Recovery Plan for the Klickitat River Population of the Middle Columbia River Steelhead Distinct Population Segment

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**Prepared by
National Marine Fisheries Service
Northwest Region**

DISCLAIMER

Endangered Species Act (ESA) recovery plans delineate reasonable actions which the best available information indicates are necessary for the conservation and survival of listed species. Plans are published by the National Marine Fisheries Service (NMFS), usually with the assistance of recovery teams, state agencies, local governments, salmon recovery boards, non-governmental organizations, interested citizens of the affected area, contractors, and others. ESA recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan formulation, other than NMFS. They represent the official position of NMFS only after they have been signed by the Northwest Regional Administrator. ESA recovery plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new information, changes in species status, and the completion of recovery actions.

With respect to the Middle Columbia Steelhead Recovery Plan, where areas of disagreement arose between a management unit plan and the species level, distinct population segment (DPS) plan, NMFS worked with the relevant parties to resolve the differences and in a few cases, identified in the DPS plan, decided not to incorporate the disputed material into the DPS plan.

ESA recovery plans provide important context for NMFS's determinations pursuant to section 7(a)(2) of the Endangered Species Act. However, recovery plans do not place any additional legal burden on NMFS or the action agency when determining whether an action would jeopardize the continued existence of a listed species or adversely modify critical habitat. The procedures for the section 7 consultation process are described in 50 CFR 402 and are applicable regardless of whether or not the actions are described in a recovery plan.

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Recovery Planning Glossary

abundance: In the context of salmon recovery, unless otherwise qualified, abundance refers to the number of adult fish returning to spawn.

adaptive management: Adaptive management in salmon recovery planning is a method of decision making in the face of uncertainty. A plan for monitoring, evaluation, and feedback is incorporated into an overall implementation plan so that the results of actions can become feedback on design and implementation of future actions.

anadromous fish: Species that are hatched in freshwater, migrate to and mature in salt water, and return to freshwater to spawn.

baseline monitoring: In the context of recovery planning, baseline monitoring is done before implementation, in order to establish historical and/or current conditions against which progress (or lack of progress) can be measured.

biogeographical region: an area defined in terms of physical and habitat features, including topography and ecological variations, where groups of organisms (in this case, salmonids) have evolved in common.

broad-sense recovery goals: Goals defined in the recovery planning process, generally by local recovery planning groups, that go beyond the requirements for delisting, to address, for example, other legislative mandates or social, economic, and ecological values.

compliance monitoring: Monitoring to determine whether a specific performance standard, environmental standard, regulation, or law is met.

delisting criteria: Criteria incorporated into ESA recovery plans that define both biological viability (biological criteria) and alleviation of the causes for decline (threats criteria based on the five listing factors in ESA section 4[a][1]), and that, when met, would result in a determination that a species is no longer threatened or endangered and can be proposed for removal from the Federal list of threatened and endangered species. These criteria are a NMFS determination and may include both technical and policy considerations.

distinct population segment (DPS): A listable entity under the ESA that meets tests of discreteness and significance according to USFWS and NMFS policy. A population is considered distinct (and hence a "species" for purposes of conservation under the ESA) if it is discrete from and significant to the remainder of its species based on factors such as physical, behavioral, or genetic characteristics, it occupies an unusual or unique ecological setting, or its loss would represent a significant gap in the species' range.

diversity: All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population. Variations could include anadromy vs. lifelong residence in freshwater, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, physiology, molecular genetic characteristics, etc.

endangered species: A species in danger of extinction throughout all or a significant portion of its range.

effectiveness monitoring: Monitoring set up to test cause-and-effect hypotheses about recovery actions: Did the management actions achieve their direct effect or goal? For example, did fencing a riparian area to exclude livestock result in recovery of riparian vegetation?

ESA recovery plan: A plan to recover a species listed as threatened or endangered under the U.S. Endangered Species Act (ESA). The ESA requires that recovery plans, to the extent practicable, incorporate (1) objective, measurable criteria that, when met, would result in a determination that the species is no longer threatened or endangered; (2) site-specific management actions that may be necessary to achieve the plan's goals; and (3) estimates of the time required and costs to implement recovery actions.

evolutionarily significant unit (ESU): A group of Pacific salmon or steelhead trout that is (1) substantially reproductively isolated from other conspecific units and (2) represents an important component of the evolutionary legacy of the species.

extinct: No longer in existence. No individuals of this species can be found.

extirpated: Locally extinct. Other populations of this species exist elsewhere. The ICTRT considers extirpated steelhead populations to be those that are entirely cut off from anadromy, such as the Crooked River population. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.

factors for decline: Five general categories of causes for decline of a species, listed in the Endangered Species Act section 4(a)(1)(b): (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence.

functionally extirpated: Describes a species that has been extirpated from an area; although a few individuals may occasionally be found, there are not enough fish or habitat in suitable condition to support a fully functional population.

hyporheic zone: Area of saturated gravel and other sediment beneath and beside streams and rivers where groundwater and surface water mix.

implementation monitoring: Monitoring to determine whether an activity was performed and/or completed as planned.

independent population: Any collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period is not substantially altered by exchanges of individuals with other populations.

indicator: A variable used to forecast the value or change in the value of another variable.

interim regional recovery plan: A recovery plan that is intended to lead to an ESA recovery plan but that is not yet complete. These plans might address only a portion of an ESU or lack other key components of an ESA recovery plan.

intrinsic potential: The estimated relative suitability of a habitat for spawning and rearing of anadromous salmonid species under historical conditions inferred from stream characteristics including channel size, gradient, and valley width.

intrinsic productivity: The expected ratio of natural-origin offspring to parent spawners at levels of abundance below carrying capacity.

iteroparous: Capable of reproducing more than once in a lifetime.

kelts: Steelhead that are returning to the ocean after spawning and have the potential to spawn again in subsequent years (unlike most salmon, steelhead do not necessarily die shortly after spawning).

large woody debris (LWD): A general term for wood naturally occurring or artificially placed in streams, including branches, stumps, logs, and logjams. Streams with adequate LWD tend to have greater habitat diversity, a natural meandering shape, and greater resistance to flooding.

legacy effects: Impacts from past activities that continue to affect a stream or watershed in the present day.

limiting factor: Physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) experienced by the fish that result in reductions in viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity). Key limiting factors are those with the greatest impacts on a population's ability to reach a desired status.

locally developed recovery plan: A plan developed by state, tribal, regional, or local planning entities to address recovery of a species. These plans are being developed by a number of entities throughout the region to address ESA as well as state, tribal, and local mandates and recovery needs.

maintained status: Population status in which the population does not meet the criteria for a viable population but does support ecological functions and preserve options for ESU/DPS recovery.

major population group (MPG): A group of salmonid populations that are geographically and genetically cohesive. The MPG is a level of organization between demographically independent populations and the ESU or DPS.

major spawning area (MaSA): A system of one or more branches that contain sufficient spawning and rearing habitat to support more than 500 spawners. For Interior Columbia salmonid populations: defined using results from intrinsic potential analysis.

management unit: A geographic area defined for recovery planning purposes on the basis of state, tribal or local jurisdictional boundaries that encompass all or a portion of the range of a listed species, ESU, or DPS.

metrics: A metric is something that quantifies a characteristic of a situation or process; for example, the number of natural-origin salmon returning to spawn to a specific location is a metric for population abundance.

minor spawning area (MiSA): A system of one or more branches that contain sufficient spawning and rearing habitat to support 50-500 spawners. For Interior Columbia salmonid populations: defined using results from intrinsic potential analysis.

morphology: The form and structure of an organism, with special emphasis on external features.

natural-origin fish: Fish that were spawned and reared in the wild, regardless of parental origin.

parr: The stage in anadromous salmonid development between absorption of the yolk sac and transformation to smolt before migration seaward.

phenotype: Any observable characteristic of an organism, such as its external appearance, development, biochemical or physiological properties, or behavior.

piscivorous: (Adj.) Describes fish that eat other fish.

productivity: The average number of surviving offspring per parent. Productivity is used as an indicator of a population's ability to sustain itself or its ability to rebound from low numbers. The terms "population growth rate" and "population productivity" are interchangeable when referring to measures of population production over an entire life cycle. Can be expressed as the number of recruits (adults) per spawner or the number of smolts per spawner.

recovery domain: An administrative unit for recovery planning defined by NMFS based on ESU boundaries, ecosystem boundaries, and existing local planning processes. Recovery domains may contain one or more listed ESUs.

recovery goals: Goals incorporated into a locally developed recovery plan, which may include delisting (i.e. no longer considered endangered or threatened), reclassification (e.g., from endangered to threatened), and/or other goals. Broad-sense goals are a subset of recovery goals (see glossary entry above).

recovery plan supplement: A NMFS supplement to a locally developed recovery plan that describes how the plan addresses ESA requirements for recovery plans. The supplement also proposes ESA delisting criteria for the ESUs addressed by the plan, since a determination of these criteria is a NMFS decision.

recovery scenarios: Scenarios that describe a target status for each population within an ESU, generally consistent with TRT recommendations for ESU viability.

redd: A nest constructed by female salmonids in streambed gravels where eggs are fertilized and deposited.
recovery strategy: Statements that identify the assumptions and logic – the rationale – for the species' recovery program.

riparian area: Area with distinctive soils and vegetation between a stream or other body of water and the adjacent upland.

salmonid: Fish of the family *Salmonidae*, including salmon, trout, chars, grayling, and whitefish. In general usage, the term usually refers to salmon, trout, and chars.

smolt: A juvenile salmonid that is undergoing physiological and behavioral changes to adapt from freshwater to saltwater as it migrates toward the ocean.

spatial structure: Characteristics of a fish population's geographic distribution. Current spatial structure depends upon the presence of fish, not merely the potential for fish to occupy an area.

stakeholders: Agencies, groups, or private citizens with an interest in recovery planning, or who will be affected by recovery planning and actions.

Technical Recovery Team (TRT): Teams convened by NMFS to develop technical products related to recovery planning. TRTs are complemented by planning forums unique to specific states, tribes, or regions, which use TRT and other technical products to identify recovery actions.

threatened species: A species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

threats: Human activities or natural events (e.g., road building, floodplain development, fish harvest, hatchery influences, volcanoes) that cause or contribute to limiting factors. Threats may exist in the present or be likely to occur in the future.

viability criteria: Criteria defined by NMFS-appointed Technical Recovery Teams to describe a viable salmonid population, based on the biological parameters of abundance, productivity, spatial structure, and diversity. These criteria are used as technical input into the recovery planning process and provide a technical foundation for development of biological delisting criteria.

viability curve: A curve describing combinations of abundance and productivity that yield a particular risk of extinction at a given level of variation over a specified time frame.

viable salmonid population (VSP): an independent population of Pacific salmon or steelhead trout that has a negligible risk of extinction over a 100-year time frame.

VSP parameters: Abundance, productivity, spatial structure, and diversity. These describe characteristics of salmonid populations that are useful in evaluating population viability. See NOAA Technical Memorandum NMFS-NWFSC-42, *Viable salmonid populations and the recovery of evolutionarily significant units* (McElhany et al. 2000).

Acronyms

A/P	abundance/productivity
BIA	Bureau of Indian Affairs
BPA	Bonneville Power Administration
CAO	Critical Areas Ordinance
CCRP	Continuous Conservation Reserve Program
CEO	County Environmental Ordinance
CFEF	Castile Falls Enumeration Facility
CFS	cubic feet/second
CKCD	Central Klickitat Conservation District
CREP	Conservation Reserve Enhancement Program
CRITFC	Columbia River Inter-Tribal Fish Commission
CRFMP	Columbia River Fisheries Management Plan
CSMEP	Collaborative Systemwide Monitoring and Evaluation Project
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CUP	Conditional Use Permits
CZO	County Zoning Ordinance
DO	dissolved oxygen
DOC	Department of Commerce
DPS	distinct population segment
EA	Environmental Assessment
Ecology	Department of Ecology
EDF	energy dissipation factor
EDT	Ecosystem Diagnosis and Treatment
EIS	Environmental Impact Statement
EKCD	Eastern Klickitat Conservation District
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
ESHB	Engrossed Substitute House Bill
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FEIS	final environmental impact statement
FMEP	Fisheries Management and Evaluation Plan
FMP	Forest Management Plan
FPO	Floodplain Management Ordinance
FSA	Farm Service Agency
FY	fiscal year
GIS	Geographic Information Systems
GPS	Global Positioning System
HGMP	Hatchery and Genetic Management Plans
HOF	hatchery-origin fish
HSRG	Hatchery Scientific Review Group
HUC	hydrologic unit code
ICTRT	Interior Columbia Technical Recovery Team
ISG	Independent Scientific Group
KMP	Klickitat Anadromous Fishery Master Plan
KWEP	Klickitat Watershed Enhancement Project
KPUD	Klickitat Public Utility District
LCFRB	Lower Columbia Fish Recovery Board

LUMA	Land Use Management Area
MaSA	major spawning area
MCR	Middle Columbia River
MEA	Management Emphasis Area
MiSA	minor spawning area
MPG	major population group
NEPA	National Environmental Policy Act
NFH	National Fish Hatchery
NMFS	National Marine Fisheries Service
NOF	natural-origin fish
NPCC	Northwest Power and Conservation Council
NPDES	National Pollutant Discharge Elimination System
NSA	National Scenic Area
NWR	National Wildlife Refuge
ODFW	Oregon Department of Fish and Wildlife
OFM	Office of Financial Management
PCSRF	Pacific Coastal Salmon Recovery Fund
PFC	Proper Functioning Condition
PIT	Passive Integrated Transponders
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
RCW	Revised Code of Washington
RM	river mile
RM&E	research, monitoring and evaluation
SDP	Substantial Development Permits
SEPA	State Environmental Policy Act
SMP	Shorelines Master Plan
SR	State Route
SRFB	Salmon Recovery Funding Board
SSB	Substitute Senate Bill
TFW	Timber, Fish, and Wildlife
TMDL	total maximum daily loads
TRT	Technical Recovery Team
USACE	U.S. Army Corps of Engineers
USBOR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VSP	viable salmonid population
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WPN	Washington Permit Notification
WRIA	Water Resource Inventory Area
WSDA	Washington State Department of Agriculture
WDOE	Washington State Department of Ecology
WDOT	Washington State Department of Transportation
WRPAC	Water Resources Planning Advisory Committee
YKFP	Yakima/Klickitat Fisheries Project
YN	Yakama Nation

Executive Summary

The Endangered Species Act of 1973 (ESA) requires NOAA's National Marine Fisheries Service (NMFS) to develop recovery plans for species listed under the Act. The purpose of recovery plans is to identify actions needed to restore threatened and endangered species to the point that they are again self-sustaining elements of their ecosystems and no longer need the protections of the ESA.

This plan focuses on the conservation and survival of Middle Columbia River steelhead (*Oncorhynchus mykiss*) in the Klickitat River subbasin (Figure ES-1).[1] It is one of several recovery plans developed for independent populations of the Middle Columbia River steelhead distinct population segment (DPS), which was listed as threatened under the ESA on March 25, 1999 and reconfirmed on January 5, 2006 (NMFS 2006a, 71 FR 834). Similar plans have been prepared for Middle Columbia steelhead populations in the White Salmon River, Rock Creek, and Yakima River, as well as in areas of southeast Washington and the State of Oregon. These separate plans are part of a DPS-level plan that integrates recovery actions across the DPS.

The Klickitat River population is of particular interest because it contains both summer and winter runs, and it potentially could make a significant contribution to recovery of the Middle Columbia steelhead DPS. The Klickitat River is one of the largest salmon producing watersheds in the Columbia basin. Recent passage improvements at Castile Falls in the upper Klickitat have opened an additional 56 miles of high quality steelhead habitat. Passage improvements in the lower Klickitat (Lyle Falls at RM 2.2) are also expected to benefit immigrating adults. In addition, a hatchery master plan under development by the Yakama Nation in consultation with NMFS is expected to improve hatchery management to support conservation of the naturally spawning steelhead (Sharp et al. 2008). Moving existing *U.S. v. Oregon* production of fall Chinook and coho from the Klickitat hatchery to the new Wahkiacus Acclimation Facility 26 miles downstream will minimize the impacts of large-scale hatchery releases on wild spring Chinook and steelhead rearing between the two facilities.

Purpose of Plan

The plan provides a roadmap for restoring the Klickitat steelhead population and its habitats to a level that supports recovery of the Middle Columbia River steelhead DPS and allows the population to become a viable component of its ecosystem. A recovery plan is a guidance document, not regulatory.

The plan describes the current status of the Klickitat population, identifies the factors and threats affecting the population, and proposes strategies and actions designed to aid in the population's recovery and build on past and current recovery efforts. Finally, the plan

[1] A description of the Major Creek watershed is included as Appendix I of this plan. Major Creek flows into the Columbia River immediately downstream of the Klickitat River and is believed to contain Middle Columbia steelhead. The Interior Columbia Technical Recovery Team has not evaluated the data for Major Creek, but because of its proximity to the Klickitat River, its steelhead may have genetic characteristics similar to the Klickitat steelhead population.

provides an implementation schedule and adaptive management framework for making needed future adjustments on the road to recovery.

Context of Plan Development

The plan is the product of a process initiated by NMFS; it incorporates information from the Yakama Nation (YN), Washington Department of Fish and Wildlife (WDFW), Klickitat County, the Washington State Governor's Salmon Recovery Office, other Federal agencies, state agencies, local governments, and the public.

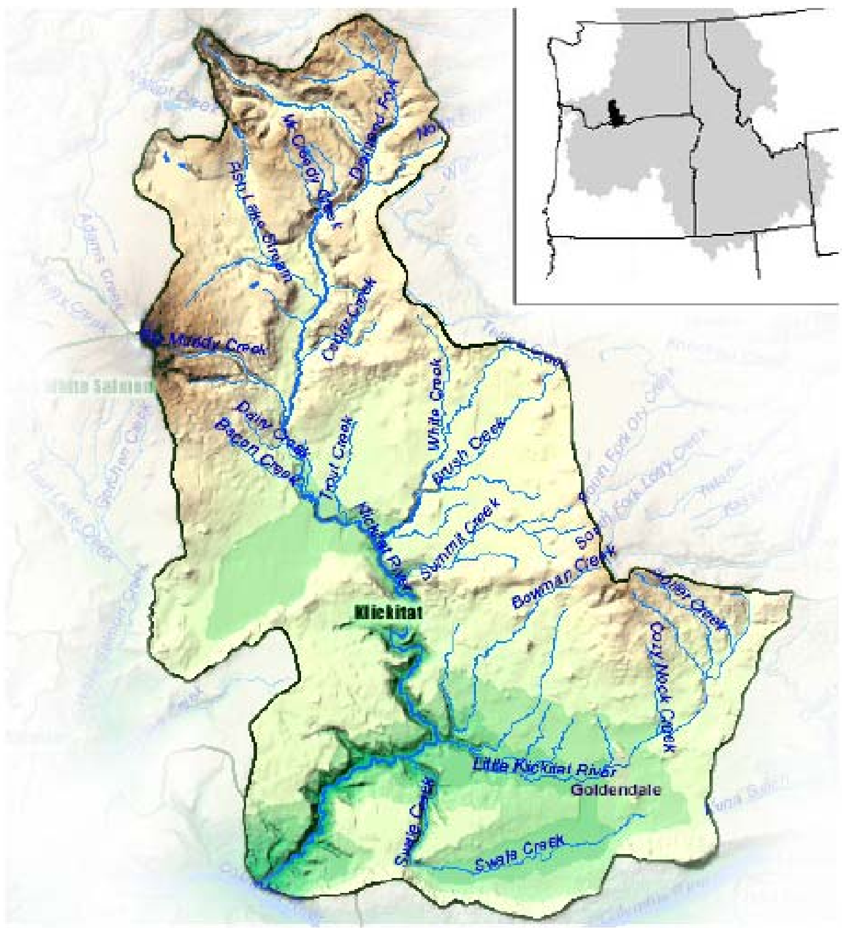


Figure ES-1. Klickitat Subbasin.

The Klickitat Plan reflects direction for Klickitat steelhead adopted into the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program subbasin plan (NPCC 2004). The subbasin plan was produced through a collaborative process involving the Yakama Nation, Washington Department of Fish and Wildlife, and NPCC.

In addition, the plan reflects technical data drawn from:

- Watershed Resource Inventory Area (WRIA) 30 watershed assessment (WPN and Aspect 2005a) and watershed management plan (WPN and Aspect 2005b)
- The Interior Columbia Technical Recovery Team (ICTRT) viability criteria for the Middle Columbia River steelhead DPS (ICTRT 2007)

Biological Background

The Klickitat River drains approximately 1,350 square miles in south central Washington before joining the Columbia River at Lyle, Washington (RM 180.4), 34 miles upstream of Bonneville Dam. The Klickitat is one of the longest undammed rivers in the Northwest.

Reasons for listing the Middle Columbia River steelhead DPS as threatened under the ESA included low returns to the Yakima River, poor abundance estimates for Klickitat River and Fifteenmile Creek steelhead, uncertainty regarding the influence of hatchery releases on the natural steelhead population, and an overall decline of naturally producing "stocks" within the DPS (64 FR 14517). The Klickitat River population is of particular interest because of containing both summer and winter runs.

The ICTRT identified 17 extant and 3 extirpated independent steelhead populations in the Middle Columbia River steelhead DPS (McClure et al. 2003). These populations are shown in Figure ES-2. The ICTRT delineated the populations based on genetic information, geography, life history traits, morphological traits, and population dynamics.

The ICTRT grouped these independent populations into four major population groups (MPGs) within the DPS: the Cascades Eastern Slope Tributaries MPG, Yakima subbasin MPG, John Day River MPG, and Umatilla/Walla Walla MPG. The Klickitat River population is one of the five extant populations (Klickitat River, Fifteenmile Creek, Rock Creek, Deschutes Eastside, and Deschutes Westside) and two extirpated populations (White Salmon River and Deschutes Crooked River) comprising the Cascades Eastern Slope Tributaries MPG (Figure ES-3). Populations in the group are united primarily by proximity and occupy diverse habitats, generally those draining the eastern slopes of the Cascades and the Columbia Plateau.

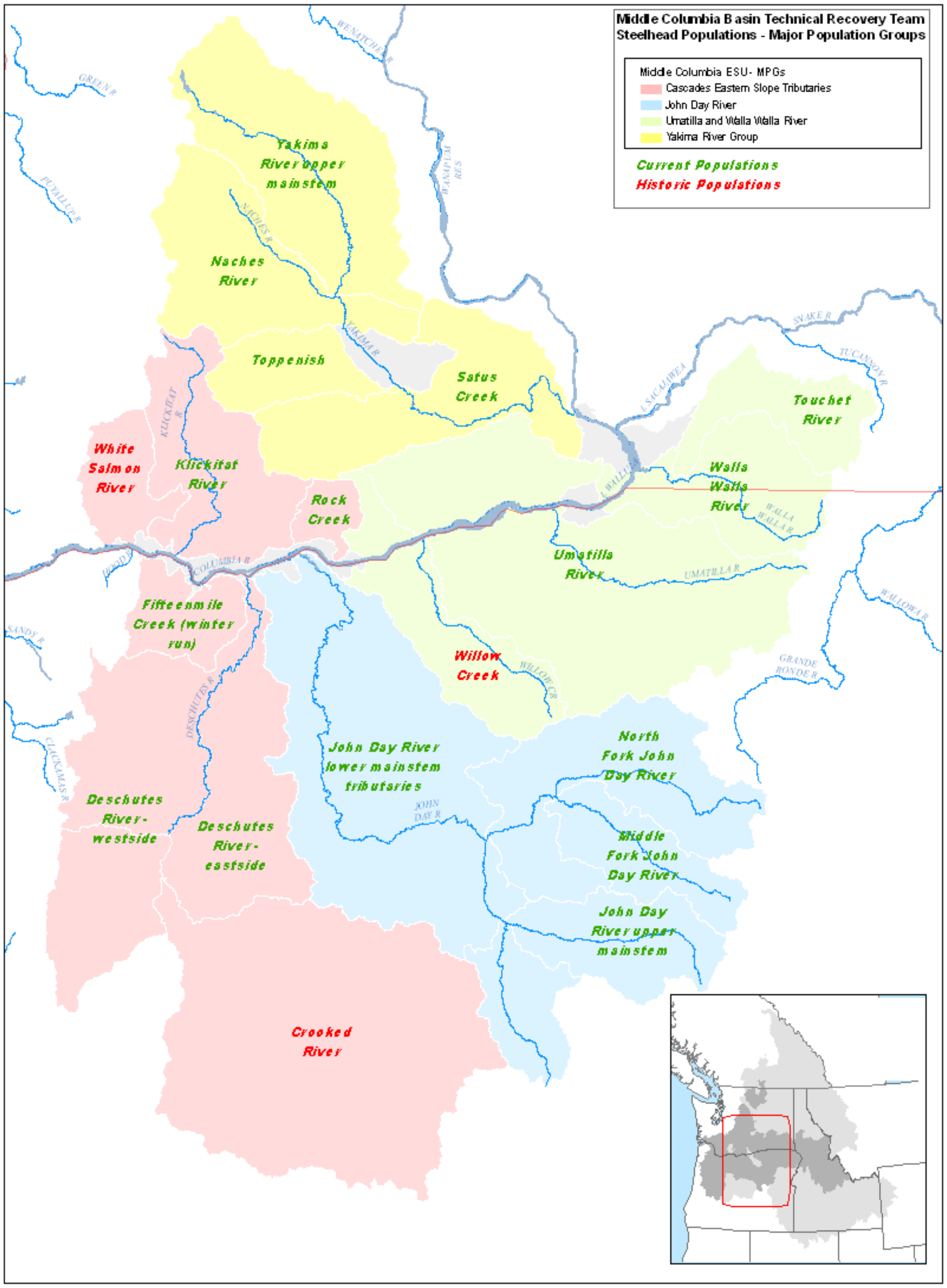


Figure ES-2. Independent Populations in the Middle Columbia River Steelhead DPS.

