Forest Service Road 110 crossing; Brownsworth Creek at U.S. Forest Service Road 34 crossing; culverts on Brownsworth Creek, 0.75 mile and 1.25 mile above U.S. Forest Service Road 34; the culvert 0.25 mile below U.S. Forest Service Road 34 (needs to be replaced to prevent repeated washout); the large diameter culvert at the Boulder Creek road crossing; nearly 80 percent of the culverts in the upper Sycan River watershed as identified in the Fremont National Forest inventory; and culverts in the North Fork Sprague River drainage, including North Fork Sprague River (2), Boulder Creek (1), Dead Cow Creek (1), and Sheepy Creek (1).

1.2.5 Analyze watercourses for ability to pass bull trout. Land use managers should assess all streams and manmade structures within their respective areas of responsibility to determine whether fish passage is blocked and/or fish are entrained. Creeks to be evaluated include Long, Deming, Threemile, Sun, Sevenmile, and Cherry Creeks.

1.2.6 Provide fish passage at water diversions. Appropriate fish passage structures should be installed at water diversions on bull trout streams, and barriers should be removed. Examples of areas that may require solutions to passage barriers include Cherry, Sevenmile, Sun, and Threemile Creeks.

1.2.7 Eliminate entrainment in diversions. Fish screens should be installed to prevent fish from entering diversion canals or pipes. Areas potentially needing screens include Long, Deming, Threemile, Sun, Sevenmile, and Cherry Creeks.

1.2.8 Assess manmade barriers. Evaluate manmade barriers as impediments to migratory bull trout and explore solutions if barriers are found to impede movement. Priority watersheds include Threemile, Sun, and Long Creeks.

1.3 Identify impaired stream channel and riparian areas and implement tasks to restore their appropriate functions.

1.3.1 Identify areas in and along streams for restoration. Streams should be surveyed to determine where reestablishment of canopy and shade would benefit native fish. Priority watersheds or stream reaches include Boulder and Threemile Creeks and the North and South Forks of the Sprague River.

1.3.2 Revegetate denuded riparian areas. Native riparian vegetation should be restored to reestablish canopy and shade in streams where investigation indicates actions are likely to benefit native fish. Priority watersheds or stream reaches include Boulder and Threemile Creeks and the North and South Forks of the Sprague River.

1.3.3 Improve grazing practices. Where investigation indicates actions are likely to benefit native fish, improve grazing practices. Priority watersheds or stream reaches include Paradise and Watson Creeks; the lower Sycan River above the marsh where sedimentation is a problem; and Brownsworth Creek and many streams in the North Fork Sprague and upper Sycan River drainages that are deficient in pool habitat.

Fine sediments should be reduced from the current 27 to 44 percent fines to less than 20 percent fines. Primary focus should be placed on managing livestock to develop riparian vegetation and managing beaver to increase the number and depth of pools. Sedge mats and root wads can be used to stabilize eroding banks.

1.3.4 Develop cooperative efforts with permittees and private landowners in the Upper Klamath Lake, Sycan River, and Upper Sprague River core areas to address riparian restoration

and grazing issues. Recommendations by the Klamath Basin Bull Trout Working Group have resulted in land management agencies making changes to grazing practices in much of the basin's bull trout habitat. Additional efforts should be pursued to develop cooperative efforts with private landowners in the Upper Klamath Lake, Sycan River, and upper Sprague River drainages. Financial assistance and incentives may be available through the Klamath Basin Watershed Restoration Program or similar projects.

1.3.5 Improve instream habitat. Instream habitat should be improved by restoring historic stream channels, restoring recruitment of large woody debris, encouraging pool development, or carrying out other appropriate strategies in streams where investigation indicates that actions are likely to benefit native fish. Priority watersheds may include Brownsworth Creek, where spawning-size gravel is rare except behind large obstructions. Restoration of channel function in Penn Creek to reestablish an intermittent connection with Rock Creek would expand seasonal fish habitat and access to Penn Creek gravels; gravels are limited in Rock Creek. Managing beaver to increase the number and depth of pools would benefit native fish in Brownsworth Creek and many streams in the North Fork Sprague River and upper Sycan River drainages. Threemile, Brownsworth, Rock, Cherry, Paradise, and Watson Creeks and the lower Sycan River above the marsh would benefit from the reintroduction of large wood and through long-term management of streamside trees to provide adequate large wood in the future.

1.4 *Operate dams to minimize negative effects on bull trout in reservoirs and downstream.*

1.5 Identify upland conditions negatively affecting bull trout habitats and implement tasks to restore appropriate functions.

1.5.1 Assess watershed uplands for high runoff. Land managers should investigate each watershed 1) to identify upland areas that may be contributing to increased runoff in watersheds exhibiting low or intermittent stream flows, such as Rock, Cherry, Threemile, Boulder, and Hammond Creeks, and 2) to make recommendations for improvement.