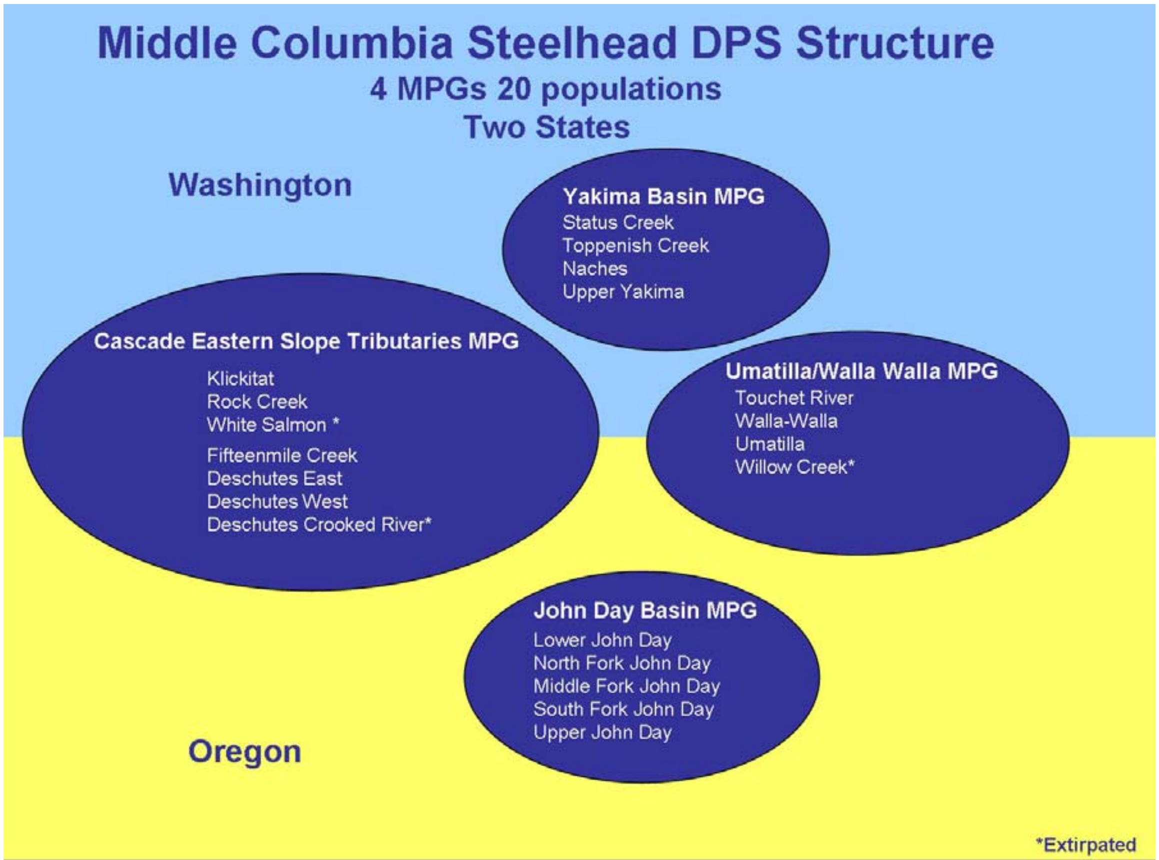


Figure ES-3. Major Population Groups and Populations of Middle Columbia Steelhead.

Historically, the presence of several natural migration barriers in the Klickitat watershed may have limited anadromous fish production, particularly during low water years. The Klickitat River flows through a deep, steep-walled canyon with several historically impassable or marginally passable falls and cascades where the river flows over resistant bedrock. In addition, access to many of the tributaries is restricted because of impassably high gradients or waterfalls close to the tributary mouths. Such historical barriers were important in maintaining separate life history strategies of *O. mykiss*, including summer steelhead, winter steelhead, and resident rainbow trout.

Approximately 102,000 summer-run steelhead from Skamania and Vancouver hatcheries are currently released directly into the Klickitat River annually. Release sites are Leidl Bridge (RM 32), the mouth of the Little Klickitat River (RM 20.2), Wahkiacus Bridge (RM 17), and Pitt Bridge (RM 10.4). The Skamania Hatchery broodstock is maintained by using adult steelhead returning to the Skamania Hatchery on the North Fork of the Washougal River. The original broodstock for the program was established with wild fish taken from both the Washougal and Klickitat River systems. In addition to the hatchery releases of steelhead, an average of 4,349,710 fall Chinook, 595,318 spring Chinook, and 3,714,083 coho are released from the hatcheries into the Klickitat River each year (Sharp et al. 2008). Coho and fall Chinook are not native to the basin upstream of Lyle Falls.

Recovery Goals and Criteria

The primary goal of ESA recovery plans is for the species to reach the point that it no longer needs the protection of the Act – i.e. to be delisted. Recovery plans may also contain "broad-sense" goals, defined in the recovery planning process, that go beyond the requirements for delisting to address, for example, other legislative mandates or social, economic, and ecological values.

Delisting criteria are applied at the DPS level, and are based on determinations of the viability of the independent populations that make up the DPS. Criteria for delisting the Middle Columbia steelhead DPS are described in the *Middle Columbia River Steelhead ESA Recovery Plan*, to which this plan is an appendix. This chapter provides recovery goals for the Klickitat steelhead population, describes the criteria to be used to assess progress toward those goals, and describes the role of the Klickitat steelhead population in overall DPS viability.

There are two kinds of criteria that enter into a delisting decision: population or demographic parameters (the biological viability criteria) and "threats" criteria related to the five listing factors detailed in the ESA (see Section 1.1). The threats criteria define the conditions under which the listing factors, or threats, can be considered to be addressed or mitigated. Together these make up the "objective, measurable criteria" required under section 4(f)(1)(B). Both kinds of criteria are discussed in this chapter.

The primary goal of this plan is for the Klickitat steelhead population to be restored to viable status and thus to support recovery of the Mid-Columbia steelhead DPS. A viable salmonid population is defined as an independent population that has negligible risk of extinction over a 100-year timeframe (McElhany et al. 2000).

If a local, collaborative Washington Gorge Recovery Board is formed, it may choose to define additional, broad-sense goals for the Klickitat steelhead population and other steelhead populations within the Washington Gorge Management Unit. The board's broad-sense goals for the area would likely build upon direction already adopted by various stakeholders in the area. These goals would then guide the board as it defines and implements future recovery actions for the Klickitat subbasin.

In the meantime, the Yakama Nation has proposed, as a broad-sense goal for the Klickitat steelhead population, the achievement of "highly viable" status, which corresponds to a one percent risk of extinction over a 100-year period. Achieving highly viable status for the population would provide for long-term, sustainable harvest and other social, cultural, and ceremonial needs, although it would likely exceed the minimum necessary to support delisting the DPS.

The ICTRT developed biologically based viability criteria for ESA-listed salmon and steelhead in the Interior Columbia domain. The ICTRT based its approach to recovery on guidance from the NMFS Technical Memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). This memorandum provides general direction for setting viability objectives at the ESU/DPS and component population levels.

The ICTRT criterion for a viable ESU/DPS is that all extant MPGs and any extirpated MPGs critical for proper functioning of the ESU/DPS should be at low risk. The ICTRT provided additional criteria for determining MPG viability (Section 3.2.1). Applying the ICTRT's viability criteria to the Cascades Eastern Slope Tributaries MPG results in the conclusion that the Klickitat steelhead population should reach viable status in order to support overall DPS viability, because of its historical abundance and the presence of both summer and winter runs.

The ICTRT classified the Klickitat steelhead population as an "Intermediate" sized population, based on historical habitat potential (ICTRT 2007) and provided viability criteria for an Intermediate population, as follows (ICTRT 2007):

Abundance
For an Intermediate population, viable status, i.e. a 5 percent or less risk of extinction over a 100-year timeframe, would require a mean minimum abundance threshold of 1,000 naturally produced spawners.

Productivity
Productivity rates at relatively low numbers of spawners should, on average, be sufficiently greater than 1.0 to allow the population to rapidly return to abundance target levels.

Spatial Structure and Diversity
In general, the ICTRT defined two goals, or biological or ecological objectives, that spatial structure and diversity criteria should achieve (ICTRT 2007, p. 47):

- Natural rates and levels of spatially mediated processes should be maintained.
- Natural patterns of variation should be maintained.

Threats Criteria and Approach
Section 3.2.2 of the Plan describes the listing factors and listing factor/threats criteria that must be addressed to delist the DPS. The listing factors are the features that were evaluated under ESA section 4(a)(1) when the initial determination was made to list the species for protection.

At the time of a delisting decision, NMFS will use the listing factors/threats criteria to review the status of the section 4(a)(1) listing factors and determine whether the affected DPS is recovered to the point that it no longer requires protections of the ESA. NMFS expects that if the proposed actions described in this and other Middle Columbia River steelhead recovery plans are implemented, the fish will make substantial progress toward meeting the listing factor/threats criteria. These criteria are identified in Section 3.3 and address the five listing factors that were evaluated under section 4(a)(1): 1) the present or threatened destruction, modification, or curtailment of the species' habitat or range; 2) over-utilization for commercial, recreational, scientific or educational purposes; 3) disease or predation; 4) the inadequacy of existing regulatory mechanisms; and 5) other natural or human-made factors affecting its continued existence.

Current Status Assessment

There are currently neither solid historical data nor accurate metrics for assessing current status of the Klickitat steelhead population. Yakama Nation biologists have provided substantial data, summarized in Chapter 4, which is, however, of a relatively short generational span and limited by significant uncertainties. The first priority for recovery for this population is to reduce these uncertainties with a targeted monitoring program (see Chapter 6, Recovery Strategy and Actions).

The ICTRT reviewed existing data, previous assessment findings, and GIS analysis for its 2005 viability assessment of this population, which is available on the Northwest Fisheries Science Center website, http://www.nwfsc.noaa.gov/trt/trt columbia.cfm.

In this recovery plan the ICTRT viability assessment is presented first, followed by currently available status information from the Yakama Nation. Discussion is also provided of findings from the ICTRT, Yakama Nation, and Klickitat County regarding identification of major and minor spawning areas.

The ICTRT found that the data for steelhead spawning in the Klickitat drainage were insufficient to estimate current abundance. It also found that the productivity of Klickitat steelhead is currently uncertain because both naturally produced and hatchery-origin steelhead return to the Klickitat River. Returns to the Klickitat River include hatchery-origin adults from annual outplants of Skamania summer steelhead stock (approximately 100,000 smolts per year) into the middle sections of the mainstem Klickitat. The spawning success of these hatchery fish is unknown. While redd surveys of steelhead spawning in the Klickitat drainage have been conducted in recent years, there is insufficient coverage to estimate the annual contribution of hatchery vs. natural steelhead in the natural production areas.

Because of insufficient data and the uncertainties regarding naturally occurring production, the ICTRT provisionally assigned the Klickitat River population **Moderate risk** for abundance and productivity (ICTRT 2007).

The ICTRT rated the Klickitat River steelhead population at **Moderate risk** for spatial structure and diversity because of the potential impact on wild steelhead from outside-stock hatchery fish. It determined that reducing the spatial structure/diversity risk to a low rating would require reducing the impacts of the outside-stock hatchery program on natural spawning areas, or determining that the natural population is actually experiencing very little impact from the Skamania stock origin returns.

Limiting Factors and Threats

1. Hatchery influences

Currently there is insufficient information to determine the effects of hatchery releases on the natural steelhead population. While it is likely that hatchery hybridization of Skamania stock with wild steelhead has occurred in the Klickitat subbasin (NPCC 2004), the level of impact on the natural population remains uncertain. However, based on hatchery release levels and sport catch estimates, the ICTRT found that it is very likely that the hatchery contribution rate to natural steelhead spawning in the Klickitat subbasin has exceeded 5 percent for more than four generations (ICTRT 2007). Straying of out-of-subbasin hatchery-produced steelhead, primarily from the Snake River and Upper Columbia, into the Klickitat subbasin may also affect the viability of the Klickitat steelhead population.

Coho and fall Chinook are not native, but have naturalized in the basin as a result of hatchery releases and are known to spawn in relatively large numbers (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009). The effects of these hatchery releases and/or the subsequently naturalized species on the Klickitat River steelhead population are unknown.

2. Habitat

Habitat factors that likely limit steelhead production in the Klickitat watershed are affected by past and/or current land use practices that stress naturally occurring conditions. For example, while low summer flows and high summer water temperatures occur naturally in some parts of the watershed because of bedrock terrain and steep slopes, anthropogenic changes in the subbasin may have increased the intensity of such factors. The habitat factors that potentially limit steelhead abundance, productivity, spatial structure, and diversity within the Klickitat watershed are the following: lack of key habitat quantity and habitat diversity, loss of floodplain function, altered hydrology, degraded channel structure, obstructed fish passage, increased fine sediment delivery, high water temperature, and altered food web. Chapter 5 and Appendix II provide more detail on these factors, as well as their potential effects on steelhead viability.

3. Harvest

Tributary recreational steelhead fisheries in the Klickitat River are selective for marked hatchery steelhead; the release of unmarked wild steelhead is required. In the Klickitat River, the recreational fisheries impact on wild summer-run steelhead is estimated to be 6 percent and for winter-run steelhead 3 percent (WDFW 2003). Treaty Native American fisheries also occur in the mainstem Klickitat River. The treaty Native American catch of all types of steelhead (summer and winter, wild and hatchery combined) in the Klickitat River is estimated at an average of 1,146 steelhead per year since 1986 (Sharp et al. 2008). Estimated tribal harvest of wild steelhead in the Klickitat averages 178 fish per year (Table 2-1) (Sharp et al. 2008).

4. Out-of-Subbasin Factors

Out-of-subbasin limiting factors and threats are discussed briefly in Section 5.4. The 2008 Biological Opinion on the operation of the FCRPS, and particularly the Supplemental Comprehensive Analysis (NMFS 2008a). http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm, details the influences from the Columbia River hydrosystem. The Columbia River Estuary Module http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery -

Plans/upload/Estuary-Module.pdf discusses factors that may limit the viability of Klickitat steelhead in the Columbia River estuary.

Recovery Strategy and Actions

The rationale linking what is known about the population's current conditions and the actions that should be taken to achieve recovery is called the recovery strategy.

Lack of information about the Klickitat River steelhead population is a major problem for recovery planning for the Middle Columbia River steelhead DPS. Using the ICTRT criteria for DPS viability, this population (among others) needs to be viable for the DPS to be viable. The Klickitat population's moderate risk rating was assigned primarily on the basis of uncertainty and lack of data, particularly with respect to the influence of hatchery fish on the wild steelhead population. Therefore, the first importance for a recovery strategy is to reduce the uncertainties by obtaining more information.

A targeted monitoring program is needed for the following purposes:

- To determine abundance and productivity of natural spawners
- To determine the proportion of hatchery and wild spawners in the Klickitat subbasin.
- To determine the adverse effects of Skamania broodstock on the Klickitat population, if any.
- Continue study and further refine understanding of habitat limiting factors.

The Yakama Nation is working with NMFS, WDFW, tribal fish and wildlife leaders, and others to develop a master plan for an integrated hatchery program for the Lower Klickitat River. The program will minimize adverse impacts on the natural steelhead spawning population. One option being explored by hatchery program managers is to replace the current program, which releases out-of-basin Skamania hatchery-origin smolts in the Klickitat River system, with a hatchery program that relies entirely on the use of natural-origin summer steelhead from the Klickitat River for broodstock. The new program would continue to provide harvest opportunities for treaty and non-treaty fisheries. A feasibility study would likely be conducted as part of the program to investigate broodstock collection and juvenile rearing strategies, expected smolt-to-adult survival rates, and the risks associated with current steelhead hatchery practices.

The Yakama Nation also is working with NMFS, WDFW, tribal leaders, and others to examine whether a conservation hatchery program could be used to accelerate recolonization of the Upper Klickitat watershed. The program could also be used to provide harvest opportunities. The need for, and use of, artificial production to accelerate recolonization would be contingent upon the rate and extent that natural recolonization occurs in the upper watershed now that passage has been restored at Castile Falls. The decision to implement an artificial propagation program in the upper Klickitat watershed would likely imply that natural recolonization has been minimal and/or is occurring at an extremely slow rate. The draft Klickitat River Anadromous Fisheries Master Plan, which describes in detail these hatchery actions, was submitted for review to fulfill the requirements for step one of the NPPC's three-step process for major projects (WDFW and Sharp et al. 2008).

Habitat conditions (e.g. high water temperatures in some tributaries) and the various natural and constructed migration barriers are considered to be limiting factors for the Klickitat steelhead population. Protecting the existing good quality habitat, restoring habitat where appropriate, and improving access to spawning areas would likely improve abundance, productivity, spatial structure, and diversity for this population. Further identification of the factors limiting the Klickitat population is a priority action.

Managing harvest to maintain current low impacts from both mainstem and tributary fisheries, and to reduce any adverse impacts that may be occurring, also is an important contribution to the population's viability.

The actions recommended to support recovery are described in more detail in the following sections. Table ES-1 organizes priority actions in terms of larger categories, called strategies. Out-of-basin recovery strategies and actions are addressed in two NMFS documents, The Columbia River Estuary Module, available at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Other-Documents.cfm, and the 2008 FCRPS Biological Opinion (NMFS 2008c).

Table ES-1. Recovery Strategies and Actions for the Klickitat River Steelhead Population.

Strategy	Key Types of Actions
Hatchery	
Determine impact of hatchery steelhead releases on viability of Klickitat steelhead population.	• Conduct annual spawner surveys to track adult steelhead occupancy of MaSAs. • Sample carcasses on spawning grounds to estimate natural/hatchery adult spawner ratios. • Increase juvenile and adult genetic sampling and analysis at spawning grounds and at various trap locations to assess level of domestication and interbreeding between hatchery and natural steelhead. • Conduct radio-tagging study to determine spatial and temporal distribution of natural population and Skamania Hatchery steelhead, and overlap between summer and winter runs.
Minimize adverse impacts of hatchery releases on natural steelhead spawning population.	• Develop and implement Klickitat steelhead integrated hatchery program. • Conduct feasibility study to gain needed information on broodstock collection, rearing strategies and expected smolt-to-adult survival rates, and to assess risks associated with current and proposed hatchery practices.
Improve steelhead passage at Lyle Falls Fishway.	• Reconstruct Lyle Falls Fishway to Federal design criteria to ease passage of steelhead and to possibly function as the broodstock collection facility.
Assess steelhead natural recolonization of upper Klickitat watershed and the potential use of artificial propagation to accelerate recolonization.	• Monitor annual natural escapement of steelhead into the upper subbasin. • Use Castile Fishway trap to collect biological data on *O. mykiss* migrating into the upper watershed, and to monitor trends in the genetic composition and diversity of the upper basin population. • Explore need for a conservation hatchery program to accelerate recolonization of upper Klickitat watershed.
Minimize adverse impacts of large-scale hatchery releases of *U.S. v. Oregon* production stocks (coho and fall Chinook) on Klickitat steelhead.	• Develop the satellite Wahkiacus Hatchery/Acclimation Facility at RM 17.0. • Transfer existing *U.S. v. Oregon* production of fall Chinook and coho from Klickitat Hatchery to new Wahkiacus facility.
Determine and minimize impacts of hatchery trout releases in the subbasin.	• Investigate impacts of WDFW hatchery trout plants into the Klickitat subbasin.
Determine the effects of hatchery releases of coho and fall Chinook and subsequent naturalization of the species on Klickitat River steelhead	• Conduct annual spawner surveys to document adult coho and fall Chinook occupancy. • Sample carcasses on spawning grounds to estimate natural/hatchery adult spawner ratios. • Develop population estimates of naturally spawning coho and fall Chinook and evaluate productivity of those species. • Conduct studies as needed to determine the effect of coho and fall Chinook on steelhead population.
Tributary Habitat	
Protect stream corridor structure and function	• Protect highest quality habitats through land acquisition, conservation easements or land trusts with willing landowners. • Adopt and manage Cooperative Agreements where beneficial. • Conserve rare and unique functioning habitats. • Consistently apply Best Management Practices and existing laws to protect and conserve natural ecological processes.
Restore passage and connectivity between habitat areas.	• Monitor effectiveness of passage improvements at Castile Falls. • Remove or replace barriers blocking or impairing passage including dikes, road culverts and irrigation structures. • Monitor and continue restoration efforts in Snyder Creek mill reach. • Ensure that pump intakes are adequately screened.
Restore riparian condition	• Restore natural riparian vegetative communities. • Develop grazing strategies that promote riparian recovery. • Monitor and continue restoration efforts in Snyder Creek mill reach.

Strategy	Key Types of Actions
Restore altered hydrographs to enhance instream flows during critical periods	• Implement agricultural water conservation measures. • Improve irrigation conveyance and efficiency. • Employ BMPs to forest, agriculture and grazing practices and to road management. • Assess effects of groundwater development on tributary flow. • Protect and/or rehabilitate springs • Increase pool habitat.
Restore water quality, including water temperatures.	• Increase riparian shading where stream temperatures are high • Assess nutrient and dissolved oxygen levels in the Little Klickitat River, particularly downstream of Goldendale. • Employ BMPs for forest, agriculture and grazing practices and for road management. • Upgrade or remove problem forest roads.
Harvest	
Manage to maintain current low impact fisheries and reduce harvest-related adverse effects in those fisheries that have significant impacts.	Maintain current management regulations for low impact fisheries and adjust tributary harvest regulations in areas where harvest significantly impacts steelhead viability.
Study and limit adverse impacts of harvest practices in Klickitat subbasin on ESA-listed species.	Eliminate illegal harvest by enforcing tribal and sport regulations in Klickitat subbasin.
Monitoring	
Monitor to determine abundance and productivity of natural spawners, proportion of hatchery and wild spawners in the Klickitat subbasin, and adverse effects, if any, of Skamania broodstock on Klickitat steelhead population.	• Continue to enumerate upstream adult migrants and downstream migrating smolts at the fish traps • Develop estimates of the efficiencies of the traps • Annually estimate the abundance of the adult and smolt populations • Develop annual estimates of productivity of natural spawners Develop improved methods for estimating abundance and productivity of natural spawners.

Cost Estimates

The highest priority strategies for the Klickitat basin address data gaps (see Section 6-1). As such, these priority strategies fall into the category of research, monitoring, and evaluation. The costs associated with these efforts are detailed in Chapter 8. Table 8-1 estimates the cost of ongoing and expanded RM&E activities to be up to $4,484,402 for years 1 through 3, and up to $15,142,783 for years 4 through 10. Information gained through filling the priority data gaps will help to refine the actions needed to reach recovery.

Costs for actions to address hatchery-related effects are distributed among research, monitoring and evaluation, detailed in Chapter 8, and capital costs and operations and maintenance costs that have been included in programs proposed under the NPCC Fish and Wildlife Program or are ongoing under that program or the Mitchell Act administered by NMFS. Capital costs for hatchery and fish passage improvements are estimated at $41.6 million; these are proposed as part of the Klickitat River Anadromous Fisheries Master Plan, submitted to the NPCC in 2008 (Sharp et al. 2008). Ongoing operations and maintenance costs are not included in the total cost of recovery calculated for the plan, per NOAA guidance for cost estimating (Plummer 2006).

The total estimated cost for completing all of the habitat projects identified in Chapter 6 is estimated to be up to $129,451,630 ($25,890,326.00 for years 1-10, and

$103,561,304.00 for years 11-50). Estimates are expressed in 2007 dollars. Estimated costs are general range summaries arranged to align with the Klickitat River Anadromous Fisheries Master Plan (Sharp et al. 2008) and Yakima/Klickitat Fisheries Project.

Implementation

NMFS has worked independently with the Yakama Nation, Washington Department of Fish and Wildlife, and local entities to develop the recovery plan for the Klickitat steelhead population. NMFS encourages the formation of a planning forum for the Washington Gorge Management Unit, a forum or entity that would take responsibility for coordinating implementation of the plan. The creation of a Washington Gorge Area Regional Board (subject to concurrence by state, tribal and local governments, including the Yakama Nation) would provide a *collaborative process* for further prioritizing recovery actions and for implementation of the Washington Gorge Management Unit plans.

Implementation of the Klickitat Subbasin Recovery plan involves addressing data gaps through research, monitoring, and evaluation; establishing schedules and priorities for recovery actions; engaging stakeholders and landowners; identifying responsibilities; and securing funding. Implementation of this plan depends on the voluntary actions and cooperation of local entities and citizen groups. An important part of implementation will be working cooperatively to develop a detailed research, monitoring, and evaluation plan addressing the additional information needs described in Chapter 8.

Funding sources for salmon and steelhead recovery actions in the Columbia Basin are varied. They include:

- Pacific Coastal Salmon Recovery Fund (PCSRF) (States and tribes)
- Salmon Recovery Funding Board (SRFB) (a combination of PCSRF and Washington State funds)
- Columbia Basin Fish Accords
- Congressional appropriations (Federal agencies)
- State appropriations (state agencies)
- Northwest Power and Conservation Council Fish and Wildlife Program (states and tribes)
- Federal / state grants
- Non-profit organization programs and grants

The 2008 Columbia River Fish Accords Memorandum of Agreement between the Three Treaty Tribes and FCRPS Action Agencies identifies funds for hatchery planning and operations and maintenance covering some of the existing and expanded activities in the Klickitat River basin. The Accords identify hatchery capital funds for the design and construction of the hatchery and passage facilities in the Klickitat River basin except the Wahkiacus Hatchery facility, and include language that states that the Action Agencies will work toward finding funding for this facility.

Research, Monitoring, and Adaptive Management

As part of implementing the Klickitat recovery plan, a detailed monitoring and evaluation program will be designed and incorporated into an adaptive management framework based on the principles and concepts laid out in the NMFS guidance document, *Adaptive Management for Salmon Recovery: Evaluation Framework and Monitoring Guidance.*

The Klickitat monitoring and evaluation program will build on existing programs designed for monitoring tributary habitat in the subbasin, hydropower actions in the Mid-Columbia, Mid-Columbia hatchery programs, and other actions outside of the Mid-Columbia tributary subbasins (e.g., Columbia mainstem hydropower, estuary and ocean conditions, mainstem and ocean harvest). The monitoring and evaluation program will provide (1) a clear statement of the metrics and indicators by which progress toward achieving goals can be assessed, (2) a plan for tracking such metrics and indicators, and (3) a decision framework through which new information from monitoring and evaluation can be used to adjust strategies or actions aimed at achieving the plan's goals.

1. Introduction

The Endangered Species Act of 1973 (ESA) requires NOAA's National Marine Fisheries Service (NMFS) to develop recovery plans for species listed under the Act. The purpose of recovery plans is to identify actions needed to restore threatened and endangered species to the point that they are again self-sustaining elements of their ecosystems and no longer need the protections of the ESA.

This recovery plan focuses on the conservation and survival of Middle Columbia River steelhead (*Oncorhynchus mykiss*) in the Klickitat subbasin (Figure 1-1). The Klickitat River drains approximately 1,350 square miles in south central Washington before joining the Columbia River at Lyle, Washington (RM 180.4), 34 miles upstream of Bonneville Dam. The Klickitat is one of the longest undammed rivers in the Northwest. The subbasin supports both summer and winter runs of steelhead.

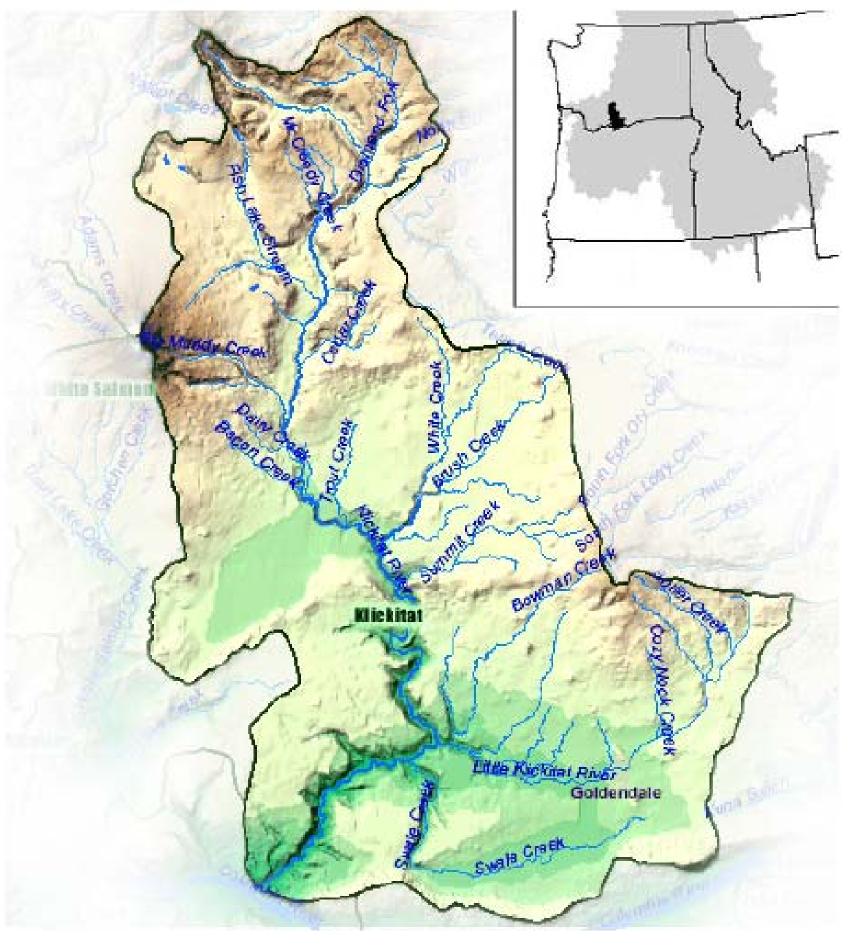


Figure 1-1. Klickitat Subbasin.

"Steelhead" is the name commonly applied to the anadromous form of the biological species *Oncorhynchus mykiss*. The species also has a non-anadromous, or resident, form that is commonly called rainbow trout. NMFS originally listed the species as threatened on March 25, 1999 (NMFS 1999), calling it an "evolutionarily significant unit" (ESU) of salmonids, which included both forms. Recently, NMFS revised its species determinations for West Coast steelhead under the ESA, delineating anadromous, steelhead-only "distinct population segments" (DPS). NMFS listed the Middle Columbia River steelhead DPS as threatened on January 5, 2006 (NMFS 2006a, 71 FR 834). The DPS is made up of steelhead populations in Oregon and Washington tributaries of the Columbia River upstream of the Hood and Wind River systems, up to and including the Yakima River. Reasons for listing the Middle Columbia River steelhead DPS included low returns to the Yakima River, poor abundance estimates for Klickitat River and Fifteenmile Creek winter steelhead, and an overall decline of naturally producing "stocks" within the DPS.

The Klickitat River population is of particular interest because of containing both summer and winter runs, and it potentially could make a significant contribution to recovery of the Middle Columbia steelhead. The Klickitat River is one of the largest salmon producing watersheds in the Columbia basin. It is located above only one dam (Bonneville), contains headwaters in the well-managed forests of the Yakama Reservation, and has had relatively little development, with relatively low human population growth expected in the near future. Recent passage improvements at Castile Falls in the upper Klickitat have opened an additional 56 miles of high quality steelhead habitat. Passage improvements in the lower Klickitat (Lyle Falls at RM 2.2) are also expected to benefit immigrating adults. In addition, a hatchery master plan under development by the Yakama Nation in consultation with NMFS is expected to improve hatchery management to support conservation of the naturally spawning steelhead.

NMFS developed this recovery plan with involvement and input from the Yakama Nation, Washington Department of Fish and Wildlife, Klickitat County, the Washington State Governor's Salmon Recovery Office, other Federal agencies, state agencies, local governments, and the public. While NMFS is the agency responsible for recovery planning for salmon and steelhead under the ESA, NMFS believes it is critically important to base ESA recovery plans for salmon on the many state, regional, tribal, local, and private conservation efforts already underway throughout the region. Local support of recovery plans by those whose activities directly affect the listed species, and whose actions will be most affected by recovery efforts, is essential. NMFS therefore supports and participates in locally led collaborative efforts to develop recovery plans, involving local communities, state, tribal, and Federal entities, and other stakeholders.

1.1 Purpose of Plan

The Plan provides a roadmap for restoring the Klickitat steelhead population and its habitats to a level that supports recovery of the Middle Columbia River steelhead DPS and allows the population to become a viable component of its ecosystem.

The Plan is a guidance document. It describes the current status of the Klickitat population and its habitat in the Klickitat drainage, and summarizes the results of a technical assessment examining the population's viability. The Plan also identifies the factors and threats potentially limiting the population and proposes strategies and actions designed to aid in the population's recovery by building on past and current efforts. Finally, the Plan provides an implementation and adaptive management framework for making needed future adjustments on the road to recovery.

1.1.1 ESA Requirements

Section 4(f) of the ESA requires that a recovery plan be developed and implemented for species listed as endangered or threatened under the statute.

ESA section 4(a)(1) lists factors for re-classification or delisting that are to be addressed in recovery plans:

A. The present or threatened destruction, modification, or curtailment of [the species'] habitat or range
B. Over-utilization for commercial, recreational, scientific or educational purposes
C. Disease or predation
D. The inadequacy of existing regulatory mechanisms
E. Other natural or human-made factors affecting its continued existence

ESA section 4(f)(1)(B) directs that recovery plans, to the extent practicable, incorporate:

1. a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;
2. objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this chapter, that the species be removed from the list; and;
3. estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

In addition, it is important for recovery plans to provide the public and decision makers with a clear understanding of the goals and scientifically supported strategies needed to recover a listed species (NMFS 2006b).

Once a species is deemed recovered and therefore removed from a listed status, section 4(g) of the ESA requires the monitoring of the species for a period of not less than five years to ensure that it retains its recovered status.

1.1.2 Coordination with Others

The Plan aims to provide consistency among related recovery planning and management efforts, including NOAA's Federal treaty and trust responsibilities and the many state and local entities involved in salmon recovery.

Federal Treaty and Trust Responsibilities

Northwest Native American tribes have legally enforceable treaty rights reserving to them a share of the harvestable salmon and steelhead. Achieving the basic purposes of the ESA such that the species no longer needs the protection of the Act may not by itself fully meet these rights and expectations, although it will lead to major improvements in the current situation. Ensuring a sufficient abundance of salmon to sustain harvest can be an important element in fulfilling trust and treaty rights as well as garnering public support for these plans.

It is NMFS policy that recovery of salmonid populations must achieve two goals: (1) the recovery and delisting of salmonids listed under the provisions of the ESA, and (2) the restoration of the meaningful exercise of tribal fishing rights. “It is the agency’s view that there is no conflict between the statutory goals of the ESA and Federal trust responsibility to Indian tribes” (Letter from Terry Garcia, Assistant Secretary for Oceans and Atmosphere, to Ted Strong, Executive Director, Columbia Inter-Tribal Fish Commission, July 21, 1998). Additionally, NMFS “will continue to join with states and tribes to develop a comprehensive approach to the restoration of fish and wildlife resources in a manner that fulfills all obligations under Federal law, including trust obligations to Indian tribes” (ibid.).

Thus, it is appropriate for recovery plans to take these considerations into account and plan for a recovery strategy that includes harvest. In some cases, the desired abundances for harvest may come about through increases in the naturally spawning population. In others, the recovery strategy may include appropriate use of hatcheries to support a portion of the harvest. So long as the overall plan is likely to achieve the biological recovery of the listed ESU, it will be acceptable as a recovery plan.

Treaty Native American fishing rights in the Columbia basin are under the continuing jurisdiction of the U.S. District Court for the District of Oregon in the case of *United States v. Oregon*, No. 68-513 (filed in 1968). The parties to *U.S. v. Oregon* are the United States acting through the Department of Interior (USFWS and Bureau of Indian Affairs) and Department of Commerce (NMFS), the Warm Springs, Umatilla, Nez Perce, Yakama, and Shoshone-Bannock Tribes, and the states of Oregon, Washington, and Idaho. In *U.S. v. Oregon*, the Court affirmed that the treaties reserved for the tribes 50 percent of the harvestable surplus of fish destined to pass through their usual and accustomed fishing areas.

The Klickitat watershed is part of the Yakama Nation’s ceded area. Yakama Nation staff developed much of the data on the Klickitat population. The Yakama Nation is voluntarily participating in recovery planning and implementation in the Yakima subbasin and throughout its ceded area as a sovereign with treaty-reserved rights on and off the reservation, and as a fish and wildlife co-manager. In so doing, the Yakama Nation does not waive or in any way alter its treaty-reserved rights.

Other Federal, State and Local Responsibilities

To ensure consistency in goals, strategies, and actions and to eliminate needless duplication of effort, the process aims to provide consistency between planning for ESA recovery, the Northwest Power and Conservation Council (NPCC) Fish and Wildlife Program, the State of Washington Watershed Management and Salmon Recovery Programs, and local planning and regulatory efforts.

This recovery plan follows ESA guidelines and builds upon direction in the Klickitat Subbasin Plan (NPCC 2004). The 2004 Klickitat Subbasin Plan was developed for the NPCC by the Yakama Nation, Washington Department of Fish and Wildlife, and other Federal, state, and local entities. It contains an assessment and inventory of fish and wildlife resources in the subbasin, as well as a management plan establishing locally informed fish and wildlife protection and restoration priorities. The NPCC adopted the Klickitat Subbasin Plan into its Fish and Wildlife Program in 2004. The NPCC and Bonneville Power Administration use the Klickitat Subbasin Plan to direct funding for projects that protect, mitigate, and enhance fish and wildlife that have been adversely impacted by the development and operation of the Columbia River hydropower system, pursuant to their obligations for implementing the Northwest Power Act of 1980.

Information and direction was also drawn from the Watershed Management Plan for Watershed Resource Inventory Area (WRIA) 30, the Klickitat drainage. The Watershed Management Plan was developed and approved in accordance with Chapter 90.82 Revised Code of Washington (Chapter 90.82 RCW). The "initiating governments" for the planning effort were Klickitat County, City of Goldendale, and Public Utility District No. 1 of Klickitat County (KPUD). The Watershed Management Plan provides for 5 years of funding for watershed plan implementation via the WRIA planning organization.

1.2 Context of Plan Development

This plan for the Klickitat steelhead population is one part of a larger effort to recover species listed throughout the Pacific Northwest. Not only is it one of several recovery plans for steelhead populations in the Middle Columbia River steelhead DPS, it is also one of many recovery plans within NMFS' larger framework of recovery planning efforts for listed salmon and steelhead populations across the Pacific Northwest.

Currently 13 ESUs and 6 DPSs of Pacific salmon and steelhead in the Pacific Northwest are listed under the ESA. NMFS has designated five geographically based recovery domains for preparing recovery plans for the listed species. The Middle Columbia River steelhead DPS falls within the Interior Columbia recovery domain (which is divided into three sub-domains: the Snake River, Mid-Columbia, and Upper Columbia). The other recovery domains are the Willamette/Lower Columbia, Puget Sound and Washington Coast, Oregon Coast, and the Southern Oregon/Northern California Coast. (http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Middle-Upper-Columbia/Index.cfm). Similar opportunities for technical and stakeholder involvement exist in each domain.

1.2.1 Technical Recovery Teams

For each domain, NMFS appointed a team of scientists, nominated for their geographic and species expertise, to provide a solid scientific foundation for recovery plans. The charge of each Technical Recovery Team (TRT) was to define ESU/DPS structures, develop recommendations on biological viability criteria for each ESU or DPS and its component populations, provide scientific support to local and regional recovery planning efforts, and provide scientific evaluations of proposed recovery plans. All the TRTs used the same biological principles for developing their recommendations for ESU/DPS and population viability criteria – criteria to be used, along with criteria based on mitigation of the factors for decline, to determine whether a species has recovered sufficiently to be downlisted or delisted. These principles are described in a NMFS technical memorandum, *Viable Salmon Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). Viable salmonid populations (VSP) are defined in terms of four parameters: abundance, population productivity or growth rate, population spatial structure, and diversity. A viable ESU/DPS is naturally self-sustaining, with a high probability of persistence over a 100-year time period. Each TRT made recommendations using the VSP framework, based on data availability, the unique biological characteristics of the ESUs/DPSs and habitats in the domain, and the members' collective experience and expertise. Although NMFS has encouraged the TRTs to develop regionally specific approaches for evaluating viability and identifying factors limiting recovery, all the TRTs are working from a common scientific foundation.

The Interior Columbia Technical Recovery Team (ICTRT) provided technical support for the Mid-Columbia River steelhead DPS recovery planning effort. The ICTRT included biologists from NMFS, state and tribal entities, and academic institutions.

1.2.2 Planning Forums

In each domain, NMFS has worked with state, tribal, local and other Federal entities to develop planning forums that build to the extent possible on ongoing, locally led recovery efforts. NMFS defined "management units" based on jurisdictional boundaries as well as areas where citizen planning efforts were underway. The Mid-Columbia management units are (1) Oregon; (2) Washington Gorge, which, in turn, is subdivided into three planning areas, White Salmon, Klickitat, and Rock Creek; (3) Yakima subbasin; and (4) Southeast Washington. These management units have active planning and implementation forums, with the exception of the Washington Gorge Management. In the Washington Gorge Management Unit, NMFS has worked independently with the Yakama Nation, Washington Department of Fish and Wildlife (WDFW), Klickitat County, and local entities to develop the recovery plan for the Klickitat steelhead population. NMFS encourages the formation of a planning forum for the Washington Gorge Management Unit (Figure 1-2).

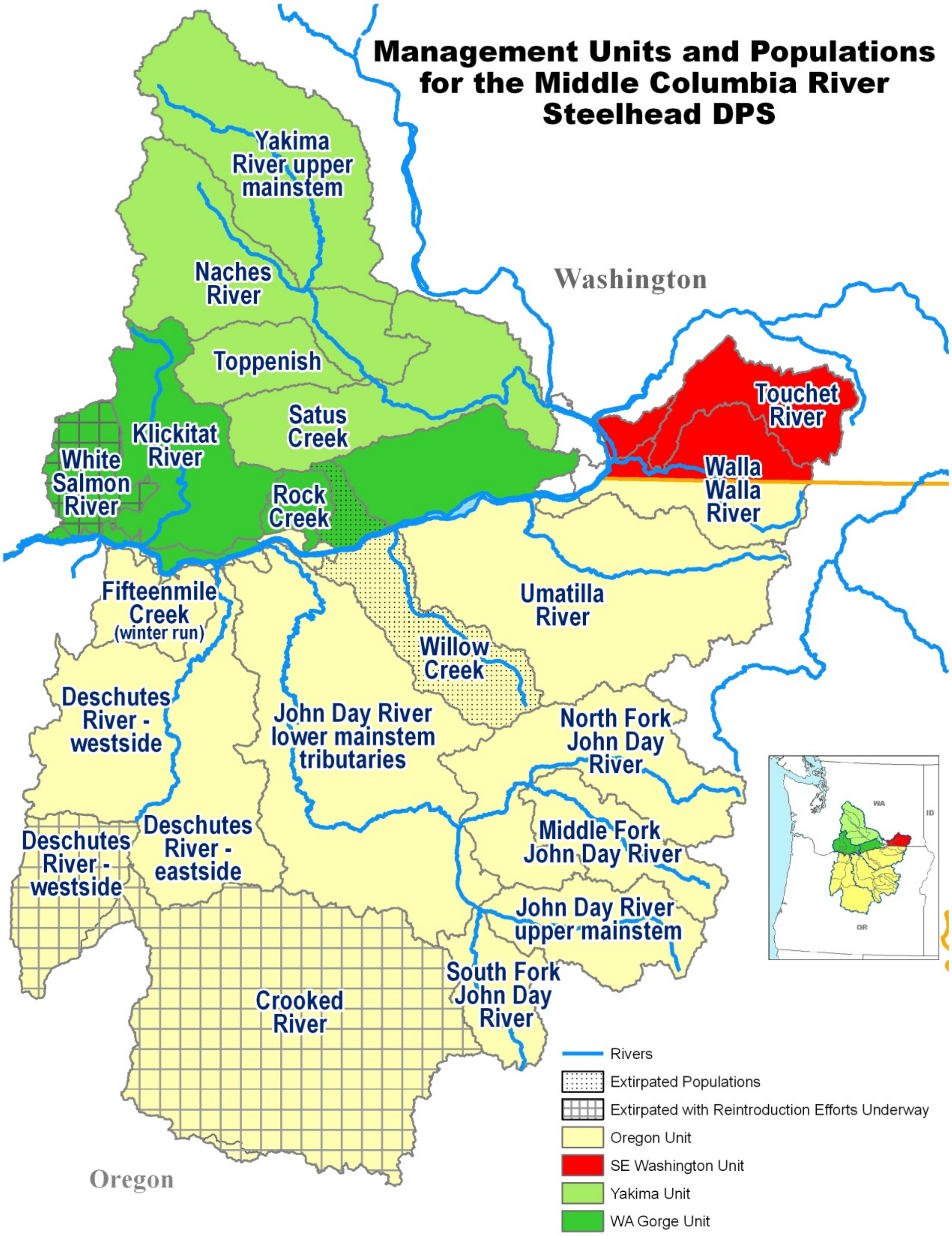


Figure 1-2. Management Units for Middle Columbia River Steelhead DPS.

1.3 How NMFS Intends to Use the Plan

Although recovery plans are not regulatory and their implementation is voluntary, they are important tools that help to do the following:

- Provide context for regulatory decisions.
- Guide decision making by Federal, state, tribal, and local jurisdictions.
- Provide criteria for status reporting and delisting decisions.
- Organize, prioritize, and sequence recovery actions.
- Organize research, monitoring, and evaluation efforts.

NMFS will encourage Federal agencies and non-Federal jurisdictions to take recovery plans under serious consideration as they make the following sorts of decisions and allocate their resources:

- Actions carried out to meet Federal ESA section 7(a)(1) obligations
- Actions that are subject to ESA sections 4d, 7(a)(2), or 10
- Hatchery and Genetic Management Plans and permit requests
- Harvest plans and permits
- Selection and prioritization of subbasin planning actions
- Development of research, monitoring, and evaluation programs
- Revision of land use and resource management plans
- Other natural resource decisions at the state, tribal, and local levels

NMFS will emphasize recovery plans in ESA section 7 (a)(2) consultations, section 10 permits, and application of the section 4(d) rule by considering:

- Delisting criteria that address both viability and threats
- Description of limiting factors and threats (factors for decline)
- Description of a recovery program (site-specific management actions necessary to achieve recovery of the species)
- Estimates of the time and cost to carry out measures to achieve the plans' goals

In implementing these programs, recovery plans will be used as a reference and a source of context, expectations, and goals. NMFS staff will encourage the Federal "Action Agencies" to describe in their biological assessments how their proposed actions will affect specific populations and limiting factors identified in the recovery plans, and to describe any mitigating measures and voluntary recovery activities in the action area.

2. Biological Background

This chapter describes population and habitat characteristics for Middle Columbia River steelhead in the Klickitat subbasin. The chapter also discusses hatchery production and releases and harvest management in the Klickitat subbasin.

2.1 Populations and Major Population Groups

The ICTRT identified 17 extant and 3 extirpated independent steelhead populations in the Middle Columbia River steelhead DPS (McClure et al. 2003). These populations are shown in Figure 2-1. The ICTRT delineated the populations based on genetic information, geography, life history traits, morphological traits, and population dynamics.

The ICTRT grouped these independent populations into four major population groups (MPGs) within the DPS: the Cascades Eastern Slope Tributaries MPG, Yakima subbasin MPG, John Day River MPG, and Umatilla/Walla Walla MPG. The Klickitat River population is one of five extant populations (Klickitat River, Fifteenmile Creek, Rock Creek, Deschutes Eastside, and Deschutes Westside) and two extirpated populations (White Salmon River and Deschutes Crooked River) comprising the Cascades Eastern Slope Tributaries MPG (Figure 2-2). Populations in the group are united primarily by proximity and occupy diverse habitats, generally those draining the eastern slopes of the Cascades and the Columbia Plateau.

2.2 Physical Setting

The Klickitat River drains an area of approximately 1,350 square miles in south central Washington. It begins in the Cascades Mountains below Cispus Pass near 5,000 feet elevation and flows just over 95 miles to join the Columbia River at Lyle, Washington (RM 180.4), 34 miles upstream of Bonneville Dam (elevation 74 feet). It is one of the longest undammed rivers in the Northwest. The Klickitat drainage stretches west to the Cascade Mountain crest, north and east to the basalt ridges and plateaus of the Yakama Reservation, and south to the Columbia River Gorge. Major tributaries to the Klickitat River include Swale Creek (RM 17.2), Little Klickitat River (RM 19.8), Outlet Creek (RM 39.7), Big Muddy Creek (RM 53.8), West Fork Klickitat River (RM 63.1), and Diamond Fork (RM 76.8) (NPCC 2004). Major Creek is a small tributary to the Columbia River that lies just downstream of the Klickitat River drainage and is believed to support Middle Columbia steelhead. Appendix I provides an overview of the Major Creek watershed and current knowledge concerning steelhead use.