1.5.2 Implement measures to increase water retention and slow runoff in watersheds exhibiting low or intermittent stream flows. In watersheds such as Rock, Cherry, Threemile, and Hammond Creeks, measures should be implemented to increase water retention and slow runoff from upland areas.

2 Prevent and reduce negative effects of nonnative fish and other nonnative taxa on bull trout.

2.1 Develop, implement, and enforce public and private fish stocking policies to reduce stocking of nonnative fish that affect bull trout.

2.2 Evaluate policies for preventing illegal transport and introduction of nonnative fish.

2.3 Provide information to the public about ecosystem concerns of illegal introductions of nonnative fish.

2.4 Evaluate biological, economic, and social effects of control of nonnative fish.

2.5 Develop tasks to reduce negative effects of nonnative taxa on bull trout.

2.5.1 Evaluate impacts of nonnative fish species in all bull trout-occupied waters and streams where reestablishment may occur. A multi-year brook trout removal program was initiated in 1996 in Threemile Creek. Monitoring to date indicates that this program has been successful. Monitoring and evaluation of brook trout impacts to bull trout should continue in Threemile Creek and should be expanded to include Crane Creek, Sun Creek, Wood River, and Long Creek. The impact of brown trout on bull trout should be evaluated in Boulder Creek, Brownsworth Creek, and the Sprague River. Evaluate potential for removal of brook trout in former bull trout streams where bull trout may be reestablished (*e.g.*, Cherry, Fourmile, Nannie, Rock, and Sevenmile Creeks).

2.5.2 Design measures to control nonnative fish. Based on results from task 2.5.1, programs to control the adverse impacts of nonnative fish species to bull trout should be designed (*i.e.*, capture, spearing, netting, piscicides, and others).

2.6 Implement control of nonnative fish where found to be feasible and appropriate.

2.6.1 Assess effectiveness of removing nonnative salmonids in bull trout streams. As part of efforts to control nonnative fish, land and resource management agencies, in conjunction with the Klamath Basin Bull Trout Working Group, should assess each stream in which nonnative salmonids have been removed to determine the effectiveness of the implemented measures.

3 Establish fisheries management goals and objectives compatible with bull trout recovery and implement practices to achieve goals.

3.1 Develop and implement State and Tribal native fish management plans integrating adaptive research.

3.1.1 Integrate bull trout recovery monitoring in the Klamath River basin into the Oregon Plan for Salmon and Watersheds. The Oregon Plan for Salmon and Watersheds (Oregon 1997) identifies a number of management actions that affect salmonids. Monitoring associated with bull trout recovery should be integrated into this program to insure coordinated action and to meet common goals and objectives.

3.1.2 Coordinate bull trout recovery with recovery efforts of other species. Resource managers should coordinate bull trout recovery efforts with management plans and strategies for other species (*e.g.*, shortnose and Lost River suckers and chinook salmon and steelhead) as necessary.

3.2 Evaluate and prevent overharvest and incidental angling mortality of bull trout.

3.2.1 Assess existing and potential impacts of angling on bull trout populations. Bull trout are highly susceptible to angling. Steps should be taken to minimize or eliminate incidental harvest of bull trout.

For example, because the Klamath Basin Bull Trout Working Group has successfully conducted an intensive program to remove nonnative fish in Threemile Creek, brook trout have nearly been eliminated from bull trout reaches. Therefore, there is little likelihood of an angler catching brook trout in this reach. Although angling pressure is light to nonexistent, any angling carries with it a significantly higher probability that incidental take of bull trout could occur. Given the low population size of bull trout in Threemile Creek, any incidental take associated with angling may have an adverse effect on the health and persistence of the bull trout population in this stream. Although the Oregon Department of Fish and Wildlife

closed angling for bull trout in the Klamath River basin in 1991, closure to all angling in Threemile Creek was deemed the best method to address the threat of incidental take for that specific stream. At the request of the Klamath Basin Bull Trout Working Group, the Oregon Department of Fish and Wildlife closed Threemile Creek, above the Westside Road, to all angling in 2000.

3.2.2 Continue to implement and monitor compliance with protective angling regulations. Proposed changes to existing regulations must be scientifically supported relative to delisting criteria (*i.e.*, harvestable surplus), as demonstrated by the monitoring program.

3.2.3 Continue to provide information to anglers about bull trout identification and special regulations. Increase the number of identification posters along bull trout-inhabited streams in the Klamath River basin. Current poster photos depict migratory forms that are uncommon in the Klamath River basin. Because anglers are more likely to encounter the smaller, more common resident form, identification posters should be changed accordingly. Angler awareness can also be improved by identification and educational exhibits. Target key spawning/rearing and resident adult areas for additional angler education efforts.