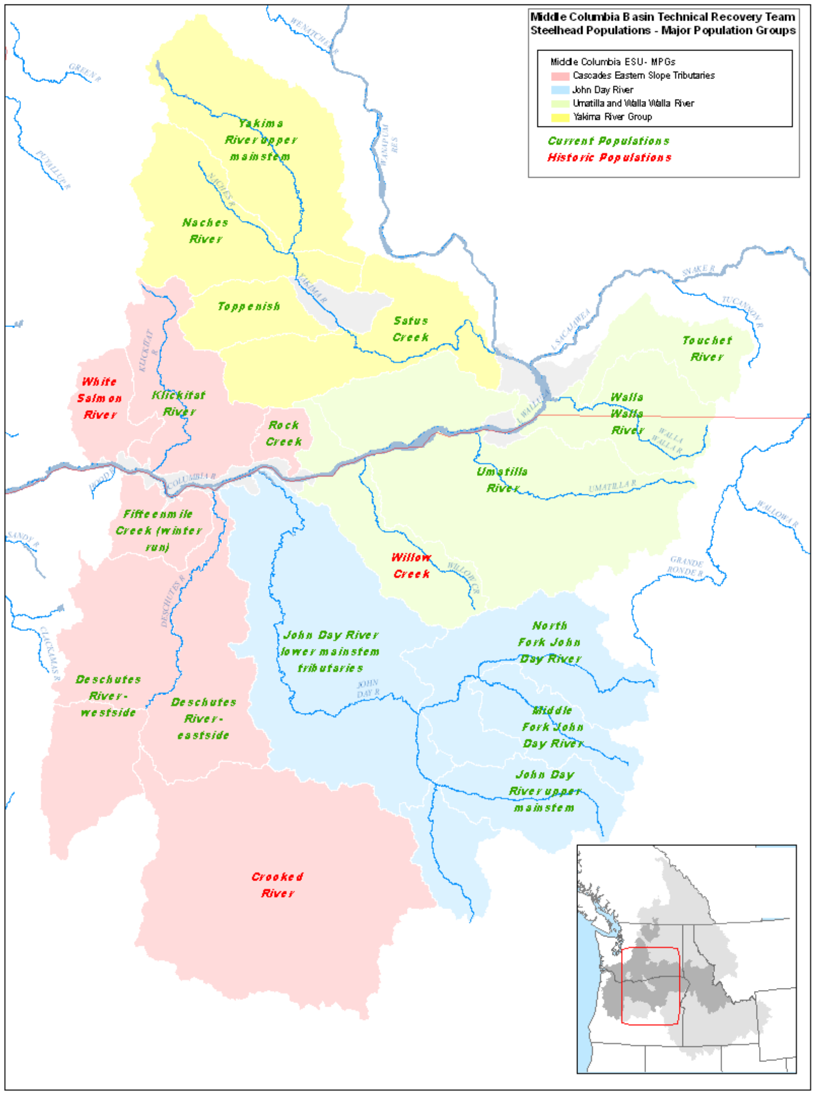


Figure 2-1. Independent Populations in the Middle Columbia River Steelhead DPS.

Forests cover three-quarters of the watershed: the Yakama Nation is the primary timberland landowner. These lands are managed according to the Yakama Nation Forest Management Plan, which designates the Klickitat watershed a "Reserve Area," where no timber harvest is planned. The State of Washington and numerous private parties own the remaining forested land, which is managed pursuant to the State Forest Practices Rules and an approved Habitat Conservation Plan (HCP). The rest of the watershed is used primarily for pasture, orchards, dry-land farming and livestock grazing. Agricultural use is concentrated in the Glenwood/Camas Prairie area in the western part of the watershed and on the southeastern plateau. Portions of the southernmost part of the Klickitat subbasin are within the Columbia River Gorge National Scenic Area (extending roughly 3 miles upstream from the mouth) (http://www.fs.fed.us/r6/columbia/maps/map.htm). The lower 10 miles of the Klickitat River are designated as a Recreational River under the National Wild and Scenic Rivers Act (http://www.rivers.gov/wsr-klickitat.html). The

Klickitat Wildlife Area, owned and managed by WDFW, covers 14,700 acres, encompasses a significant portion of the Klickitat River between the confluence with the Little Klickitat River and White Creek, as well as smaller segments of land along the lower river, downstream of the Little Klickitat River http://www.ecy.wa.gov/services/gis/maps/wria/mpl/mpl30.pdf. Columbia Land Trust recently acquired for conservation the west bank of the Klickitat River extending from just below the confluence with the Little Klickitat River north approximately 15 miles.

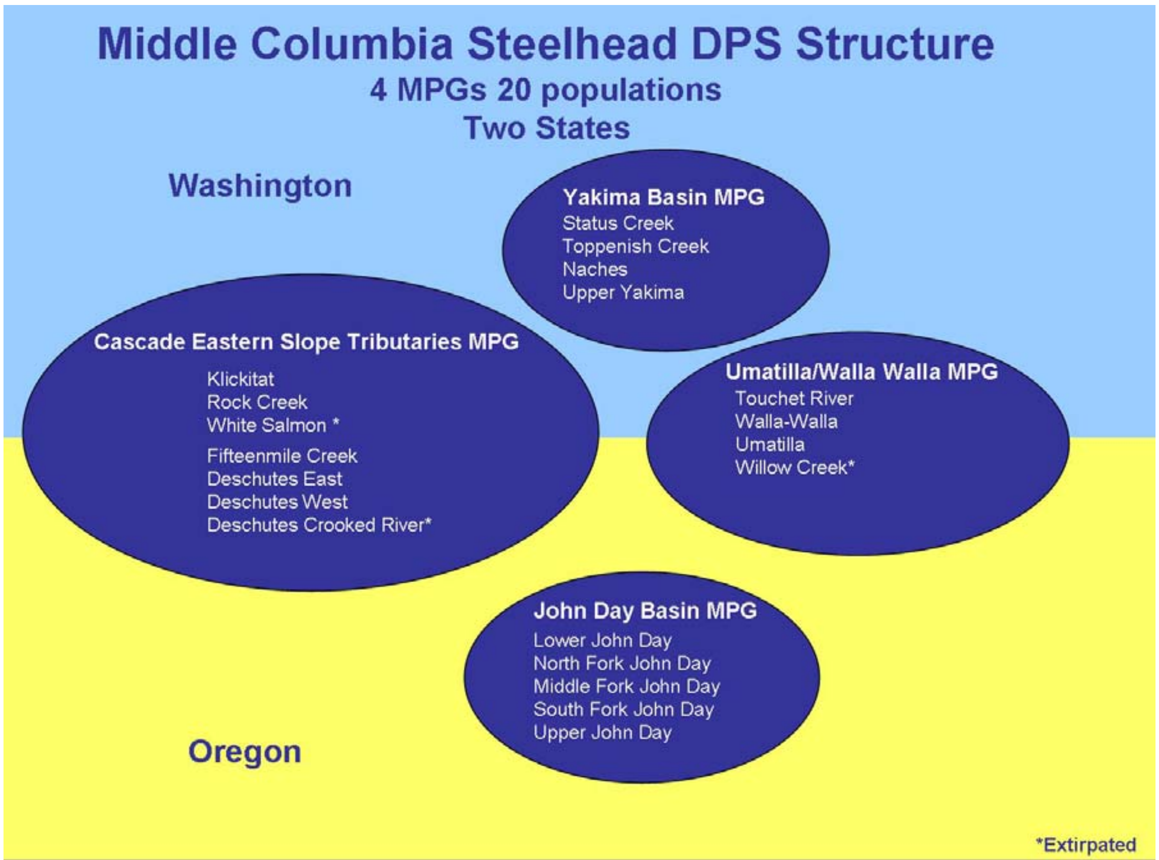


Figure 2-2. Major Population Groups and Populations of Middle Columbia Steelhead.

Several entities share responsibility for land and water management in the Klickitat subbasin (Figure 2-3). The subbasin is almost equally divided between Klickitat and Yakima counties. The City of Goldendale is the Klickitat County seat. The City of Yakima is the Yakima County seat. The subbasin supports a total population of approximately 11,000 people. As of the 2000 census, the City of Goldendale had a population of 3,760 (www.census.gov). The towns of Klickitat, Lyle, and Glenwood are unincorporated. The Yakama Nation is also a caretaker of subbasin resources. The Yakama Reservation comprises 1,573 square miles in Klickitat and Yakima counties. About a third of the Klickitat watershed, including the headwaters of the Klickitat River, lies within the reservation. The Yakama Nation ceded the rest of the Klickitat area in the June 9, 1855 treaty with the United States, reserving fishing, hunting and gathering rights, among other rights and responsibilities. The Klickitat watershed contains a "usual and accustomed fishing area" of historical, traditional, and modern cultural significance at Lyle Falls. In addition, the subbasin falls within Washington's Middle Columbia River Salmon Recovery Region ─ one of several Salmon Recovery Regions designated within Washington State ─ which includes salmon-bearing streams in Benton, Kittitas, Yakima, and parts of Chelan and Klickitat counties. It is also designated as the state's Water Resource Inventory Area (WRIA) 30.

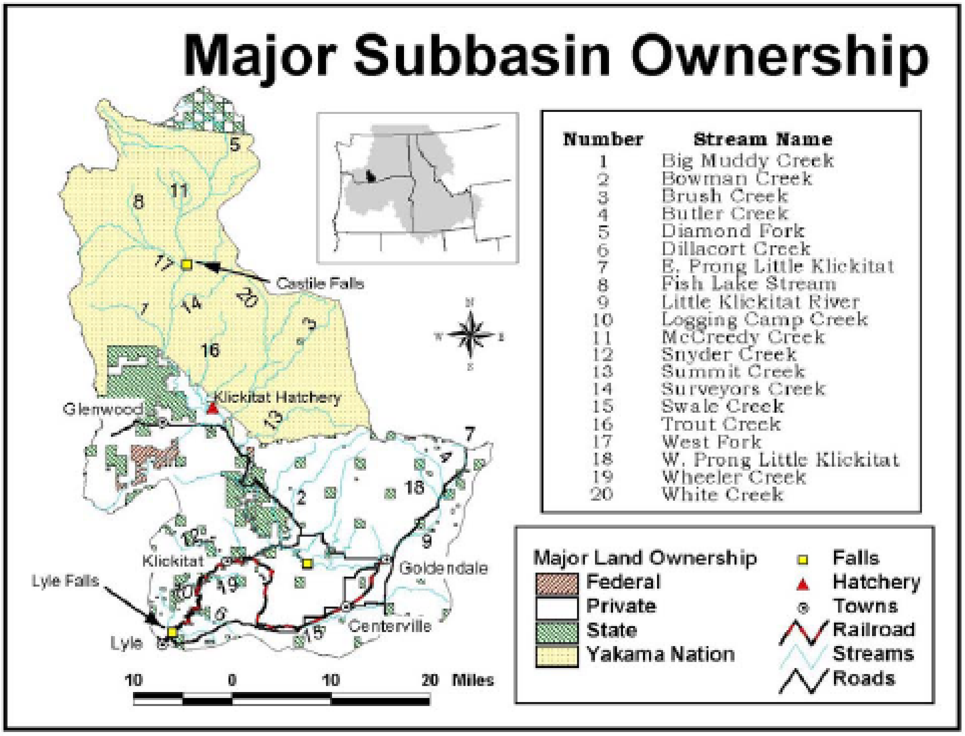


Figure 2-3. Klickitat Subbasin Land Ownership, Towns and Stream Locations (NPCC 2004).

2.3 Ecosystem Conditions

The Klickitat subbasin consists primarily of a basalt plateau with a total thickness of several thousand feet (Cline 1976), which is dissected by deep, steep-walled canyons carved by the watershed's network of streams and rivers. The Klickitat River, for example, flows through a deep canyon (700 to 1500 feet deep), and most of its tributaries are similarly incised. The erosion-resistant nature of some of the basalt strata has caused the formation of numerous waterfalls that restrict fish movement, including three notable waterfalls: Lyle Falls (RM 2.2 on the mainstem Klickitat River), Castile Falls (RM 64.0 to 64.5 on the mainstem Klickitat River), and Little Klickitat Falls (RM 6.1 on the Little Klickitat River).

2.3.1 Hydrology

Most streams in the Klickitat subbasin have natural runoff patterns, since there is no flow regulation within the watershed. Flow in the Klickitat River is primarily fed by snowmelt in spring and early summer, and by glacial melt in late spring and summer. Peak flows in the upper subbasin (upstream of Cedar Valley tributaries and some of the smaller tributaries to the north of Glenwood, e.g. Dairy and Bacon creeks) are predominantly snowmelt-driven, although the largest events (e.g., 1996) involve rain at high elevations and rapid melting throughout the entire Klickitat subbasin (Figure 2-4). Peak flows in the middle and lower Klickitat subbasin often occur during the winter and are driven by rain-on-snow events.

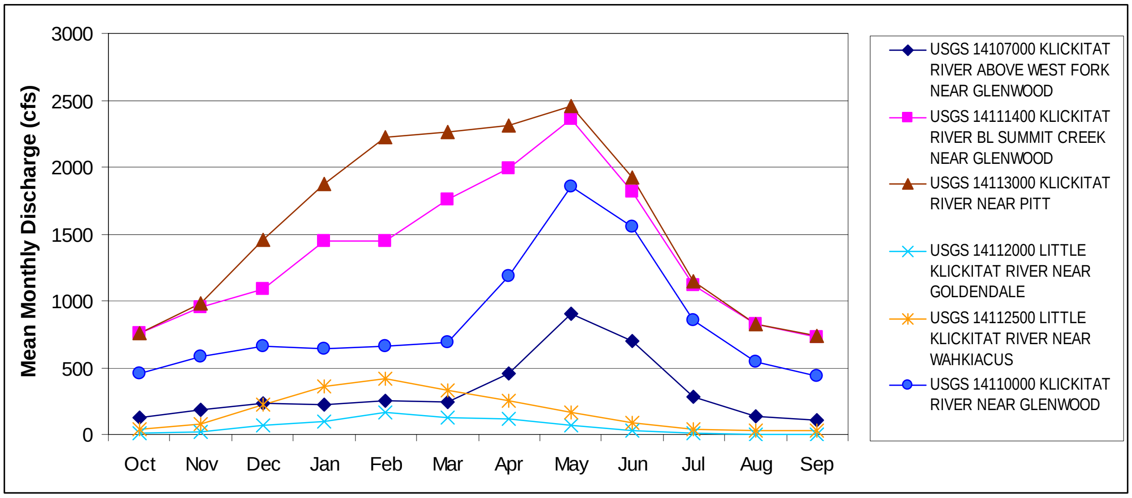


Figure 2-4. Mean Monthly Stream Flow for Six USGS-Operated Gauges on the Little Klickitat and Mainstem Klickitat rivers. (data source: USGS 2009).

The Little Klickitat River flows from the Simcoe Mountains and is largely fed by snowmelt supplemented by base flow from groundwater sources. Snow melts out of the Simcoe Mountains earlier than in the Cascade Mountains and snow pack tends to be substantially smaller. Peak flows in the Little Klickitat occur through the winter because the elevation of the watershed is within the rain-on-snow zone. The Little Klickitat River has continuous flow over nearly all of its length (Ecology 2008).

In some areas, groundwater discharge adds substantial flow to local streams. The volcanic rocks on the Mt. Adams side of the Klickitat River contain permeable volcanic debris and lava tubes. The Columbia River Basalt that underlies most of the Klickitat River Basin represents the largest source for groundwater supply within the subbasin. Cline (1976) estimates that about 60 percent of the average annual stream flow leaving the Yakama Reservation in the Klickitat River is groundwater discharge, with individual springs discharging up to 40 cubic feet/second (cfs). Springs are common in the Camas Prairie (Glenwood) area, reflecting the abundance of shallow ground water in the area (WPN and Aspect 2005a).

The middle and upper subbasin provide the vast majority of surface and ground water that contribute to mainstem baseflow. As shown in Figure 2-4, flow that supports the lower Klickitat River from July through November originates from the upper and middle Klickitat subbasin (measured at Summit Creek).

Low flow may limit steelhead production in many streams in the lower and middle Klickitat watersheds. In the lower subbasin, Swale Creek, Knight Canyon, Dillacort, Wheeler, upper Canyon, Beeks Canyon, and Dead Canyon creeks, and portions of White

Creek, dry up partially or completely in most years (WPN and Aspect 2005a). The only lower subbasin tributaries that maintain continuous or nearly continuous surface flow are the Little Klickitat River, Logging Camp Canyon and Snyder Canyon creeks, though perennial flows become restricted to middle and upper portions of Logging Camp Canyon and Snyder Creek after mid- to late-June (J. Spencer, personal communication 2006).

2.3.2 Water Quality

Water quality in the Klickitat River is influenced by natural and human factors. Glaciers on Mt. Adams, a 12,000-foot dormant volcano with an extensive glacier system, are prone to occasional outburst floods that deliver torrents of water, volcanic debris, and fine sediment via snowmelt to Big Muddy and Little Muddy creeks and the West Fork Klickitat. This results in high mainstem suspended sediment during summer months that colors the Klickitat River from the West Fork to the Columbia River, 63 miles downstream. Fine sediments associated with forestry, roads, agricultural practices, and construction may also be delivered to streams. The quantities of sediment delivered through land use practices and the effects of anthropogenic inputs have not been evaluated.

One segment of Swale Creek has been included on the Washington Department of Ecology's (WDOE's) 2008 list of impaired water bodies (303d list) because of temperature impairment (http://www.ecy.wa.gov/programs/wq/303d/2008/index.html). A water quality study was completed between June and December 2003 to assess the water temperature situation in Swale Creek and to estimate the potential and natural temperature situation in the lower portion of the creek which runs through a canyon (WPN and Aspect 2005a). The temperature criterion of 18ºC was exceeded at all stations monitored in 2003. Under current conditions, the upper two reaches of the canyon (covering roughly nine miles) are largely dry, with isolated bedrock dominated pools. In this area, shade tends to be very sparse around the pools (<25 percent). The lower three miles of Swale Creek (excluding the mouth) maintain a continuous flow during summer months with negligible volume (estimated at 0.25 to 0.5 cfs during the 2003 study; WPN and Aspect 2005a). Shade in the lower three miles approaches 100 percent effective shade in some areas. The *Klickitat River Watershed Management Plan*, developed pursuant to section 90.82 RCW, calls for an analysis to determine whether Swale Creek is appropriately categorized with respect to Washington State's surface water temperature standards, and it calls for the development and implementation of a plan to improve stream temperatures (WPN and Aspect 2005b). According to a 2002 assessment, Swale Creek has the potential to provide viable habitat for anadromous salmonids if the channel is restored and perennial water enhanced (Inter-Fluve 2002).

Several reaches in the Little Klickitat River were previously on WDOE's water quality assessment (also known as the 303(d) list) as Category 5 (i.e., impaired) for water temperature, but were reclassified to "Category 4A" (water bodies that have an approved TMDL) once the TMDL was completed for that subbasin (Brock and Stohr 2002, Anderson 2004, Ecology 2008). The TMDL and its detailed implementation plan outline actions to be taken to increase shade levels and stream flow in the Little Klickitat River subbasin. Many of these actions are being implemented. The City of Goldendale previously relied on springs to meet water demand. Use of most of the spring facilities has been discontinued in favor of deep groundwater sources (personal communication, Dave Griffin, City of Goldendale). The Central Klickitat Conservation District (CKCD), in cooperation with area landowners, has completed tree planting along the stream in many areas (personal communication, Jim Hill CKCD). In 2006 the CKCD was awarded a grant for stream flow and temperature monitoring, riparian planting, and other actions to implement the TMDL Detailed Implementation Plan. A study completed in 2009 comparing riparian condition current canopy closure condition with historical photos found that riparian cover along the stream has been increasing over the past 30 to 40 years (Aspect and WPN 2009). The study results will serve as a baseline for future monitoring. Other actions to address the temperature issue in the stream are in progress.

2.3.3 Riparian Function and Condition

Riparian areas in most of the subbasin remain more or less intact; however, in some areas past and current timber harvest practices, roads, cattle access to riparian areas, and other localized actions have resulted in riparian corridor degradation.

In the plateau reaches, agricultural and urban land uses likely had a significant impact on the ecological functions of the riparian forest. The McCormick Meadow area of the upper Klickitat River in the tribally designated Primitive Area was heavily grazed for approximately 60 years, leaving a legacy of related problems (e.g., bank erosion, poor riparian cover, etc.). Heavy grazing in the area was terminated about 15 years ago and more recent grazing has been lighter. Riparian vegetation along Swale Creek and the Little Klickitat River has been increasing over the past 30 to 40 years (Aspect and WPN 2009). There has been no assessment of trends in riparian vegetation along the lower Klickitat River.

Reductions in beaver populations in the subbasin may have contributed to the drying and loss of some wetland and riparian habitats. Outlet Creek has been mechanically drained through the construction of ditches, but there is a natural barrier to steelhead near the mouth of the creek. It is possible that loss of wetlands in tributary headwaters in conjunction with water withdrawals may have diminished storage capacity and recharge capability. However, studies by USGS in other basins indicate that surface irrigation can increase recharge over predevelopment conditions, depending on the scale of the irrigation and other variables (Bauer and Vaccaro 1990, Vaccaro and Olsen 2007). A detailed examination of the hydrology of the Klickitat subbasin currently underway as part of implementing the WRIA 30 watershed plan will be useful for recovery planning.

2.3.4 Migration Barriers

The presence of several natural migration barriers in the Klickitat watershed may have historically limited anadromous fish production, particularly during low water years. The Klickitat River flows through a deep, steep-walled canyon with several historically impassable or marginally passable falls and cascades where the river flows over resistant bedrock. In addition, access to many of the tributaries is restricted because of impassably high gradients close to the tributary mouths. Such historical barriers were important in maintaining separate life history strategies of *O. mykiss*, including summer steelhead, winter steelhead and resident rainbow trout.

The most significant natural barriers are the following:

- Lyle Falls (RM 2.2), a series of 5 falls from 4 to 12 feet high that historically were considered impassable during lowest water conditions in the summer and early fall (WSCC 2000). Historical data on steelhead distribution in the Klickitat subbasin are scarce; however, it is assumed that summer steelhead, like spring Chinook, were able to negotiate Lyle Falls (Bryant 1949). In 1952, Washington Department of Fisheries removed rock and constructed two fishways at the falls. Currently, Lyle Falls is not a barrier to salmon and steelhead, but passage at the natural falls is considered difficult under certain flow conditions (WSCC 2000). Planned repairs, modifications, and retrofits to the Lyle Falls Fishway will increase passage into the Klickitat subbasin.

- Castile Falls (RM 64), a series of 11 falls with an elevation drop of 80 feet over one-half mile. The falls historically presented an impediment to upstream passage of adult fish, but a 1960s attempt to improve fish passage at the falls inadvertently obstructed nearly all migration to habitat above the fishway. Recent improvements, including development of the Castile Falls Fishway, were completed in 2005 and provide steelhead and Chinook passage to the headwaters of the Klickitat. The fishway allows access to approximately 56 miles of spawning and rearing habitat in the upper mainstem and tributaries (NPCC 2004).

- Little Klickitat River Falls (RM 6.1), a 15 to 16-foot falls, restricts steelhead access to habitat areas in the upper Little Klickitat drainage. Fish passage is possible in rare cases, but these tend to be very high flow events (floods) in winter (D. Rawding, personal communication 2006). Steelhead redds above the falls were documented in 1996 and 1997, but these were years of high stream flow (WPN and Aspect 2005a). Further research is needed to obtain accurate estimates of passage frequency above the falls and steelhead spawning in the upper Little Klickitat (NPCC 2004).

- Two sets of falls on the West Fork Klickitat River — a 15 to 20-foot falls at RM 0.3 and another 15 to 20-foot falls just below the confluence of Little Muddy Creek and Fish Lake Stream at RM 4.8 — currently hinder upstream anadromous fish passage, and probably limited historical passage to upstream habitat (Thiesfeld 2001).

- A steep set of falls near the mouth of Surveyor's Creek. "The stream is impassible to salmon from the mouth upstream for about 0.8 mile. This area drops 400 feet in a series of cascades and impassable falls formed by huge slabs of rock" (LeMeir and Smith 1952).

- A 60 foot falls on Outlet Creek (RM 1.1) presents a complete barrier to all salmonids both presently and historically.

2.4 Life History Characteristics

Oncorhynchus mykiss, of which steelhead and rainbow trout are members, have a wide variety of life history strategies (Busby et al. 1996). Anadromy is not obligatory in *O. mykiss*, and the heritability of anadromy is much debated (Rounsefell 1958; Mullan et al. 1992). Progeny of anadromous steelhead can spend their entire lives in freshwater (residualize), while progeny of rainbow trout can migrate seaward. Although anadromous steelhead are the focus of interest within the Klickitat, both anadromous and resident forms are well documented in the Klickitat watershed. Resident rainbow trout are more widespread in the upper mainstem and perennial tributaries without barriers than in the lower subbasin tributaries. Anecdotal evidence, however, suggests historically wider distribution and greater population of resident *O. mykiss* in the Klickitat subbasin (B. Sharp, personal communication with YN Tribal Elders 2007).

Steelhead can be divided into two basic run types based on their level of sexual maturity at the time they enter fresh water and the duration of the spawning migration. The stream-maturing type, or summer steelhead, enters fresh water in a sexually immature condition and requires several months in fresh water to mature and spawn. The ocean-maturing type, or winter steelhead, enters fresh water with well-developed gonads and spawns relatively shortly after river entry (Bambrick et al. 2004).

The Klickitat River subbasin supports runs of winter and summer steelhead. Both are native to the system. Ocean-maturing or winter-run fish typically ascend streams between November and April, while summer-run, stream-maturing fish typically enter rivers between May and October. Genetic analysis shows some degree of differentiation between tributaries to the Klickitat River; genetic samples from the upper Klickitat, White Creek and Trout Creek seem to diverge most widely from the Skamania Hatchery stock (Phelps et al. 2000). Six or seven genetically distinct subpopulations have been identified within the Klickitat subbasin in recent genetic analysis (Narum et al. 2006). Analysis of genetic structure of Klickitat *O. mykiss* is ongoing. Further genetic sampling of adult native summer and winter steelhead will help identify genetic structure and enable a parentage analysis.

All winter populations in the Middle Columbia River steelhead DPS are small and unmonitored. Oregon estimates that during the early 2000s there were approximately 500 winter steelhead distributed across several small basins centered near Fifteenmile Creek. Washington populations are centered near the Klickitat. More accurate abundance estimates and productivity information are not available for winter steelhead populations in this DPS (WDFW and ODFW 2006). Little is known for certain about the small winter-run in the Klickitat (of perhaps <100 spawners), though winter steelhead appear to ascend into the river from November to April, peaking in March. Howell et al. (1985) hypothesized that winter-run fish spawned in the mainstem Klickitat from just above the confluence with the Columbia to the Little Klickitat confluence from March through June. Recent years of observations show that mainstem steelhead spawning is concentrated between the Little Klickitat (RM 20.44) and Leidl Bridge (RM 32). It is difficult to differentiate between the spawning distributions of the two stocks.

Steelhead spawn in clear, cool streams with suitable gravel size, depth and flow velocity. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small wood. Depending on water temperature, steelhead eggs may incubate for 1.5 to four months before hatching. Summer rearing takes place primarily in the faster parts of pools, although young-of-the-year are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types (Bambrick et al. 2004).

Young steelhead typically rear in streams for some time before migrating to the ocean as smolts, which usually peaks in April and May in the Klickitat (Howell et al. 1985). Steelhead smolts migrate at ages ranging from 1-5 years throughout the Columbia Basin: Klickitat steelhead age composition consists of 13 percent 1-year, 83 percent 2-year and 4 percent 3-year outmigrants (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009). Some older juveniles may move downstream to rear in larger tributaries and mainstem rivers. Steelhead grow rapidly after reaching the ocean, where they forage in coastal and offshore waters of the North Pacific. Most steelhead spend two years in the ocean (range 1-4) before migrating back to their natal stream (Shapovalov and Taft 1954; Narver 1969; Ward and Slaney 1988). Once in the river, steelhead rarely eat and grow little, if at all (Maher and Larkin 1954). These combined behaviors produce fish that range between 3 and 7 years of age at the time of spawning.

Some steelhead are *iteroparous* (do not die after spawning). A small proportion of repeat spawners (known as kelts) may return to the ocean for a short period and repeat the spawning migration, a life history adaptation that may be fundamental to ensuring population stability. Respawning rates may be affected by environmental conditions, location of the natal stream, sex, size at maturity, and differences in the energy investment of spawning among different stocks and species (Fleming 1998). Winter-run fish tend to have higher respawning rates, and enter fresh water in a sexually mature state, while summer fish tend to mature sexually in fresh water (Withler 1966). Reduced genetic contributions from populations formerly supplemented by repeat spawners may contribute to the decline of steelhead stocks in the Columbia River Basin (NMFS 2000).

Iteroparity rates for Klickitat River steelhead were reported at 3.2 percent from combined sampling periods 1979 to 1981 (Howell et al. 1985) and 2005 (Yakama Nation and WDFW unpublished adult trapping data 2005). Sampling of adults at Lyle Falls Fishway in 2004 and 2005 has indicated repeat spawning rates of 2.9 percent for summer steelhead and 8.8 percent for winters. Most repeat spawners are females. Acquiring better estimates of kelt presence in the subbasin remains a priority for the Yakama Nation.

Existing data on steelhead sex ratio, age structure and frequency of re-spawning in the Klickitat subbasin is based on a sport catch sample from 1979-1981, and preliminary results from the Lyle Falls adult trap sampling and scale analysis conducted from July 2004 to October 2005 (Yakama Nation and WDFW unpublished adult trapping data 2005). Trapping efficiency and steelhead passage frequency through the ladder at Lyle Falls are still not certain, but it is likely that the sample represents only a small percentage of the total run.

During adult trap sampling and scale analysis, researchers identified adult fish as winter or summer steelhead based on a combination of observed morphological traits, in-migration timing, copepods, and scale analysis. Scales from both hatchery and wild fish were sampled and a determination of age made; however, only those fish for which there was a high level of certainty as to their run affiliation (winter or summer) were included in the demographic analysis (C. Frederiksen, personal communication 2006). Wild are identified as non-clipped adult returns into the Lyle adult trap. Skamania Hatchery summer steelhead (100 percent marked) are released as smolts into the lower Klickitat River. There are no hatchery winter steelhead releases.

Combined results from the two sampling periods show that ocean ages at return of adult summer steelhead averaged 16.7 percent 1-ocean, 72.8 percent 2-ocean, 7.3 percent 3-ocean and 3.2 percent consisting of repeat spawners (Figure 2-5). Females constituted 57.5 percent of the sample; males 42.5 percent. Figure 2-6 illustrates the length frequency distribution at ocean age of Klickitat summer-run steelhead. Trap data also suggest that hatchery steelhead have an earlier peak in migration timing than wild fish (Yakama Nation and WDFW unpublished adult trapping data 2005).

Among those fish identified as winter steelhead during the adult trapping period of 2004-2005, 1-ocean fish were predominant 47.1 percent, 2-ocean fish made up 41.2 percent of the sample, and 8.8 percent were 3-ocean fish and 8.8 percent were repeat spawners (Figure 2-7). The proportion of female to male winter steelhead was 64.5 to 35.5 percent. Due to the sampling period representing one returning brood year, ocean age structures depicted here for winter-run steelhead may not be representative of average ocean age composition (Yakama Nation and WDFW unpublished adult trapping data 2005). Figure 2-8 illustrates the length frequency distribution at ocean age of Klickitat winter-run steelhead.

Genetic analysis currently being conducted may contribute to data distinguishing the two steelhead runs in the subbasin. Sampling will continue in the future. Results of ongoing analysis will help to better differentiate the run timing between summer and winter steelhead, and provide additional data on the age structure, sex ratio and length frequency of fishing passing through the adult trap.

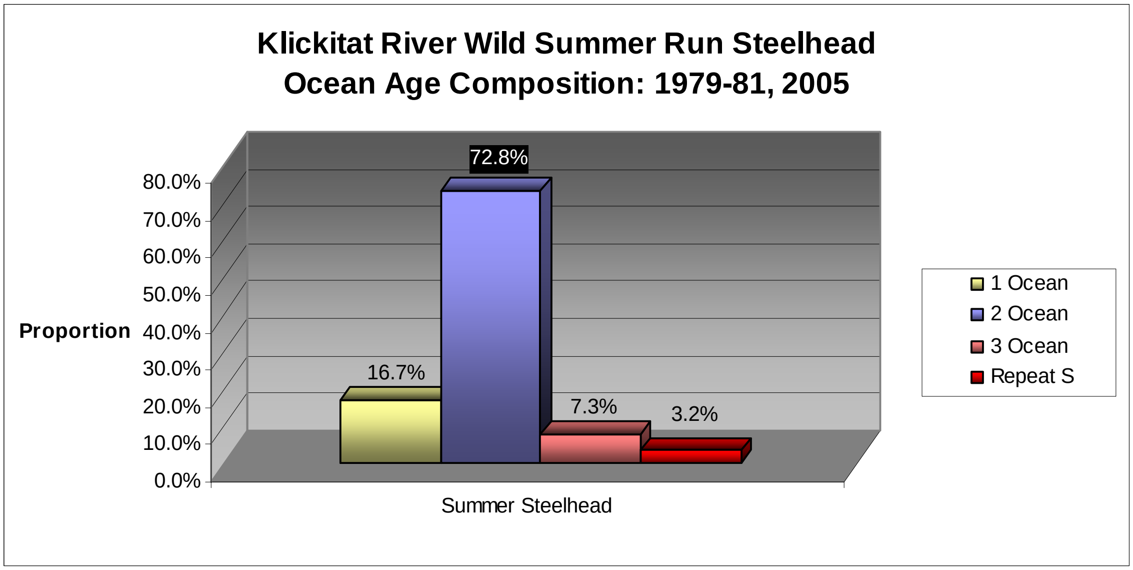


Figure 2-5. Average Ocean Age Composition of Wild Summer Steelhead in the Klickitat River, 2004-2005 (Yakama Nation and WDFW unpublished adult trapping data 2005).

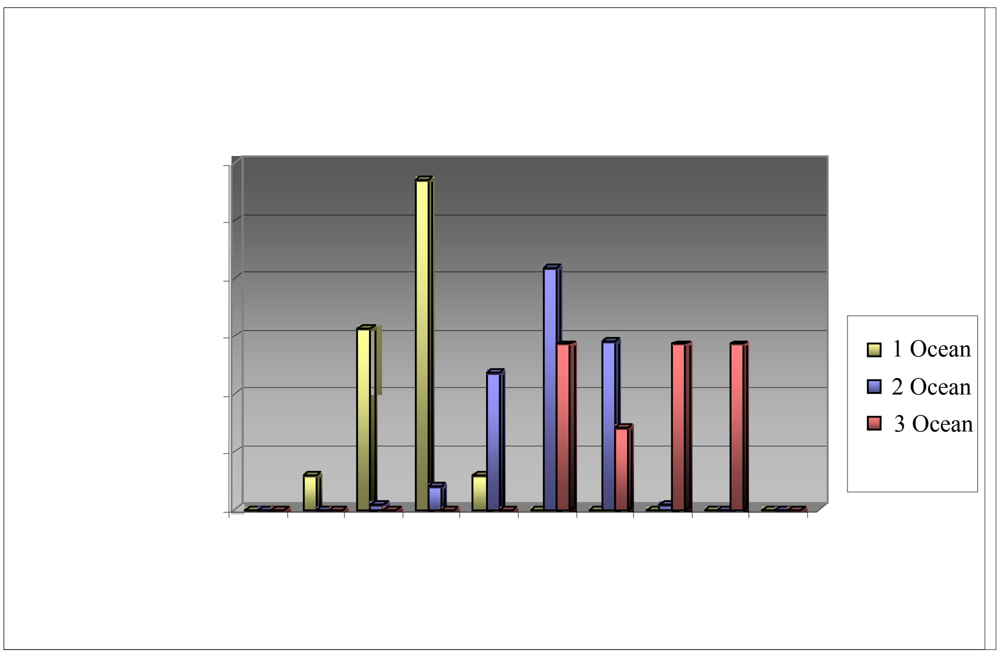


Figure 2-6. Frequency Distribution of Fork Length[2] at Ocean Age of Wild Summer Steelhead in the Klickitat River, 2004-2005 (Yakama Nation and WDFW unpublished adult trapping data 2005).

[2] Length of fish from tip of nose to fork of tail.

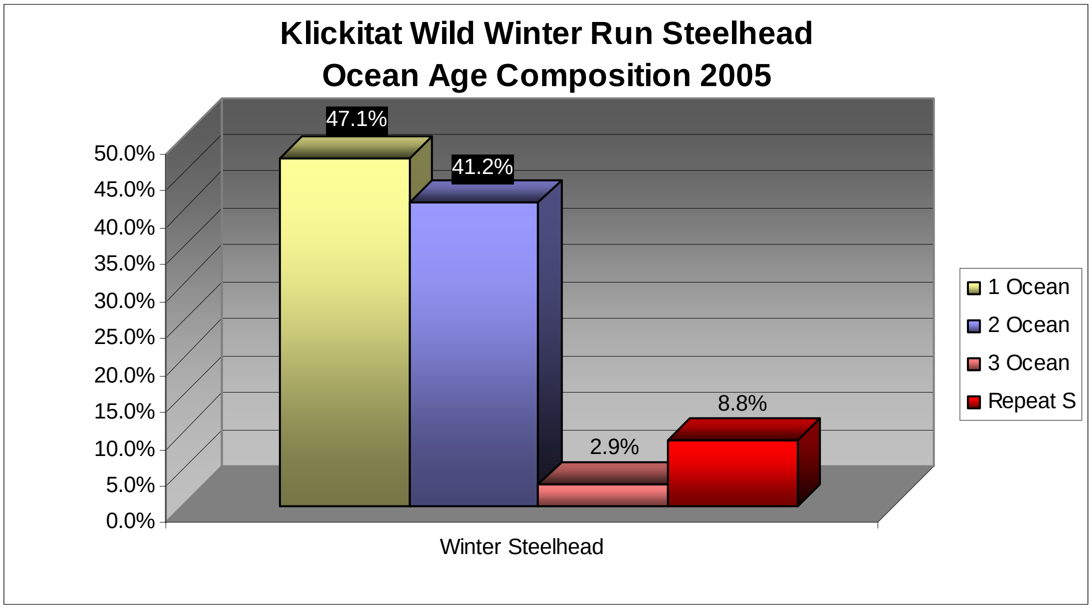
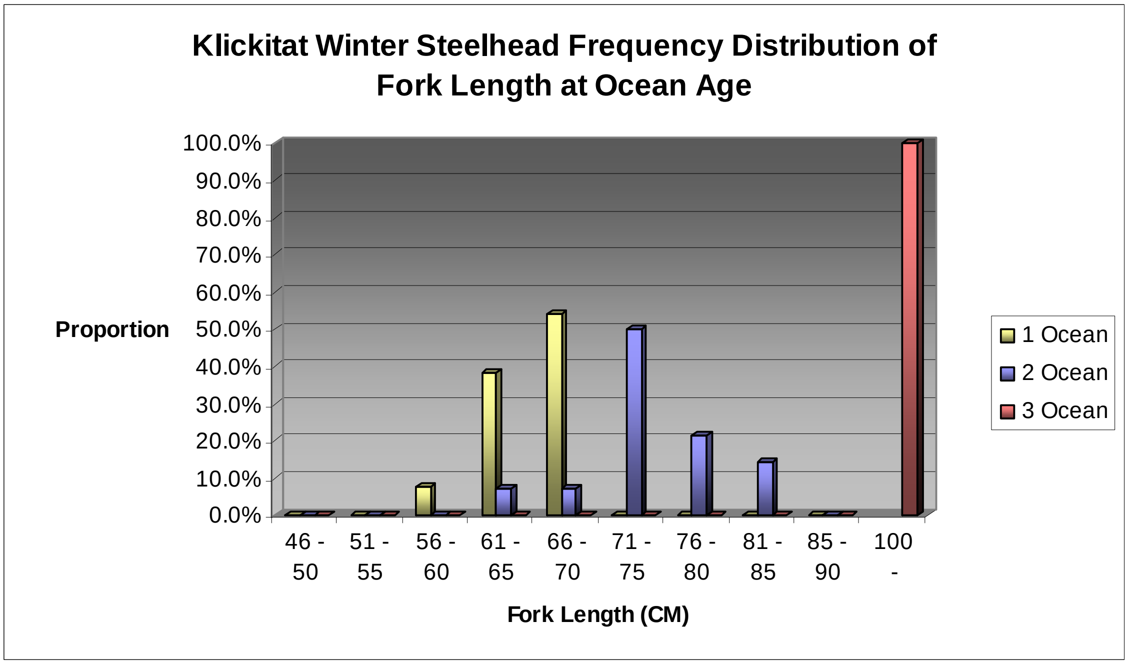


Figure 2-7. Average Ocean Age Composition of Klickitat Wild Winter-run Steelhead (Yakama Nation and WDFW unpublished adult trapping data 2005).

Figure 2-8. Frequency Distribution of Fork Length at Ocean Age of Wild Winter Steelhead in the Klickitat River, 2004-2005 (Yakama Nation and WDFW unpublished adult trapping data 2005).



***Only 1, 3-ocean wild winter steelhead was sampled, hence the abnormally high apparent proportion of fish assigned to large fork lengths.**

3. Recovery Goals and Viability Criteria

The primary goal of ESA recovery plans is for the species to reach the point that it no longer needs the protection of the Act – i.e. to be delisted. Recovery plans may also contain "broad-sense goals," defined in the recovery planning process, that go beyond the requirements for delisting to address, for example, other legislative mandates or social, economic, and ecological values.

Delisting criteria are applied at the DPS level, and are based on determinations of the viability of the independent populations that make up the DPS. Criteria for delisting the Middle Columbia steelhead DPS are described in the *Middle Columbia Steelhead ESA Recovery Plan*, to which this plan is an appendix. This chapter provides recovery goals for the Klickitat steelhead population, describes the criteria to be used to assess progress toward those goals, and describes the role of the Klickitat steelhead population in overall DPS viability.

There are two kinds of criteria that enter into a delisting decision: population, or demographic parameters (the biological recovery criteria) and "threats" criteria related to the five listing factors detailed in the ESA. The threats criteria define the conditions under which the listing factors, or threats, can be considered to be addressed or mitigated. Together these make up the "objective, measurable criteria" required under section 4(f)(1)(B) of the ESA. Both kinds of criteria are discussed in this chapter.

3.1 Recovery Goals

The primary goal of this plan is for the Klickitat steelhead population to be restored to viable status and thus to support recovery of the Mid-Columbia steelhead DPS. A viable salmonid population is defined as an independent population that has negligible risk of extinction over a 100-year timeframe (McElhany et al. 2000).

If a local, collaborative Washington Gorge Recovery Board is formed, it may choose to define additional, broad-sense goals for the Klickitat subbasin and other areas within the Washington Gorge Management Unit. The Board's broad-sense goals for the area would likely build on direction, and respond to the interests identified by various stakeholders in the area. These goals would then guide the Board as it defines and implements future recovery actions for the Klickitat subbasin.

In the meantime, the Yakama Nation has proposed, as a broad-sense goal for the Klickitat steelhead population, the achievement of "highly viable" status, which corresponds to a one percent risk of extinction in a 100-year period. Achieving highly viable status for the population would provide for long-term, sustainable harvest and other social, cultural, and ceremonial needs, although it would likely exceed the minimum necessary to support delisting the DPS.

3.2 Biological Viability Criteria

The ICTRT developed biologically based viability criteria for ESA-listed salmon and steelhead in the Interior Columbia domain. The ICTRT based its approach to recovery on guidance from the NMFS Technical Memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). This memorandum provides general direction for setting viability objectives at the ESU/DPS and component population levels.

Viability criteria at the population level address four VSP parameters (McElhany et al. 2000):

- *Abundance* – the average number of spawners in a population over a generation or more,
- *Productivity* – the performance of a population over time in terms of recruits produced per spawner,
- *Spatial Structure* – a population's geographic distribution and the processes that affect that distribution, and
- *Diversity* – the distribution of genetic, life history and phenotypic variation within and among populations.

The ICTRT grouped specific population level criteria into two categories to assess viability at the independent population level: measures addressing abundance and productivity, and measures addressing spatial structure and diversity. The viability of an independent population is determined by integrating risks across the four parameters.

3.2.1 DPS and MPG Viability Criteria

Since MPGs are geographically and genetically cohesive groups of populations, they are critical components of ESU/DPS spatial structure and diversity. Having all MPGs within an ESU/DPS at low risk provides the greatest probability of persistence for the ESU/DPS. Thus, the ICTRT criterion for a viable ESU/DPS is that all extant MPGs and any extirpated MPGs critical for proper functioning of the ESU/DPS should be at low risk.

Further, the following five criteria should be met for an MPG to be regarded as low risk (viable) (ICTRT 2007):

1. At least one-half of the populations historically within the MPG (with a minimum of two populations) should meet viability standards.

2. At least one population should be classified as "Highly Viable."

3. Viable populations within an MPG should include some populations classified (based on historical intrinsic potential) as "Very Large," "Large," or "Intermediate," generally reflecting the proportions historically present within the MPG. In particular, Very Large and Large populations should be at or above their composite historical fraction within each MPG.

4. All major life history strategies (e.g. spring and summer run timing) that were present historically within the MPG should be represented in populations meeting viability requirements.

5. Remaining MPG populations should be maintained with sufficient abundance, productivity, spatial structure, and diversity to provide for ecological functions and to preserve options for ESU/DPS recovery.

3.2.2 Application of Biological Viability Criteria to Klickitat Population

The ICTRT classified the Klickitat steelhead population as an "Intermediate" sized population based on historical habitat potential (ICTRT 2007).

Applying the ICTRT's viability criteria to the Cascades Eastern Slope Tributaries MPG results in the conclusion that the Klickitat steelhead population should reach viable status in order to support overall DPS viability, because of the population's historical abundance and the presence of both summer and winter runs.

Abundance
For an Intermediate population, viable status, i.e. a 5 percent or less risk of extinction over a 100-year timeframe, would require a mean minimum abundance threshold of 1,000 naturally produced spawners.

Productivity
Viable populations demonstrate sufficient productivity to support a net replacement rate of 1:1 or higher at abundance levels established as long-term targets. Productivity rates at relatively low numbers of spawners should, on average, be sufficiently greater than 1.0 to allow the population to rapidly return to abundance target levels.

Spatial Structure and Diversity
The ICTRT identified six major spawning areas (MaSAs) and four minor spawning areas (MiSAs) within the Klickitat population boundaries based on its historical intrinsic potential analysis. The analysis indicated that the upper mainstem Klickitat watershed was once a highly productive steelhead spawning area.

In general, the ICTRT defined two goals, or biological or ecological objectives, that spatial structure and diversity criteria should achieve:

- Maintaining natural rates and levels of spatially mediated processes. This goal serves (1) to minimize the likelihood that populations will be lost due to local catastrophe, (2) to maintain natural rates of recolonization within the population and between populations, and (3) to maintain other population functions that depend on the spatial arrangement of the population.

- Maintaining natural patterns of variation. This goal serves to ensure that populations can withstand environmental variation in the short and long terms. (ICTRT 2007, p. 47).

Data on Klickitat steelhead are limited. The primary factors contributing the moderate risk designation in the ICTRT (2009) viability assessment were related to lack of information on: a) the population's abundance and productivity, and, b) the effects of hatchery operations on the population. One of the primary goals of the Klickitat recovery plan is to attain the information needed to address these uncertainties.

3.3 Threats Criteria

Listing factors are those features that were evaluated under section 4(a)(1) when the initial determination was made to list the species for protection under the ESA. These may or may not still be limiting recovery when in the future NMFS reevaluates the status of the species to determine whether the protections of the ESA are no longer warranted and the species could be delisted.

At the time of a delisting decision, NMFS will examine whether the section 4(a)(1) listing factors have been addressed. To assist in this examination, NMFS will use the listing factors (or threats) criteria described below in addition to evaluation of biological recovery criteria and other relevant data and policy considerations.

To determine that the affected DPS is recovered to the point that it no longer requires the protections of the ESA, NMFS will review the status of the listing factors according to the specific criteria identified for each of them. The threats need to have been addressed to the point that delisting is not likely to result in their re-emergence. It is possible that current perceived threats will become insignificant in the future because of changes in the natural environment or changes in the way threats affect the entire life cycle of salmon. Consequently, NMFS expects that the ranking of threats will change over time and that new threats may be identified. During the status reviews, NMFS will evaluate and review the listing factor criteria under conditions at the time.

The specific criteria listed below for each of the relevant listing/delisting factors helps to ensure that underlying causes of decline have been addressed and mitigated prior to considering a species for delisting. NMFS anticipates that if the proposed actions described in the Plan are implemented, they will make substantial progress toward meeting the following listing factor (threats) criteria:

Factor A: The present or threatened destruction, modification, or curtailment of its habitat or range

To determine that the DPS is recovered, threats to habitat should be addressed to a degree sufficient to support a viable Middle Columbia River steelhead DPS as outlined below:

1. Impaired fish passage (e.g., dams and culverts) is addressed, either through removal or modification of obstructions, to improve survival and restore access to historically accessible habitat where necessary to support recovery goals.
2. Flow conditions that support sufficient steelhead rearing, spawning, and migration of a viable DPS are achieved, where possible, through management of mainstem and

tributary irrigation and hydropower operations, and through the improvement of other water user efficiencies and conservation, including for municipal supply and other consumptive purposes.

3. Forest management practices that protect watershed and stream functions are implemented on Federal, state, tribal, and private lands.
4. Agricultural practices, including grazing, are implemented to protect and restore riparian areas, floodplains, and stream channels, and to protect water quality from sediment, pesticide, herbicide, and fertilizer runoff.
5. Urban and rural development, including land use conversion from agriculture and forestland to residential uses, avoids impairment of water quality or impair natural stream conditions.
6. The effects of toxic contaminants on salmonid fitness and survival in the mainstem and tributaries are sufficiently limited so as not to affect recovery.
7. Channel function, including vegetated riparian areas, canopy cover, stream-bank stability, off-channel and side-channel habitats, natural substrate and sediment processes, and channel complexity is restored to provide adequate rearing and spawning habitat.
8. Floodplain function and the availability of floodplain habitats for salmon are restored to a degree sufficient to support a viable DPS. This restoration should include connectivity between river and floodplain and the restoration of altered sediment routing.
9. Water operations management in the mainstem and tributaries maximize survival of juvenile rearing, emigrating smolts, and immigrating and spawning adults.

Factor B: Over-utilization for commercial, recreational, scientific or educational purposes

To determine that the DPS is recovered, any utilization for commercial, recreational, scientific, or educational purposes should be managed as outlined below:

1. Fishery management plans for steelhead are in place that (a) accurately account for total fishery mortality (i.e., both landed catch and non-landed mortalities) and constrain mortality rates to levels that are consistent with achieving population viability (i.e., provide for adequate spawning escapement given their productivity); and (b) are implemented in such a way as to avoid deleterious genetic effects on populations or negatively affect the distribution of populations.
2. Federal, state and tribal fishing rules and regulations are effectively enforced.
3. Technical tools accurately assess the effects of the harvest regimes so that harvest objectives are met but not exceeded.
4. Scientific handling of fish from adult and juvenile trapping operations is minimized to reduce indirect mortalities associated with education or scientific programs, while

recognizing that monitoring, research, and education are key actions for conservation of the species.