3.3 Evaluate potential effects of introduced fish and associated sport fisheries on bull trout recovery and implement tasks to minimize negative effects on bull trout.

3.4 Evaluate effects of existing and proposed sport fishing regulations on bull trout.

4 Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.

4.1 Incorporate conservation of genetic and phenotypic attributes of bull trout into recovery and management plans.

4.1.1 Determine genetic relationships among bull trout populations in the Klamath River Recovery Unit. Samples have been collected from local bull trout populations in Threemile, Sun, and Long Creeks. Additional samples from other local populations need to be collected (*i.e.*, Brownsworth, Deming, Leonard, and Boulder/Dixon Creeks) and analyzed.

4.2 Maintain existing opportunities for gene flow among bull trout populations.

4.3 Develop genetic management plans and guidelines for appropriate use of transplantation and artificial propagation.

5 Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.

5.1 Design and implement a standardized monitoring program to assess the effectiveness of recovery efforts affecting bull trout and their habitats.

5.2 Conduct research evaluating relationships among bull trout distribution and abundance, bull trout habitat, and recovery tasks.

5.2.1 Determine range of temperature tolerances for bull trout life stages in different habitats. Use the results of ongoing temperature studies to address the adequacy of existing State of

Oregon and State of California regulations and recovery efforts.

5.2.2 Assess current and historical effects of upland management on changes to the hydrograph. Activities in upland areas, such as logging, road building, and grazing, have affected hydrograph regimes in bull trout watersheds. Effects include changes in the timing and magnitude of peak flows in Long Creek and Fourmile Creek watersheds. Flows in Hammond Creek have changed from perennial to intermittent.

5.3 Conduct evaluations of the adequacy and effectiveness of current and past best management practices in maintaining or achieving habitat conditions conducive to bull trout recovery.

5.4 Evaluate effects of diseases and parasites on bull trout and develop and implement strategies to minimize negative effects.

5.4.1 Research the effects of *Ceratomyxa shasta* on bull trout. Determine whether *C. shasta* is a limiting factor on the distribution of bull trout in the Klamath River basin.

5.4.2 Monitor presence of *Ceratomyxa shasta* in bull trout habitat. If *C. shasta* is a limiting factor in the distribution of bull trout in the Klamath River basin (task 5.4.1), monitor for presence in important bull trout spawning and rearing areas.

5.4.3 Assess fisheries and habitat management activities to reduce the risk of disease transmission. This measure includes maintaining and refining fish health screening and transplant protocols to reduce risk of disease transmission.

5.5 Develop and conduct research and monitoring studies to improve information concerning the distribution and status of bull trout.

5.6 Identify evaluations needed to improve understanding of relationships among genetic characteristics, phenotypic traits, and local populations of bull trout.

5.6.1 Delineate important migratory habitat. Investigate connectivity among core area populations in the Klamath River Recovery Unit, including seasonal use of different habitat types by adult and subadult migratory bull trout.

5.6.2 Assess severity of threat due to hybridization with brook trout. This measure includes determining the reproductive viability of bull trout/brook trout hybrids, brook trout colonization rates, desirability and effectiveness of barriers to brook trout passage, and evaluation of brook trout removal/eradication programs. Priority watersheds include occupied and potential habitat in the Upper Klamath Lake and Sycan River core areas identified in Table 6.

6 Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.

6.1 Use partnerships and collaborative processes to protect, maintain, and restore functioning core areas for bull trout.

6.1.1 Encourage floodplain protection. Development frequently exacerbates water temperature problems, increases nutrient loads, decreases bank stability, alters instream and riparian habitat, and changes hydrologic response of affected watersheds. To protect floodplains, land and resource agencies should promote land use planning and management that discourages development of floodplains and seeks long-term habitat protection through purchase, conservation easements, landowner incentives, and management plans. Local governments should be encouraged to develop, implement, and

promote floodplain regulations that restrict encroachment and mitigate habitat loss throughout the upper Klamath River basin.

6.1.2 Promote collaborative efforts by supporting existing local watershed working groups in developing and accomplishing site-specific protection and restoration activities. Develop agreements with local watershed working groups to complete watershed assessment of private lands under Oregon Watershed Enhancement Board protocols. Integrate existing information from Federal watershed analysis with new information on private lands. Work with water management organizations to maximize instream flow through established water rights processes.

6.2 Use existing Federal authorities to conserve and restore bull trout.

6.3 Evaluate existing Federal, State, and Tribal habitat protection standards and regulations and evaluate their effectiveness for bull trout conservation.

7 Assess the implementation of bull trout recovery by recovery units and revise recovery unit plans based on evaluations.

7.1 Convene annual meetings of each recovery unit team to review progress on recovery plan implementation.

7.2 Assess effectiveness of recovery efforts.

7.3 Revise scope of recovery as suggested by new information.