5. To the degree sufficient to support a viable DPS, routine instream construction and maintenance practices are implemented in a manner to reduce or eliminate mortality of listed species.

Factor C: Disease or predation

To determine that the DPS is recovered, any disease or predation that threatens its continued existence should be addressed as outlined below:

1. Hatchery operations do not subject steelhead populations to deleterious diseases and parasites and do not result in increased predation rates of wild steelhead.
2. Predation by avian predators is managed in a way that promotes recovery of salmon and steelhead populations.
3. The northern pikeminnow are managed to reduce predation on steelhead to a degree sufficient to meet recovery goals.
4. Populations of introduced smallmouth bass, walleye, and catfish are managed such that competition or predation does not impede steelhead recovery.
5. Predation by marine mammals on steelhead runs below Bonneville Dam is managed within the framework of applicable statutes and to the degree necessary to protect upstream migration of steelhead.

Physiological stress and physical injury that may cause disease or increase susceptibility to pathogens during rearing or migration should be reduced during critical low flow periods (e.g. low water years) or poor passage conditions (e.g. at diversion dams or bypasses).

Factor D: The inadequacy of existing regulatory mechanisms

To determine that the DPS is recovered, any inadequacy of existing regulatory mechanisms that threatens its continued existence should be addressed to the degree necessary to support a viable DPS, as outlined below:

1. Sufficient resources, priorities, regulatory frameworks, and coordination mechanisms are established and/or maintained for effective enforcement of land and water use regulations that protect and restore habitats and for the effective management of fisheries.
2. Habitat conditions and watershed functions are protected through land-use planning that guides human population growth and development.
3. Habitat conditions and watershed function are protected through regulations that govern resource extraction such as timber harvest and gravel mining.

4. Habitat conditions and watershed functions are protected through land protection agreements as appropriate, where existing policy or regulations do not provide adequate protection.
5. Regulatory, control, and education measures to prevent additional exotic plant and animal species invasions are in place.

Factor E: Other natural or human-made factors affecting its continued existence

To determine that the DPS is recovered, other natural and human-made threats to its continued existence should be addressed as outlined below:

1. Steelhead hatchery programs are being operated in a manner that is consistent with individual watershed and region-wide recovery approaches; appropriate criteria should be used for the integration of hatchery steelhead populations and extant natural populations inhabiting watersheds where the hatchery fish return.
2. Hatcheries operate using appropriate ecological, genetic, and demographic risk containment measures for (1) hatchery-origin adults returning to natural spawning areas, (2) release of hatchery juveniles, (3) handling of natural-origin adults at hatchery facilities, (4) withdrawal of water for hatchery use, (5) discharge of hatchery effluent, and (6) maintenance of fish health during their propagation in the hatchery.
3. Mechanisms are in place to effectively continue monitoring the proportion of hatchery and wild spawners in the subbasin.
4. Mechanisms are in place to reduce the incidence of, and impacts from, introduced, invasive, or exotic plant and animal species.
5. Nutrient enrichment programs should be evaluated to determine where additional nutrient inputs can provide significant benefits.

4. Current Status Assessment

There are currently neither solid historical data nor accurate metrics for assessing current status of the Klickitat steelhead population. The first priority for recovery planning for this population is to reduce the uncertainties with a targeted monitoring program (see Chapter 6, Recovery Strategy and Actions, and Chapter 8, Monitoring, Research, and Adaptive Management).

The ICTRT reviewed existing data, previous assessment findings and GIS analysis for its 2005 viability assessment of the Klickitat population. This work has been updated by the ICTRT (2009). The Yakama Nation staff biologists provided substantial additional data, summarized in this chapter, which is, however, of a relatively short generational span and limited by significant uncertainties.

The ICTRT viability assessment is presented first, followed by currently available status information from the Yakama Nation. Discussion is also provided of ICTRT, Yakama Nation, and Klickitat County findings regarding identification of major and minor spawning areas.

4.1 ICTRT Status Assessment

4.1.1 Major and Minor Spawning Areas

The ICTRT identified major and minor spawning areas in the Klickitat system using model results that estimated the historical amount of potentially accessible spawning and rearing habitat available to the specific population based on stream width, gradient, and valley width from GIS-based analysis of tributary habitat associated with each population (ICTRT 2007). This historical intrinsic potential analysis conducted by the ICTRT identified six major spawning areas (MaSAs) and four minor spawning areas (MiSAs) within the Klickitat population boundaries (Figure 4-1). The ICTRT defines a major spawning area as a system of one or more branches that contains sufficient historical intrinsic habitat potential to support at least 500 spawners. This structure is typical of intermediate or large drainages. The ICTRT defines minor spawning areas as contiguous production areas capable of supporting between 50 and 500 spawners. The ICTRT does not consider any population fewer than 500 spawners to be viable, regardless of its intrinsic productivity (ICTRT 2007).

Major spawning areas identified by the ICTRT in the Klickitat drainage are the Upper Mainstem Klickitat, White River, Upper Little Klickitat, Lower Mainstem Klickitat, Middle Mainstem Klickitat and West Fork Klickitat MaSAs. Minor spawning areas are the Swale Creek, Lower Little Klickitat, Trout Creek and Surveyors Creek MiSAs. Middle Columbia steelhead occupy all major spawning areas in the Klickitat drainage with the exception of the West Fork Klickitat MaSA.

There is a high degree of correlation between the assessment areas used in the Klickitat River subbasin plan (NPCC 2004) and the areas identified using the ICTRT intrinsic potential analysis. In addition, the ICTRT analysis was modified based on input from regional biologists to identify reaches in the Little Klickitat drainage and MaSAs that are inaccessible under some annual flow conditions.

Yakama Nation Fisheries staff noted that several tributaries identified by the ICTRT as having high intrinsic habitat potential differ in various aspects from Yakama Nation resource specialists' understanding of the areas (see Figure 4-2). For example, there are discrepancies between a few headwater tributaries such as Sheep and Blue creeks. Sections of Swale, Big Muddy, and Hellroaring creeks, upper Knight and Wide Sky canyons and other creeks are included by the ICTRT as having segments of high intrinsic historical potential for steelhead spawning habitat, although Yakama Nation staff consider it highly improbable that the segments were even historically conducive to spawning, because of geomorphological and biotic factors. Yakama Nation staff also contend that historical spawning distribution of steelhead in Trout Creek and the Little Klickitat River was unlikely to have extended as far upstream as the ICTRT's GIS model indicates. The Yakama Nation Fisheries staff delineated 11 spawning areas in the Klickitat watershed, based on EDT analysis, that they believe better reflect spawning habitat areas for the steelhead population. Appendix III discusses these areas and compares them to the areas identified by the ICTRT.

Klickitat County staff agree that the distribution of steelhead in the Little Klickitat is unlikely to extend as far upstream as the ICTRT's GIS model indicates. They believe that fish distribution in the Little Klickitat stops at the falls at RM 6.1, except in rare years when some minor passage may occur under certain unusual flow conditions. They note that the ICTRT's estimate of fish distribution in Swale Creek is also over-represented, and that during summer and fall steelhead are found only in the lower three miles where there is water (WPN and Aspect 2005a).

Despite these differences between GIS data and hardcopy maps, the basic patterns of predicted and observed occupancy of the subbasin are similar. Because the intrinsic potential model incorporates broad scale landscape and hydrological variables, subbasin specific characteristics often cause local differences between observations, professional knowledge, and modeled predictions of pre-development habitat conditions. However, using the ICTRT's habitat branching and MaSA/MiSA accumulation methods, these disparities are generally insignificant at the MaSA/MiSA scale. Many of the tributaries mentioned above contain well below one percent of the total intrinsic habitat modeled within the Klickitat population.

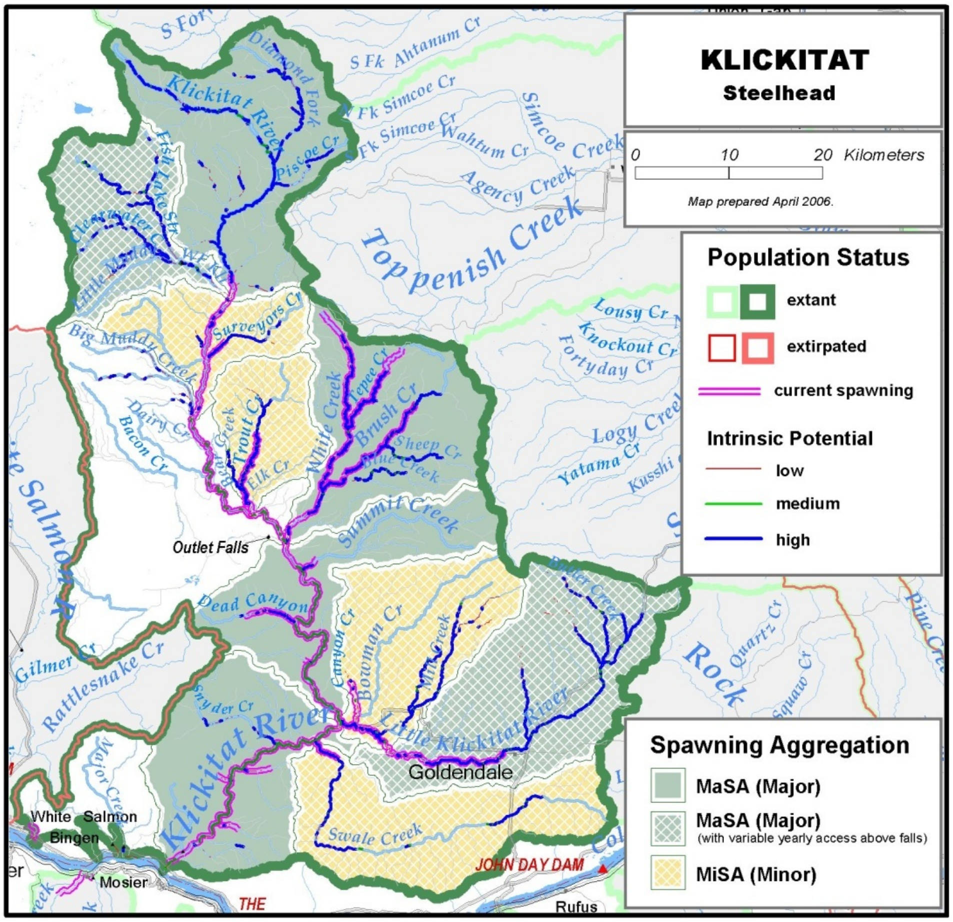


Figure 4-1. Klickitat River Steelhead population boundary and historical major and minor spawning areas (ICTRT 2007).

4.1.2 Abundance and Productivity

The ICTRT (2009) found that annual estimates of the total number of steelhead spawning in the Klickitat River drainage prior to the 2005-2006 return year have not been generated. Redd surveys of steelhead spawning in the Klickitat River drainage have been conducted in recent years, but there is insufficient coverage to allow for directly estimating annual abundance from those samples.

Separate estimates of the escapement of hatchery-origin and natural-origin steelhead past Lyle Falls have been generated for the 2005-2006 return year using mark-recapture methods (Gray 2007). An estimated 1,577 natural-origin and 1,833 hatchery-origin adult steelhead were estimated to have passed above Lyle Falls and the associated tribal fishery in that return year. Returns to the Klickitat River include hatchery-origin adults from annual out-plants of Skamania Hatchery summer steelhead from North Fork Washougal River broodstock (approximately 100,000 smolts per year) into the middle sections of the mainstem Klickitat River. A hatchery-directed sport fishery has harvested an estimated 1,400 to 3,700 fish per year between 2000 and 2004 (http://wdfw.wa.gov/fish/papers/steelhead/m_col_esu.pdf). The estimated returns above Lyle Falls would be reduced by hatchery sport harvest (direct catch of hatchery, incidental mortalities of natural-origin fish), potential fall back and any pre-spawning mortalities.

Assuming that annual estimates of the number of steelhead passing Lyle Falls continue to be generated, after a sufficient number of estimates are accumulated, it may be possible to use a derived relationship between index area redd counts and total abundance to extend annual estimates back using the recent historical redd counts.

Determining the relative distribution of hatchery and natural-origin spawners on the spawning grounds would reduce uncertainty with generating productivity estimates from the return series. Estimated abundance and harvest data provided by the Yakama Nation are included as Appendix IV.

The ICTRT was able to assign a size category to the Klickitat steelhead population based on historical intrinsic potential analysis. Size categories reflect drainage complexity and the distribution of current and historical spawning habitat. Upstream limits on the potential use of tributary habitat for spawning and rearing were defined in terms of physical barriers, stream gradient, width, and water temperature, on the basis of multiple sources, including GIS data, published accounts, field personnel, and local expert review. The ICTRT considers the Klickitat River population to be an "intermediate" sized population. To be considered viable, i.e. having a 5 percent or less risk of extinction over a 100-year timeframe, an intermediate-sized population should have a mean minimum abundance of 1,000 naturally produced spawners.

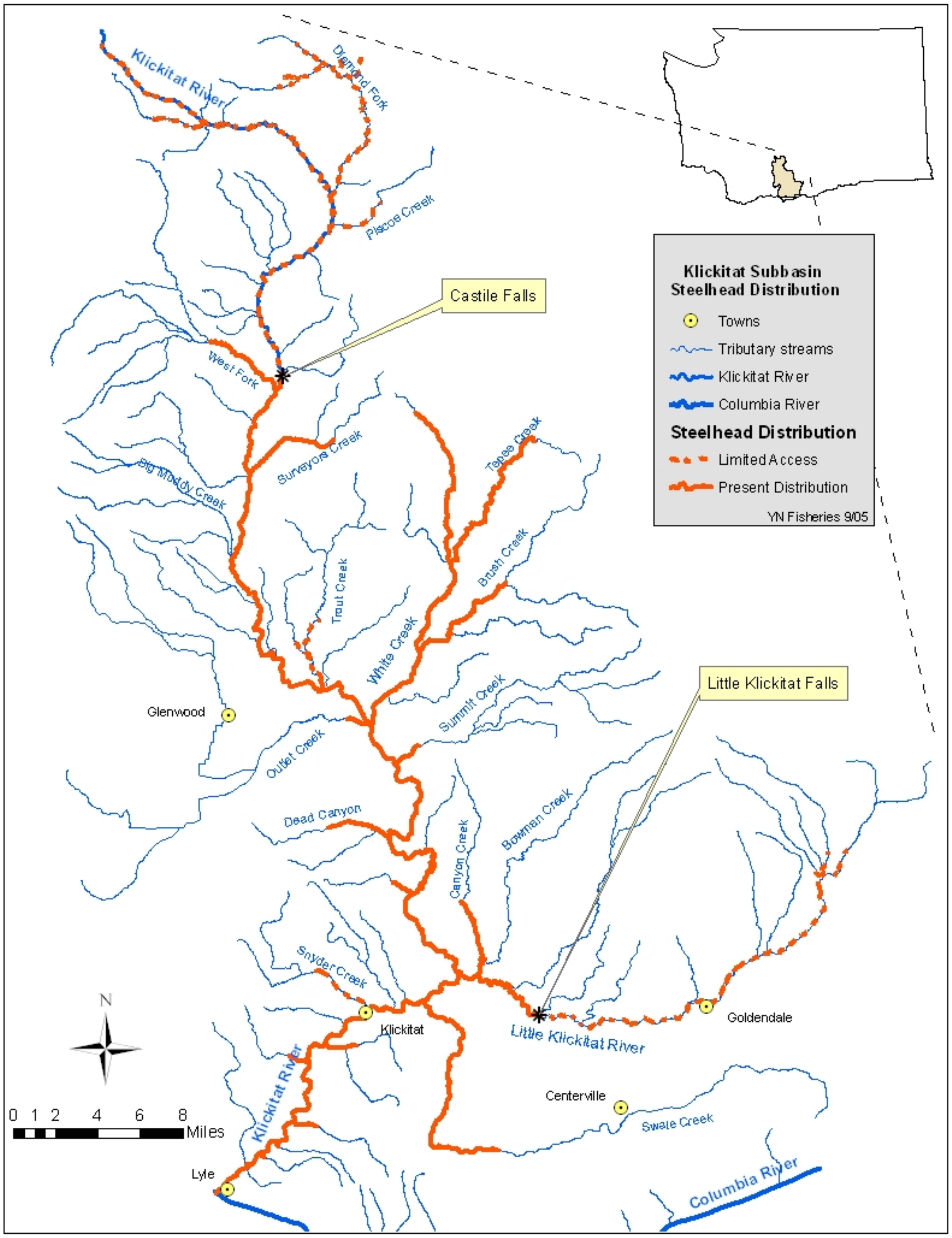
Because of insufficient data and the uncertainties regarding naturally occurring production, the ICTRT provisionally assigned the Klickitat River population **Moderate risk** for abundance and productivity (ICTRT 2007).

4.1.3 Spatial Structure and Diversity

Current steelhead spawning in the Klickitat mainstem is concentrated between RM 5 and RM 50, with occasional spawning above Castile Falls (RM 64). Figure 4-2 shows current steelhead distribution in the Klickitat subbasin, with areas of "limited access," as inferred based on restrictions in passage conditions, represented by dashed lines. Tributary spawning currently occurs in the White Creek watershed (including Tepee and Brush creeks), Dead Canyon, Swale Canyon, Wheeler, Summit, and lower Bowman creeks, the lower (and occasionally upper) Little Klickitat River, and other smaller tributaries.

Winter steelhead are believed to spawn between the confluence of the Klickitat with the Columbia River and the confluence of the Little Klickitat with the mainstem (Howell et al. 1985). Further research on spawning distribution of winter steelhead in the Klickitat subbasin is needed. Steelhead distribution, however, is expected to extend into the upper watershed in the near future because passage for anadromous fish at Castile Falls has recently been restored and the upper subbasin is now re-connected.

Figure 4-2. Summer and Winter Steelhead Distribution in the Klickitat Subbasin (NPCC 2004).



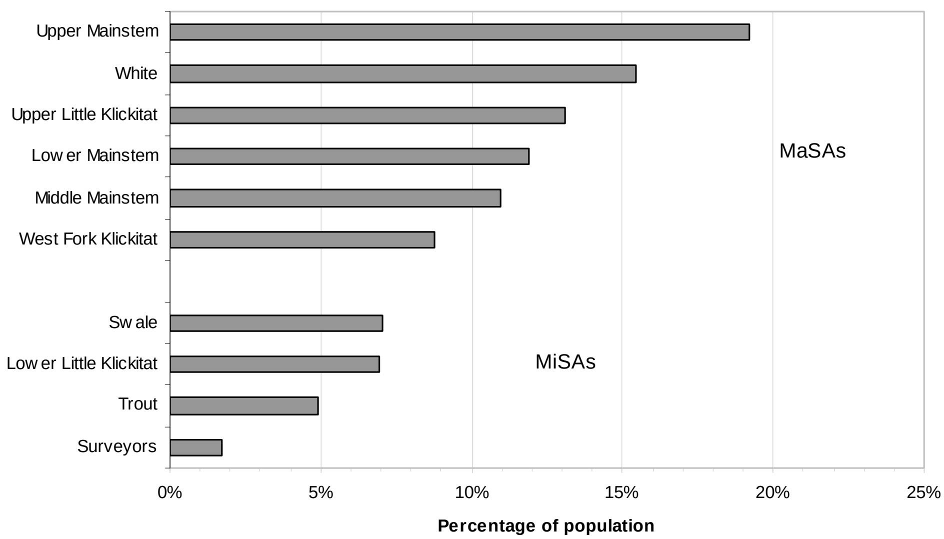
Based on its historical intrinsic potential analysis, the ICTRT identified six major spawning areas (MaSAs) (systems of one or more branches capable of supporting 500 spawners), and four minor spawning areas (MiSAs) (able to support between 50 and 500 spawners) within the Klickitat population boundaries (ICTRT 2007) (Table 4-1 and Figure 4-3). The analysis assumed that the upper mainstem Klickitat watershed was once a highly productive steelhead spawning area.

Table 4-1. Klickitat Summer/Winter Steelhead population basin statistics and intrinsic potential analysis summary (ICTRT 2009).

Drainage Area (km^2)	**3,632**
Stream lengths km[a] (total)	**2,590**
Stream lengths km[a] (below natural barriers)	**1,701**
Branched stream area weighted by intrinsic potential (km2)	**2.978**
Branched stream area km2 (weighted and temp. limited)[b]	**2.978**
Total stream area weighted by intrinsic potential (km2)	**3.990**
Total stream area weighted by intrinsic potential (km2) temp limited[b]	**3.990**
Size and Complexity category	**Intermediate / B (dendritic)**
Number of MaSAs	**6**
Number of MiSAs	**4**

[a]All stream segments greater than or equal to 3.8m bankfull width were included
[b]Temperature limited areas were assessed by subtracting area with mean weekly modeled water temperature greater than 22°C

Figure 4-3. Percentage of Historical Spawning Habitat by Major/Minor Spawning Area. (ICTRT 2009).



Genetic samples from different areas within the Klickitat River system cluster together but appear to be relatively homogeneous. Compared to other populations, the Klickitat subpopulation samples cluster together. The closest association is with the Skamania Hatchery stock; the level of differentiation suggests a common origin. The ICTRT rated the Klickitat steelhead population as at **Moderate risk** for this metric (ICTRT 2009).

The ICTRT rated the Klickitat River steelhead population at **Moderate risk** for spatial structure and diversity based on an assessment of the cumulative scores across the individual spatial structure/diversity factors and metrics (Table 4-2). It determined that reducing the spatial structure/diversity risk to a low rating would require reducing the impacts of the outside stock hatchery program on natural spawning areas, or determining that the natural population is actually experiencing very little impact from the Skamania stock origin returns.

Table 4-2 summarizes ICTRT viability assessment results for Klickitat steelhead population spatial structure and diversity factors and metrics. Table 4-3 shows the ICTRT's spatial structure and diversity scoring table for the population.

Table 4-2. ICTRT viability assessment results for Klickitat steelhead population spatial structure and diversity factors and metrics (ICTRT 2009).

Factors and Metrics	Risk Rating	ICTRT Comments
A.1.a. Number and spatial arrangement of spawning areas.	Low	All six of MaSAs inferred as occupied based on the WDFW and YN data. More data needed to confirm current distribution information.
A.l.b. Spatial extent or range of population.	Low	Intrinsic potential approach assumes that steelhead had access to the upper Klickitat (mainstem and tributaries above Castile Falls) and the upper sections of the Little Klickitat River. Historical access to the upper Klickitat may have been limited by Castile Falls. WDFW and YN data indicate that all MaSAs and MiSAs are currently occupied. Distributions should be confirmed through systematic ground surveys.
A.1.c. Increase or decrease in gaps or continuities between spawning areas	Low	The WDFW current distributions and the YN redd survey data sets indicate that the lower most MaSAs are at least partially occupied and there is a presence of steelhead spawners in the MiSAs below the Little Klickitat River. There are no intervening gaps among the occupied MaSAs in the Klickitat.
B.1.a. Major life history strategies	Low	There is no evidence of loss of a major juvenile life history pattern.
B.l.b. Phenotypic variation.	Moderate	It is possible that continual inputs of outside hatchery-origin spawners (Skamania stock) have altered spawning timing and other phenotypic characteristics of the native run. Rating is precautionary given absence of more specific information on the relative contributions of hatchery spawners to natural spawners.
B.1.c. Genetic variation.	Moderate	Genetic samples from different areas within the Klickitat River system cluster together but appear to be relatively homogeneous. Compared to other populations, the Klickitat subpopulation samples cluster together. The closest association is with the Skamania Hatchery stock; the level of differentiation suggests a common origin.
B.2.a. Spawner composition.	High	No systematic sampling studies have been done to determine the relative contribution of returns from the hatchery releases in the Klickitat to natural spawning areas. The only reported information on relative hatchery wild composition for the Klickitat are results of sport catch sampling efforts in the late 1980s, indicating that up to 2/3 of the catch were hatchery-origin. It is possible that those estimates reflect the contribution rates in the lower Klickitat and are not directly representative of hatchery contribution rates to spawning in the majority of natural production areas. Based on release levels and sport catch estimates, it is very likely that the hatchery contribution rate to natural spawning has exceeded 5 percent for more than 4 generations. Rating reflects the absence of direct information confirming differential spawning distribution of hatchery and natural fish and/or information on relative contribution rates to natural spawning areas.
B.3.a. Distribution of population across habitat types	Low	Current spawning distribution (WDFW GIS layer and YN fisheries redd survey results) indicates occupied MaSAs cover three of the four historical regions. Current and historical ecoregion ratios need to be checked (specifically the relative contribution of the Grand Fir Mixed Forest).
B.4.a. Selective change in natural processes or selective impacts.	Low	Low risk estimates given across the four sectors: hydropower system, harvest, hatcheries, habitat.

Table 4-3. Spatial Structure and Diversity Scoring Table: Klickitat Steelhead Population (ICTRT 2009).

<table>
<tr><th rowspan="2">Metric</th><th colspan="5">Risk Assessment Scores</th></tr>
<tr><th>Metric</th><th>Factor</th><th>Mechanism</th><th>Goal</th><th>Population</th></tr>
<tr><td>A.1.a</td><td>L (1)</td><td>L (1)</td><td rowspan="3">Mean = 1.25 Low Risk</td><td rowspan="3">Low Risk</td><td rowspan="12">Moderate Risk</td></tr>
<tr><td>A.1.b</td><td>L (1)</td><td>L (1)</td></tr>
<tr><td>A.1.c</td><td>L (1)</td><td>L (1)</td></tr>
<tr><td>B.1.a</td><td>L (1)</td><td>L (1)</td><td rowspan="3">Moderate Risk</td><td rowspan="9">Moderate Risk</td></tr>
<tr><td>B.1.b</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>B.1.c</td><td>M (0)</td><td>M (0)</td></tr>
<tr><td>B.2.a(1)</td><td>H (-1)</td><td rowspan="4">High Risk (-1)</td><td rowspan="4">High Risk (-1)</td></tr>
<tr><td>B.2.a(2)</td><td>NA</td></tr>
<tr><td>B.2.a(3)</td><td>NA</td></tr>
<tr><td>B.2.a(4)</td><td>NA</td></tr>
<tr><td>B.3.a</td><td>L (1)</td><td>L (1)</td><td>L (1)</td></tr>
<tr><td>B.4.a</td><td>L (1)</td><td>L (1)</td><td>L (1)</td></tr>
</table>

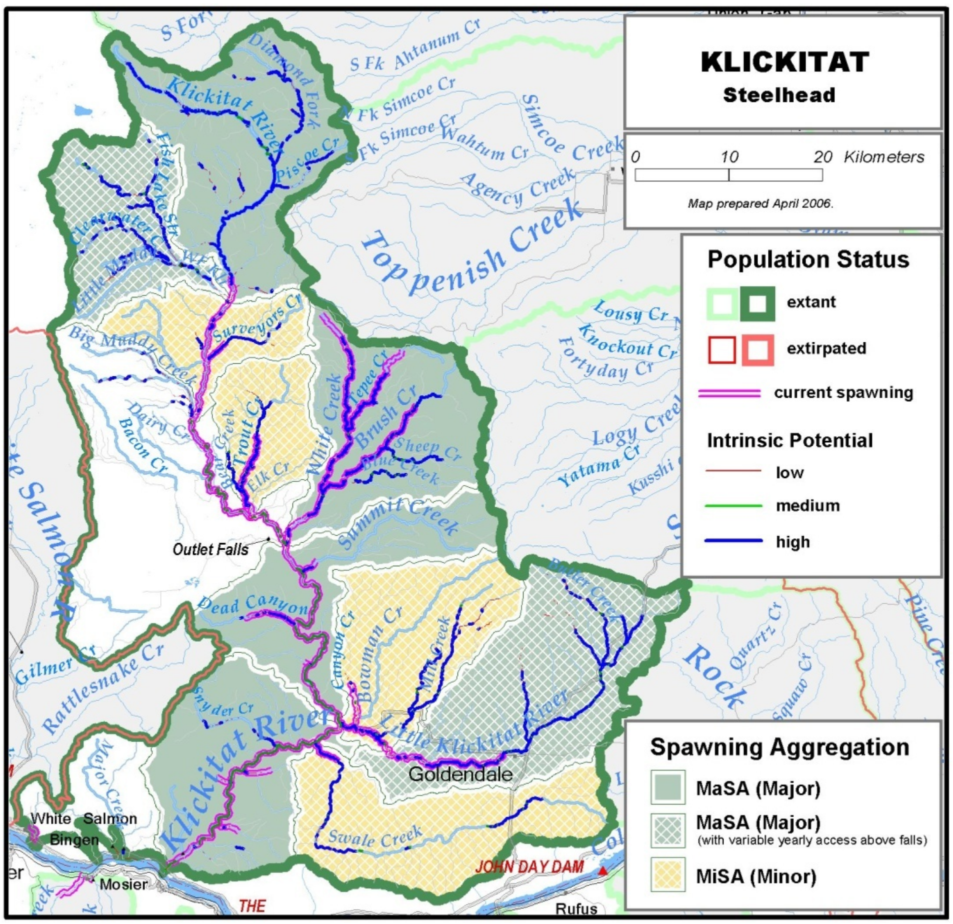
4.1.4 Overall Risk Rating

The ICTRT rated the Klickitat River steelhead population at **Moderate risk** of extinction in one hundred years for both abundance/productivity and spatial structure/diversity. Thus, the population does not meet the criteria for a viable population as defined by the ICTRT (ICTRT 2007). Figure 4-4 is a matrix that illustrates the combinations of risk levels for all four VSP parameters that define low, moderate, and high risk ratings for a population or DPS. "Viable" status is defined as having no more than a 5 percent likelihood of extinction within 100 years. Moderate risk corresponds to "maintained" status, which designates a population that can contribute to overall DPS viability by providing ecological functions and preserving options for recovery. Maintained populations can serve as buffers against catastrophic losses to other, more viable populations and/or uncertainty in the ICTRT population and MPG criteria. Ensuring that the less than viable populations meet maintained standards reduces the risk for the MPG. However, as previously noted, the Klickitat population has characteristics that are sufficiently important to the DPS to make it an appropriate candidate for viable status.

The ICTRT noted that developing a method for generating annual estimates of natural contributions to spawning in the Klickitat would allow for a more accurate assessment of both abundance and productivity. With respect to spatial structure and diversity, the population would benefit from actions that promote or confirm a high level of separation between hatchery-origin spawners and natural production. More detailed evaluations of genetic patterns within the population, and of the range of life history variations present in the population, could also contribute to improving the status level assigned through application of the ICTRT criteria.

		Spatial Structure/Diversity Risk			
		Very Low	**Low**	**Moderate**	**High**
Abundance/ Productivity Risk	**Very Low** (<1%)	**HV**	**HV**	**V**	**M**
	Low (1-5%)	**V**	**V**	**V**	**M**
	Moderate (6 – 25%)	**M**	**M**	**M Klickitat River***	**HR**
	High (>25%)	**HR**	**HR**	**HR**	**HR**

Figure 4-4. Viable Salmonid Population Parameter Risk Ratings for the Klickitat River Steelhead Salmon Population (ICTRT 2009). ***Viability Key: HV – Highly Viable; V – Viable; M – Maintained; HR – High Risk; * = Candidate for Maintained; Shaded cells – does not meet viability criteria (darkest cells are at greatest risk).***



5. Limiting Factors and Threats

The reasons for a species' decline are generally described in terms of limiting factors and threats. Analysis of limiting factors and threats across the entire species' life cycle forms the basis for designing recovery strategies and actions. NMFS defines limiting factors as the biological and physical conditions limiting DPS and population status (e.g. elevated water temperature), and defines threats as those human activities or naturally induced actions that cause the limiting factors (e.g. removal of riparian vegetation for agricultural or residential purposes, which causes loss of shade and, consequently, elevated water temperature).

While the term "threats" carries a negative connotation, it does not mean that activities identified as threats are inherently undesirable. They are often legitimate human activities that may at times have unintended negative consequences on fish populations—and that can usually be managed in a manner that minimizes or eliminates the negative impacts.

For steelhead and other salmonids, survival to reproduce depends on a complex, interacting system of environmental conditions, with different conditions needed for each life stage. Optimal water temperature, for example, varies (within limits) for adult migration vs. egg incubation or juvenile rearing. In addition, the particular factors limiting production may vary across different sections of the tributary drainage used by a particular population. Data on a full range of potential limiting factors is rarely available at the reach level. As a result, the identification of limiting factors for salmonids often includes elements based on inference and expert opinion.

The list of potential limiting factors for the Klickitat steelhead population, as for the other populations that make up the DPS, is based on a substantial body of research on salmonids, local field data and field observations, and the considered opinions of regional experts. These are implicitly hypothetical statements, made with the expectation that by taking action in the face of some degree of scientific uncertainty, monitoring the results, continuing to conduct research as a high priority, and adapting our management actions in response, the state of our knowledge will improve and so will the survival of these fish, although not necessarily in a directly parallel process. In that spirit, this chapter describes the factors, based on the best available science, considered to be limiting Middle Columbia River steelhead production in the Klickitat subbasin.

5.1 Hatchery Effects

Uncertainty regarding the effects of hatchery releases on the naturally spawning population is one of the two primary reasons the ICTRT rated the Klickitat steelhead population as at moderate risk (the other factor is the lack of information regarding abundance) (ICTRT 2009). Hatchery releases and interactions between hatchery and wild fish are likely to have a significant impact on the viability and productivity of the naturally spawning population.

Hatchery-bred smolts from the Skamania and Vancouver hatcheries have been released into the Klickitat River for nearly 40 years. Releases were also made from the Beaver Creek and Naches hatcheries. Releases have averaged approximately 102,000 smolts annually since 1982, ranging from 16,000 smolts in 1995 to 118,500 smolts in 2000. The current hatchery steelhead production goal for the Klickitat subbasin is an annual release of 120,000 summer-run steelhead from Skamania and Vancouver hatcheries directly into the Klickitat River. Both hatcheries use Skamania Hatchery broodstock, which is maintained using steelhead returning to the Skamania Hatchery on the Washougal River. The broodstock for the program was originally established with wild fish taken from both the Washougal and Klickitat River systems. To limit adverse interactions with naturally produced juvenile steelhead, hatchery summer steelhead are released at times and sizes that result in rapid emigration from the subbasin. The releases occur in the mainstem Klickitat River below the primary upstream spawning and rearing areas.

Skamania summer steelhead releases in the Klickitat River mainly provide for sport fisheries in the river (Bosch et al. 2004). Hatchery-reared winter steelhead have never been released in the Klickitat subbasin (Sharp 2000).

Currently there is insufficient information to determine the effects of hatchery releases on the natural steelhead population. While it is likely that hatchery hybridization of Skamania stock with wild steelhead has occurred in the Klickitat subbasin (NPCC 2004), the level of impact on the natural population remains uncertain. In its recent viability assessment for the population, the ICTRT (2007) found that the only reported information on relative hatchery/wild composition for the Klickitat was from sport catch sampling in the late 1980s, indicating that up to two-thirds of the catch were hatchery-origin. The ICTRT noted that it is possible that those estimates reflect the contribution rates in the lower Klickitat and are not directly representative of hatchery contribution rates to spawning in the majority of natural production areas. However, based on release levels and sport catch estimates, the ICTRT found that it is very likely that the hatchery contribution rate to natural steelhead spawning in the Klickitat subbasin has exceeded 5 percent for more than four generations (ICTRT 2007). Updated information from Gray (2005) indicates that 47.6 percent of the returning fish were hatchery-origin, based on the number of fish passing through the Lyle fish trap between July 2004 and February 2005. The percentage of hatchery-origin steelhead that passed through the fish trap in 2007, 2008, and 2009 ranged from 55.4 to 67.0 (http://www.ykfp.org/klickitat/).

Narum et al. (2006) argued that only 4 percent of the naturally produced steelhead could be attributed to the hatchery stock, and that genetic integrity and variation of native Klickitat River steelhead have been maintained despite repeated hatchery introductions. Berejikian and Ford (2004) estimated that the non-local Skamania Hatchery summer steelhead are less than 30 percent as effective as the naturally produced steelhead in producing returning adults.

Hatchery releases of coho and spring and fall Chinook into the mainstem Klickitat River may also affect natural steelhead production. In addition to the steelhead hatchery releases, an average of 4,349,710 fall Chinook, 595,318 spring Chinook, and 3,714,083 coho are released into the Klickitat River each year (Sharp et al. 2008). These species are not native, but have naturalized in the basin and are known to spawn in relatively large numbers (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009).

A synthesis of many studies in other basins by Weber and Fausch (2003) indicates that competition from hatchery outplants has the potential to decrease the productivity of the rearing life stages and increase predation on wild juvenile steelhead; however, the effects of the introduction of coho and fall Chinook on steelhead production in the Klickitat River have not been evaluated. It is believed that the current release of 3.7 million coho from the hatchery downstream into the middle mainstem Klickitat River may be competing with, and preying on listed steelhead juveniles (Sharp et al. 2008). The Klickitat Master Plan (Sharp et al. 2008) proposes to reduce the annual coho releases to 1.0 million and move all releases downstream to the proposed Wahkiacus Hatchery and Acclimation Facility. Hatchery releases of juvenile fall Chinook are not expected to compete with listed steelhead because of different habitat preferences; however, they may compete with naturally produced spring Chinook (Sharp et al. 2008).

Table 5-1. Results of redd surveys completed by Yakama Nation Fisheries in the Klickitat basin, 2002 through 2007 (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009).

Year	Species	Miles Surveyed	# Redds[1]	Redds/Mile	# Live Spawners	# Morts
2002	Spring Chinook	58.1	389	6.7	248	158
	Fall Chinook	48.6	1225	25.2	1655	1133
	Coho	67.2	480	7.1	1781	384
	Steelhead	127.6	261	2.0	150	17
2003	Spring Chinook	58.1	332	5.7	213	50
	Fall Chinook	40.6	474	11.7	1423	1258
	Coho	53.8	112	2.1	424	149
	Steelhead	120.1	290	2.4	124	16
2004	Spring Chinook	70.8	195	2.8	222	57
	Fall Chinook	48.7	777	16.0	1404	776
	Coho	53.9	57	1.1	404	19
	Steelhead	142.8	220	1.5	141	6
2005	Spring Chinook	68.2	50	0.7	98	0

Year	Species	Miles Surveyed	# Redds[1]	Redds/Mile	# Live Spawners	# Morts
	Fall Chinook	48.7	505	10.4	1466	243
	Coho	40.5	0	0.0	114	21
	Steelhead	146.3	157	1.1	288	2
2006	Spring Chinook	68.2	82	1.2	68	11
	Fall Chinook	36.9	119	3.2	684	286
	Coho	40.5	1	0.0	218	45
	Steelhead	123.8	10	0.1	23	3
2007	Spring Chinook	61.2	104	1.7	70	18
	Fall Chinook	48.8	253	5.2	557	62
	Coho	56	190	3.4	1499	133
	Steelhead	135.3	67	0.5	50	8

1 The number of redds is not directly comparable between species since differences in flows affect the efficiency of the surveys.

Straying of out-of-subbasin hatchery-produced steelhead, primarily from the Snake River and Upper Columbia River, into the Klickitat subbasin may also affect the viability of the Klickitat steelhead population. These strays are believed to enter the Klickitat to flee higher temperatures in the mainstem Columbia for cooler water refuges (Keefer et al. 2002). Juvenile transportation, artificial rearing, early run timing, and multiple fallbacks/ re-ascensions at dams also seem to be related to increased incidence of straying behavior (Keefer et al. 2005). Permanent strays, as opposed to “dip-ins” in the non-natal tributary, compete with endangered native fish. Out-of-subbasin spawning by hatchery fish can directly harm local wild populations (Waples et al. 1991; Chilcote 2003). Intra-basin stray rates for hatchery steelhead into Columbia River tributaries may be as high as 6.8 percent (Keefer et al. 2005).

5.2. Freshwater Habitat

The following discussion summarizes what is known and hypothesized regarding potential limiting factors based on best available information for each major and minor spawning area (MaSA and MiSA) identified by the ICTRT. Information used to identify these factors and the potentially associated threats came from available data reports and analyses for the basin, the Northwest Power and Conservation Council’s 2004 subbasin planning process, the Klickitat Lead Entity process performed under the Washington State Salmon Recovery Planning process, SB2496, a Yakama Nation 2006 EDT model run incorporating major spawning areas (unpublished), and the watershed planning process, chapter 90.82 RCW.

As described in more detail in Section 2.3, Ecosystem Conditions, and Appendix II, the Klickitat watershed offers areas of good quality habitat for steelhead as well as areas of degraded riparian condition, decreased floodplain function, altered hydrology, degraded channel structure and complexity, fish migration barriers, increased sediment loads, and degraded water quality, particularly with respect to high summer temperatures.

5.2.1 Major Spawning Areas

The ICTRT identified the following six major spawning areas in the Klickitat drainage, all of which are occupied by Middle Columbia steelhead except the West Fork Klickitat MaSA.

Upper Mainstem Major Spawning Area

As identified by the ICTRT, the Upper Mainstem MaSA contains the Klickitat River mainstem from the confluence with the West Fork Klickitat to the headwaters, including McCreedy, Chaparral, Piscoe, Diamond Fork, Butte Meadows, Coyote creeks and Huckleberry Creek below the falls. All but a small section of the Upper Mainstem Klickitat MaSA is above Castile Falls.

Potential limiting factors: *Impaired fish passage, altered sediment routing, degraded water quality (temperature), degraded channel structure and complexity, habitat quality and quantity, altered hydrology, competition, harassment/poaching.*

Steelhead recently regained access to historical habitat above Castile Falls after the fishway was modified to allow fish passage over a wider range of river flow conditions. There is historical evidence (from Yakama Nation Tribal Elders) of steelhead above Castile Falls. Historically, the difficult passage over the falls probably limited the number of fish using upstream habitat. Based on fish surveys and interviews with Tribal fishermen, LeMeir et al. (1957) identified only resident trout upstream of Castile Falls. While it is believed that the falls has always impeded upstream passage of adult fish, a 1960s attempt to improve fish passage at the falls inadvertently obstructed nearly all migration to habitat above the fishway. The recently completed fishway modifications resolved this problem. In addition to the falls, at least three culverts in Piscoe Creek have been identified as barriers to upstream juvenile and resident fish passage, according to WDFW protocols (Yakama Nation Fisheries Program 2003).

The Yakama Nation has monitored sediment levels at 20 sites in the Klickitat basin (http://www.ykfp.org/klickitat/Data_SedRpts.htm; Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009). Reported fine sediment (<0.85 mm) levels in the creek are less than 20 percent (a widely used indicator of spawning gravel condition: gravels that contain fewer than 20 percent fines are considered to be reasonably healthy for salmonids) in all mainstem sample locations in the Upper Mainstem Klickitat MaSA (Table 5-2).

Stream temperatures in the Upper Mainstem Klickitat MaSA frequently exceed 16^{o} C in summer but rarely reach lethal temperatures (Table 5-3). (http://www.ykfp.org/klickitat/Data_SedRpts.htm; Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009). Temperatures above 22^{o} C (72^{o} F) are highly stressful for steelhead but not necessarily lethal. According to Washington State Water

Quality Standards, Class A waters should not exceed 22° C, and Class AA water summer temperatures should not exceed 62.3° F.

Table 5-2. Fine sediment concentrations in gravels in the major and minor spawning areas in the Klickitat basin (data source: Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 21005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009.

MaSA/MiSA	Location	Years Sampled	Average % fine sediment (<0.85mm) in spawning gravel	Average % fine sediment (<6.73mm) in spawning gravel
West Fork Klickitat	West Fork Klickitat near the 255 road	1999	14.3	33.8
Upper Mainstem Klickitat	Klickitat near Signal Park Bridge	1999, 2001-2002	11.4	26.1
	Klickitat near Parrot's Crossing	1999-2000, 2002-2007	13.9	32.0
	Klickitat near Hatchery	1999	49.3	60.8
White Creek	Teepee Creek below IXL Road Crossing	2006	21.1	45.0
	White Creek below Teepee Creek	2005-2006	19.8	38.5
Middle Mainstem	Klickitat below White Creek	1999-2007	12.2	31.1
	Klickitat near Leidl Bridge	1998, 2000, 2003-2007	11.1	26.1
	Klickitat near Stinson	1999-2000, 2002-2006	13.2	28.2
Lower Mainstem Klickitat	Klickitat below Little Klickitat	1999-2007	14.1	28.9
	Klickitat below Swale Creek	1999-2000, 2003-2006	13.8	35.3
Upper Little Klickitat	East Prong	1999-2000	15	30.3
	Three Creeks	1999	23.0	37.1
	Goldendale	2000	11.9	18.6

Table 5-3. Maximum recorded temperature, average annual number of days that temperature exceeds 16°C, and average annual number of days that temperature exceeds 22°C in the major and minor spawning areas in the Klickitat basin (data source: Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 21005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009.

MaSA/MiSA	Location	Years Sampled	Max Temperature	Average Annual # Days > 16°C	Average Annual # Days >22°C
West Fork Klickitat	At 255 Bridge	1997-2007	14.1	0	0
Surveyor's Creek	Surveyor's Creek Road Crossing	1996-2007	22.4	4.1	0.1
Trout Creek	At River Rte Rd	1997-2007	25.6	65.1	9.5

MaSA/MiSA	Location	Years Sampled	Max Temperature	Average Annual # Days > 16°C	Average Annual # Days >22°C
	Crossing				
White Creek	Teepee Creek at IXL Rd Crossing	2003-2007	25.3	116	0.4
	White Creek at IXL Rd Crossing	2003-2007	23.5	21.4	1.4
Lower Little Klickitat	Near Mouth	1996-2007	27.7	81.5	11.1
	Near Confluence with Klickitat	1997-2007	25.6	65.5	9.8
Upper Little Klickitat	Three Creeks	1996-2007	26.7	59.6	10.9
	Owen Road	1996-2005	29.8	88.4	42.8
Lower Klickitat Mainstem	Near Little Klickitat	2001-2007	22.8	42.5	0.3
	At Old Lyle Trap Site	1997-2001	20.5	22.6	0.2
	At New Lyle Trap Site	2003-2004	20.9	47	0
Swale Creek	At Harms Rd	1997-2003	32.3	78.1	27.4
	Near Mouth	1997-2004	31.9	45.4	29.1

Threats in the Upper Mainstem MaSA are primarily the continued use and construction of roads, continued timber harvest in riparian areas, off-road vehicle use, and grazing. Timber harvest in this area on state and privately owned timberlands is subject to the Washington State Forest Practices rules, while harvest on the Yakama Reservation lands is governed by the Yakama Nation Forest Management Plan for 2005-2014. Future development in the upper portion of the Diamond Fork may affect habitat, depending on the use in that area, locations of development, and construction methods employed.

White Creek Major Spawning Area
The White Creek MaSA includes White Creek, Brush Creek, Tepee Creek, West Fork White Creek, and unnamed NW (White), E, NE and SE (Tepee) tributaries.

Potential limiting factors: *flow, habitat quality and quantity, impaired fish passage, altered sediment routing, degraded water quality (temperature), competition, degraded channel structure and complexity.*

The White Creek watershed (138 sq. miles), including Teepee Creek, supports a substantial portion of total observed steelhead spawning within the surveyed areas of the Klickitat subbasin (Evenson et al. 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009).

Fine sediment (<0.85 mm) levels in the White Creek exceed 20 percent in some areas (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009) (Table 5-2).

Stream temperatures in the White Creek basin frequently exceed 16°C in summer. Lethal or near-lethal temperatures occur rarely at the upper temperature monitoring sites, but exceed 22°C an average 11.1 days per year at the mouth (Table 5-3) (http://www.ykfp.org/klickitat/Data_SedRpts.htm; Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009).

Current habitat conditions in the White Creek watershed reflect past land use, particularly overgrazing, riparian timber harvest and road construction throughout the watershed. Instream large woody debris levels are low in many reaches and base flows are very low to non-existent in many reaches. Due to inhospitable flow and truncated flow duration in the vicinity of many spawning areas, post-emergence movement by steelhead fry and migration by juveniles is critical to their survival. Extensive reaches of both White and Tepee creeks have become incised and flow is now intermittent in many places where anecdotal evidence suggests it was once perennial.

Changes in channel morphology are related to livestock grazing, road interactions, and in some locations, historical removal of LWD. Impacts from grazing (in the form of altered riparian vegetation, bank erosion, and channel incision) are ongoing and evident in several meadow reaches within the watershed. At least seven culverts within the MaSA block upstream migration to spawning and rearing habitat ─ primarily for juveniles and residents, but also for some adults at some flows.

Much of Tepee Creek and portions of White and Brush creeks are highly incised with high, sparsely vegetated, eroding banks. The incision restricts floodplain access and has resulted in a higher-energy stream environment in which bed and bank erosion are common and habitat conditions are poor. Road inventory and analysis of watershed hydrology in the upper Tepee and White Creek watersheds indicated a marked increase in peak discharge (Northwest Hydraulic Consultants 2003).

LWD and pool frequency are very low (Conley 2005). Known historical failures of road crossings likely contributed to debris torrents which exacerbated downcutting of the channel bed, loss of LWD, reduced in-channel complexity and connectivity, and accelerated the export of spawning gravel. Spawning gravel and areas of velocity refugia are also limited.

Middle Mainstem Major Spawning Area

The Middle Mainstem MaSA contains the Klickitat River mainstem from the Little Klickitat River to the confluence with White Creek and includes Summit Creek, Beeks Canyon, and Dead Canyon.

Potential limiting factors: *altered sediment routing, habitat quality and quantity, degraded water quality (temperature), harassment/poaching, flow, predation, competition with hatchery fish, degraded channel structure and complexity, impaired fish passage.*

The middle mainstem Klickitat River MaSA supports over half of the observed mainstem steelhead spawning (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009), and has some of the greatest channel complexity. It also serves as the migration and rearing corridor for steelhead accessing upper reaches in the subbasin.

Large numbers of hatchery produced spring Chinook salmon, fall Chinook salmon, coho salmon and summer steelhead are released from the Klickitat Hatchery directly into the river within this MaSA (Sharp et al. 2008). These hatchery releases likely compete for food and rearing space with naturally produced steelhead. This area is also used extensively by the naturally spawning introduced fall Chinook and coho (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009), which also compete for food and rearing space.

Much of the middle mainstem Klickitat River is located in or adjacent to the Klickitat Wildlife Area. The right of way for the haul road paralleling the Klickitat River's west bank has been acquired by Columbia Land Trust. There is very little development and few roads in the unit. Some grazing occurs in the area. Logging occurs in the headwaters. As indicated in Section 2.3.2 of this Plan, the Big Muddy and Little Muddy creeks and West Fork Klickitat transport substantial quantities of sediment from a natural source to the Klickitat River above this MaSA. Logging-related impacts upstream of the MaSA might also be a source of sediment in the middle mainstem Klickitat River. However, available data suggest that fine sediment (<0.85 mm) levels in the spawning gravels in the mainstem Klickitat portion of the MaSA are reasonably low, below 20 percent fine sediment (Table 5-2) (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009). No data on stream flow, water temperatures, or levels of sediment in spawning gravels are available for Summit Creek, Beeks Canyon, or Dead Canyon.

Lower Mainstem Major Spawning Area

The Lower Mainstem MaSA extends from the mouth of the Klickitat River to the Little Klickitat River (RM 20.2) and includes Snyder Canyon, Dillacort, Wheeler and Logging Camp creeks. Lyle Falls (RM 2.19) restricts upstream passage to a degree.

Potential limiting factors: *habitat quality and quantity, competition, degraded water quality (temperature), altered sediment routing, predation, hatchery-related adverse effects, impaired fish passage, degraded channel structure and complexity, withdrawals, altered hydrology, harassment/poaching.*

The Lower Mainstem MaSA provides a migration and/or rearing corridor for 100 percent of steelhead, spring and fall Chinook, and coho in the Klickitat subbasin. The town of Klickitat is located near the upper end of the Lower Mainstem MaSA. A railroad and Highway 142 parallel the river along much of its length within the MaSA. The lower portion of the MaSA passes through a steep-sided bedrock canyon. Lyle Falls is located near the lower end of the MaSA. The falls historically impeded passage for spring Chinook and steelhead, but prevented passage for fall Chinook and coho. Lyle Falls was first modified in 1954 to improve passage, and a major remodel of the fishway at Lyle Falls is scheduled to begin in 2010 (Sharp et al. 2008).

Data suggest that fine (<0.85 mm) sediment levels in the gravels are typically low (below 20 percent) in the mainstem Klickitat River portion of the MaSA (Table 5-2), but sediment data are not available for the tributaries within the MaSA. Data suggest that water temperatures in the mainstem Klickitat rarely reach potentially lethal temperatures (Table 5-3). Water temperatures in Snyder Creek, Logging Camp Creeks, and Dillacort Canyon frequently exceed state standards and also exceed lethal temperatures in some years (Table 5-4).

Large numbers of hatchery produced spring Chinook salmon, fall Chinook salmon, and coho salmon are released directly into the river above this MaSA, and hatchery summer steelhead are released within this MaSA (Sharp et al. 2008). These hatchery releases may compete for food and rearing space with naturally produced steelhead. Development impacts in the town of Klickitat likely have some local effect on habitat. There are stretches where the road prevents establishment of riparian vegetation. The road and railroad also impinge on the river in some locations.

Table 5-4. Summary of water temperature data collected in the tributaries included in the Lower Mainstem Major Spawning Area (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 21005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009).

Location	*Dates*	*Average Annual No. Days >16°C*	*Percent of days >18°C*	*Percent of days >22°C*
Snyder Creek at Mill	1997-2007	24.7	12.5	**0**
Snyder Creek at Mouth	1997-2007	65.5	40.6	11.2
Logging Camp Creek	2002-early 2007	59.4	43.2	10.8 (all in 2003 – 54 days total that year)
Dillacort Canyon	1997-early 2997	59.9	31.7	12.5

Upper Little Klickitat Major Spawning Area

The upper Little Klickitat MaSA encompasses the Little Klickitat River from Little Klickitat Falls to the headwaters and includes Spring, Cozy Nook, and Bloodgood creeks, West Prong and East Prong Little Klickitat, Idlewild Canyon, Dry and Butler creeks.

Potential limiting factors: *Upstream passage over a natural barrier. Other potential limiting factors include: habitat quality and quantity, flow, altered sediment routing, degraded water quality (temperature), disease, predation, competition, hatchery-related effects, and degraded channel structure and complexity.*

The upper Little Klickitat MaSA contains a mix of forested uplands managed for timber, with agricultural and grazing land in the lower region. As of the 2000 census, the City of

Goldendale, which has a population of approximately 3760 people (www.census.gov), is the only urban development in the Little Klickitat watershed. The two main thoroughfares of the Klickitat subbasin, SR 142 and US 97, converge at and pass through Goldendale. Hatchery rainbow trout are released into this MaSA to support recreational fisheries.

Little Klickitat Falls, located at river mile 6.1, is 15 to 16 feet high (WPN and Aspect 2005a). Fish passage is possible in rare cases, but these tend to be very high flow events (floods) in winter (D. Rawding, personal communication 2006). In some years when a very high flow event coincides with the time steelhead are moving upstream, a few fish may pass the falls and enter the MaSA. The presence of the barrier functionally excludes steelhead from the upper Little Klickitat MaSA in most years.

Water temperature in the Little Klickitat River frequently exceeds the state standard and can exceed the likely lethal temperature in some areas (Table 3, Broack and Stohr 2002). The East Prong, West Prong, and mainstem Little Klickitat River; and Butler Creek, a major tributary to the Little Klickitat River, were listed on the 1998 303(d) list for temperature. Subsequently, a TMDL assessment and implementation plan were developed and adopted for the Little Klickitat River subbasin (Brock and Stohr 2002; Anderson 2004). Currently, the Little Klickitat River is listed as a Category 4b stream, meaning that the stream has an approved TMDL in place that is actively being implemented (Ecology 2008).

Since steelhead rarely pass the falls, water temperatures in the Upper Little Klickitat MaSA likely do not affect overall steelhead production, except for the influence on water temperature downstream of the falls. A recent analysis of the trends in riparian vegetation within the Little Klickitat basin indicated that riparian vegetation has generally been increasing over the past 30 to 40 years (Aspect and WPN 2009).

Sediment inputs into the Little Klickitat River MaSA could potentially affect spawning areas in the lower Little Klickitat MiSA. A Watershed Analysis was completed for the headwaters of the Little Klickitat basin in 1999 (Raines et al. 1999). That analysis indicated that forest roads were contributing significant sediment to the headwater streams. Since the analysis was completed, the new Washington Forest Practices Rules were adopted; this area is now covered under a Habitat Conservation Plan (http://www.dnr.wa.gov/BusinessPermits/Topics/ForestPracticesHCP/Pages/fp_hcp.aspx). The rules mandate the treatment of roads to minimize sediment inputs.

West Fork Klickitat Major Spawning Area

The West Fork MaSA includes the West Fork Klickitat River from top of falls #1 to headwaters, including Clearwater, Trappers and Fish Lake creeks.

Potential limiting factors: Natural passage barriers and possibly altered sediment routing.

A falls that totals 15 feet at RM 0.3 on the West Fork Klickitat currently hinders upstream anadromous fish passage, and probably limited historical passage to upstream habitat (LeMeir and Smith 1952). Another falls, 15 to 20 feet high, lies approximately four miles upstream and likely poses a similar challenge to upstream migration. LeMeir and Smith (1952) considered these falls to be passage barriers. Although some potential spawning areas exist in the watershed, factors such as gradient and natural confinement contribute to the assumption that this watershed would not be heavily used by spawning anadromous fish (though it is a stronghold for bull trout).

This watershed ranked low in EDT model outputs for restoration potential, since existing data suggest that the West Fork environment has not been significantly altered from historical conditions. Currently, the biggest threat in the watershed is road failures upstream of fish-bearing reaches, which generate torrents and contribute fine sediment. Determining the extent and frequency of steelhead passage and spawning in this system is considered a research need.

5.2.2 Minor Spawning Areas

Swale Creek Minor Spawning Area

The Swale Creek MiSA includes Swale Creek from the mouth to the south tributary below Harms Rd (RM 12.22).

Potential limiting factors: *It is likely that high stream temperature and low stream flow are limiting factors in this MiSA. Degraded habitat quality and quantity, altered sediment routing, disease, competition, predation, and degraded channel structure and complexity are also potential limiting factors.*

Stream flow in Swale Creek is intermittent near the mouth and upstream of river mile 3.1 (WPN and Aspect, 2005a). Stream flow in the lower 3 miles of the creek has been estimated at less than 0.25 cfs during summer (WPN and Aspect 2005a, Aspect 2007).

Stream flow in Swale Creek is influenced by a unique geological situation. The Warwick Fault, running northwest-southeast through Warwick (at roughly RM 12), is an important structural control on groundwater flow in the basin (WPN and Aspect, 2005a; Aspect 2007). The fault forms a structural closure to the Swale Creek valley and creates an impoundment of groundwater to the east of the fault. The presence of the fault impedes westerly groundwater flow (WPN and Aspect 2005a; Aspect 2007). The upper and lower portions of Swale Creek are hydrologically connected in winter and spring when the alluvium upstream of the fault is saturated, resulting in surface flow. The groundwater subsequently drops after the spring rains. The upper and lower basins become hydrologically isolated once the groundwater level drops below the top of the fault. This normally occurs in April or May. Water present in Swale Creek in summer and fall downstream of Warwick is an expression of local seeps and springs located below the fault (WPN and Aspect, 2005a; Aspect 2007).

The cadastral survey notes of the 1800s generally indicate that the flow situation in the 1860s was similar to what is seen today (WPN and Aspect, 2005a). Studies of the local geology and groundwater flow in the area also indicate that it is unlikely that land use has affected the quantity of water entering this segment (WPN and Aspect, 2005a).

Swale Creek has been listed as Category 5 (impaired, requires a water quality improvement plan) on the State of Washington's 303(d) list for exceedances of state temperature criteria (Ecology 2008). Water temperature at all monitoring stations exceed 22^{o}C (potentially lethal) in all years (WPN and Aspect, 2005a). Since the creek is isolated from the Klickitat River in summer and movement of juvenile fish into the Klickitat is prevented, juveniles rearing in Swale Creek are likely subject to significant mortality when water temperatures rise above potentially lethal temperatures.

Riparian vegetation along the lower 3 miles of the creek, which are perennially wet, is generally dense (WPN and Aspect, 2005a). A review of aerial photographs taken since 1954 indicated that vegetation over the last 60 years has been influenced by a number of large flooding events that removed mature vegetation (WPN and Aspect, 2005a). An analysis of the trends in vegetation over time found that vegetation has generally been increasing along Swale Creek over the past 30 to 40 years (Aspect and WPN 2009).

Limited information is available regarding other habitat conditions in the MiSA.
An abandoned railroad bed confines the creek upstream of the perennial wetted area.

Surveyor's Creek Minor Spawning Area

The Surveyor's Creek MiSA contains branched habitat from Surveyor's Creek. The MiSA, as shown in Figure 4-4, contains mainstem Klickitat habitat, but this is only due to the methodology of using existing Hydrologic Unit Code (HUC) GIS data where possible. In this case, because the relevant HUC for Surveyor's Creek was selected, the MiSA encompassed other reaches that did not meet branched habitat criteria but were within the HUC boundary.

Potential limiting factors: *Upstream passage is the primary limiting factor. Other potential limiting factors are altered sediment routing, water temperature, and competition.*

The stream is impassable to salmon and steelhead. Between the mouth of the creek and a location approximately 0.8 miles upstream, the creek drops about 400 feet in a series of cascades and impassable falls (LeMeir 1952). Water temperatures frequently exceed 16^{o}C, and occasionally reach potentially lethal temperatures (Table 5-3).

Lower Little Klickitat Minor Spawning Area

The Lower Little Klickitat MiSA covers the Little Klickitat River from the mouth to Little Klickitat Falls (RM 6.2), including lower Canyon and Bowman creeks.

Potential limiting factors: *Temperature is likely the primary limiting factor in the Lower Little Klickitat MiSA. The following are also potential limiting factors: disease,* *altered sediment routing, competition, habitat quality and quantity, predation, flow, and hatchery-related effects.*

The lower 6.1 miles of the Little Klickitat River provide rearing and limited spawning habitat for steelhead. Much of the MiSA runs through a deep canyon. There is little development along the canyon reach. Lower in the reach, some grazing and minor jeep trails are present. The mainstem Little Klickitat River and its tributaries Mill Creek and Bowman Creek are listed as a Category 4a for temperature on Ecology's 303(d) list (Ecology 2008). Water temperatures regularly exceed the state standard in summer and occasionally exceed potentially lethal temperatures (Table 5-3). Riparian vegetation has generally increased since 1969 within the MiSA (Aspect and WPN 2009). The Little Klickitat TMDL (Anderson 2004, Brock and Stohr 2002) includes the Lower Little Klickitat River MiSA. The WRIA 30 Management Plan (WPN and Aspect 2005b) and the TMDL outline actions that should be taken to address temperature in the MiSA. Little to no data are available to address any other factors in this MiSA.

Trout Creek Minor Spawning Area

The Trout Creek MiSA extends up Trout Creek from the top of the falls to the headwaters and includes Bear Creek.

Potential limiting factors: *Natural passage barrier. The following are also potential limiting factors: altered sediment routing, competition, degraded water quality (temperature), habitat quality and quantity, and flow.*

Lower Trout Creek has a relatively steep gradient (20-25 percent over almost 0.25 miles). It is composed primarily of a boulder substrate, which does not, however, exceed the WDFW criteria for anadromous fish-bearing waters (20 percent gradient for 160 meters - continuous, or waterfall over 12 feet in height). No steelhead have been observed to date above the high gradient reach (Evenson and Zendt 2004; Yakama Nation Fisheries Program 2003; Zendt and Evenson 2005; Zendt and Babcock 2007; Zendt 2006; Zendt and Babcock 2009).

5.3 Tributary Harvest

In the Klickitat River, there is both a recreational harvest and a Native American treaty harvest. Recreational fisheries for winter and summer steelhead occur in the Klickitat River from June 1 through November 30. Most steelhead are caught from June through September. A dip net fishery exclusive to enrolled Yakama tribal members is located at Lyle Falls (RM 2). Fishing seasons are set annually by the Yakama tribal council and are subject to in-year closures depending on run strength. The tribal steelhead dip net fishery generally occurs from April 1 through December 31. Harvest is monitored by Yakama Nation fisheries program personnel.

Recreational steelhead fisheries in the Klickitat River are restricted to adipose fin-clipped hatchery steelhead only. Current regulations prohibit sport fishing for steelhead in the Klickitat River from December through May, and the treaty fishery is closed from January through March to protect the winter run (Bosch et al. 2004). Release of all unmarked wild steelhead is required. Tribal harvest regulations do not require the release of unmarked fish; however, many tribal fishers are returning wild fish to the river (J. Kiona, personal communication 2005). The Klickitat River Anadromous Fisheries Master Plan proposes to use an education outreach program to encourage more tribal fishers to adopt this practice while still respecting tribal culture and tradition (Sharp et al. 2008).

The overall mortality rate for catch-and-release fisheries depends on the encounter rate of naturally produced fish (percentage of run actually caught and released) in the fisheries, and the mortality rate associated with being caught and released (hook-and-release mortality). In winter steelhead fisheries, WDFW (2008) estimates that catch-and-release mortality is less than 5 percent, while mortality in summer steelhead fisheries in the Klickitat River is estimated to be less than 10 percent of the wild fish handled. The catch and release mortality only affects that proportion of the wild run that is encountered in the fishery. WDFW (2008) estimates that in the Klickitat River tributary fisheries that 63 percent of the summer-run steelhead and 34 percent of the winter-run steelhead are handled. Multiplying the catch and release mortality rates by the encounter rates provides the estimate of tributary fisheries impacts of 6 percent for summer-run and 2 percent for winter-run wild steelhead (WDFW 2008).

ODFW performed a number of Population Viability Assessment model runs for 27 steelhead populations to assess the impact of fisheries mortality on the status and recovery of steelhead in Oregon (Chilcote 2001). As mortality rates became greater than 40 percent the probability of extinction increased dramatically. To address this concern, steelhead fisheries are managed not to exceed a maximum mortality limit of 20 percent. This conservative approach is used to provide a buffer for errors, even though the model results suggest that management under a 40 percent limit is unlikely to cause extinction.

Treaty Native American fisheries also occur in the mainstem Klickitat River. The treaty Native American catch of all types of steelhead (summer and winter, wild and hatchery combined) in the Klickitat River is estimated at an average of 1,146 steelhead per year since 1986 (Sharp et al. 2008). Estimated tribal harvest of wild steelhead in the Klickitat averages 178 fish per year (Table 2-1) (Sharp et al. 2008).

Steelhead harvest (sport and tribal combined) in the Klickitat River has averaged about 2,500 fish annually from 1987 to 2004, with Skamania strain steelhead comprising an average 98.1 percent of the sport catch from 1986-2003 (Table 5-5). By contrast, a sport harvest-only table covering the years 1962-1966 averaged an annual catch of 3,312 steelhead (summer only), peaking in 1966 at 8,093 fish (Washington Department of Game and Oregon State Game Commission 1968).

Table 5-5. Estimated Harvest for Klickitat River Steelhead, 1986-2007 (Sharp et al. 2008).

Year	Sport			Tribal		
	Hatchery	Wild	Total	Hatchery[1]	Wild[1]	Total
1986-87	1,426	54	1,480	5,107	901	6,008
1987-88	1,480	34	1,514	1,141	201	1,342
1988-89	1,718	0	1,718	1,263	223	1,486
1989-90	833	0	833	536	95	631
1990-91	1,055	0	1,055	1,464	258	1,722
1991-92	823	8	831	1,620	286	1,906
1992-93	1,260	0	1,260	1,033	182	1,215
1993-94	1,211	25	1,236	1,151	203	1,354
1994-95	857	34	891	482	85	567
1995-96	864	9	873	433	76	509
1996-97	608	14	622	241	43	284
1997-98	1,062	18	1,080	455	80	535
1998-99	650	12	662	224	39	263
1999-00	575	28	603	214	0	214
2000-01	1,433	59	1,492	495	67	562
2001-02	3,708	16	3,724	724	55	779
2002-03	3,552	97	3,649	1285	363	1,648
2003-04[2]	1,673	0	1,673	369	151	520
2004-05	1,658	0	1,658	747	153	900
2005-06	1,115	0	1,115	368	98	466
2006-07					61	
Avg:	1,378	20	1,398	968	178	1,146

Note: Data for this table are from YN and WDFW databases and US v. Oregon TAC reports

[1]Hatchery and wild proportions of tribal harvest are estimated as follows: For 1999-00 through 2005-06 percentages estimated from sampling of ceremonial and subsistence harvest were applied to total tribal harvest.
For 1986-87 through 1998-99 the average percentages from the 1999-2005 sampling were applied to total tribal harvest.
[2]Sport Harvest numbers include data from May 1 - April 30 except for 2003-04, which does not include April data

In the most recent ten years between 1997-98 and 2006-07, tribal harvest of wild steelhead in the Klickitat has ranged from 0 to 363 with an average of 107 fish annually (Table 5-5 above). Estimated harvest rates derived for years prior to 2005-06 are likely biased in favor of high returns, as a result of underestimated spawner escapement and total run size to the mouth of the Klickitat. For the return years of 2005-06 and 2006-07, estimated tribal harvest rates on wild steelhead were 5.8 percent and 3.5 percent, respectively (based on wild run abundance and tribal harvest below Lyle Falls as described in Appendix IV). Expansion of the spawner escapement estimates for harvest prior to these two years would suggest a much higher rate upward around 15 percent for the period of record of 1986-2007. Considering the recent two year average of 4.7 percent expanded from the mark recapture abundance estimates, actual harvest over the recent ten year period of record has probably ranged from 3.5 percent - 10 percent of the wild run to the mouth of the Klickitat.

Steelhead occupy many waters that are also occupied by resident trout species. It is not possible to visually separate juvenile steelhead from similarly sized stream-resident rainbow trout. Because juvenile steelhead and resident rainbow trout are the same species, are similar in size, and have the same food habits and habitat preferences, it is reasonable to assume that catch-and-release mortality studies on stream-resident trout also apply to juvenile steelhead. WDFW has implemented a number of regulation changes to limit impacts on juvenile steelhead in the Klickitat River. These include increasing the minimum size limit for rainbow trout fisheries from 6 inches to the current size limit of 12 inches. The daily bag limit was also reduced from 6 fish to 2 fish. Trout angling is only open from June 1 to November 30. These changes have reduced impacts on naturally produced juvenile steelhead/trout to less than 1 percent of the population, a substantial reduction from historical impacts of tributary fisheries, which were estimated to be over 50 percent (WDFW 2008). The continued release of rainbow trout in tributaries to the Little Klickitat River and the associated fisheries that do not follow the same regulations may adversely affect those naturally produced steelhead that are able to pass above the falls in the lower Little Klickitat River. Fisheries that target non-resident warm water species can affect juvenile steelhead but these fisheries are not present in the Klickitat River (WDFW 2008). WDFW has submitted to NMFS a Fisheries Management and Evaluation Plan (FMEP) for tributary fisheries in the Middle Columbia steelhead DPS to cover impacts from these fisheries under the 4(d) rule limit 4 of the ESA (WDFW 2008).

Harvest of salmon and steelhead in the Klickitat River may include “dip-in” fish, which are destined for tributaries farther up the Columbia and Snake river systems, but temporarily stray to the Klickitat’s cool water refuges in the river’s lower reaches for short periods before continuing their upstream migrations. The contribution of dip-in hatchery steelhead in the Klickitat River harvest is believed to be small. Most hatchery steelhead are taken from river sections upstream of where dip-in fish are found, and the proportion of the harvest is primarily 2- and 3-salt fish typical of the Klickitat River steelhead (D. Rawding, personal communication 2006).

5.4 Out-of-Subbasin Limiting Factors and Threats

The Middle Columbia River Steelhead DPS Recovery Plan uses information from two “modules” developed by NMFS to address conditions in the Columbia River mainstem and estuary that affect all Middle Columbia steelhead: the Hydro Module, based on the NMFS 2008 Biological Opinion on the Federal Columbia River Power System, and the Estuary Module (NMFS 2007). In addition to proposed actions in the management unit plans, the DPS Plan relies upon Hatchery and Genetic Management Plans and Artificial Production for Pacific Salmon (Appendix C of the Supplemental Comprehensive Analysis, NMFS 2008 Biological Opinion) to address hatchery effects. For harvest effects, the Plan refers to fishery management planning through the 2008 U.S. v. Oregon agreement for mainstem fisheries, and Fisheries Management Evaluation Plans for tributary fisheries. The reader is referred to the DPS plan for this information. The following is a summary of the information most relevant to the Klickitat Plan.

5.4.1 Harvest

Steelhead destined for the Klickitat drainage can be caught in three types of fisheries as they migrate through the Columbia River and Pacific Ocean: ocean fisheries or mainstem Columbia River tribal or nontribal fisheries.

Ocean Fisheries

Steelhead are rarely caught in ocean fisheries; therefore, these fisheries are not considered a significant source of mortality to Middle Columbia River steelhead (NMFS 2000). Ocean fishing mortality on Middle Columbia River steelhead is assumed to be zero.

Columbia River Mainstem Non-Tribal Fisheries

There has been no direct freshwater non-tribal harvest on wild steelhead from the Mid-Columbia DPS since 1992, when the last wild fish catch-and-release regulations on these populations became effective. Therefore, all current non-tribal harvest impacts on Mid-Columbia DPS steelhead are due to incidental bycatch in commercial or recreational fisheries that target hatchery steelhead or other species, and monitoring these impacts is complex. Released fish experience a mortality rate, possibly delayed and difficult to measure, that is highly variable and depends on what gear is used, how the fish is caught by the gear, how the fish are handled during capture and release, and environmental conditions. Release mortality is estimated to be very low (below 1 percent of encounters), with an unknown range of error. Recreational fisheries are monitored by creel surveys (fisheries technicians interview anglers about their catch, gear, and wild steelhead releases); the total recreational impact on winter and summer steelhead as they move through the mainstem to the tributaries is estimated to be less than 2.5 percent (ODFW 2009, Oregon Recovery Plan).

There are three stocks of summer steelhead used for management of treaty and non-treaty mainstem fisheries, including the lower Columbia River Skamania stock, upriver A-run stock, and upriver B-run stock. All MCR steelhead populations are designated A-run, with two populations being winter run. In NOAA’s Biological Opinion for the 2008-2017 *U.S. v. Oregon* Fisheries Agreement the wild MCR steelhead DPS in the non-treaty winter, spring, and summer mainstem fisheries are subject to a 2 percent harvest rate limit (NMFS 2008b). Non-treaty fall fisheries are also limited to a 2 percent harvest rate limit for A-run summer steelhead. The total annual harvest rate limit for A-run steelhead in non-treaty fisheries is 4 percent and 2 percent for the summer-run and winter-run of the MCR steelhead DPS, respectively. The expected harvest impacts from non-treaty fisheries are less than the limits proposed in the *U.S. v. Oregon* fisheries Agreement. The yearly incidental catch of A-run steelhead in non-treaty fisheries has averaged 1.6 percent since 1999, and is not expected to change over the course of the Agreement (NMFS 2008b).

Treaty Native American Fisheries

Tribal fishers in Zone 6 of the Columbia mainstem (between Bonneville Dam and McNary Dam) continue to retain wild steelhead for commercial sale or for personal use. The *U.S. v. Oregon* Fisheries Agreement does not establish specific harvest rate limits for treaty-Native American fisheries on steelhead during the spring or summer seasons which extend through July 31. Reported steelhead catch in Zone 6 winter and spring fisheries for 2003 to 2005 ranged from 0.7 percent to 7.9 percent of the winter steelhead run over Bonneville Dam. In 2004, reported and estimated non-reported steelhead catch together amounted to 4.8 percent of the run at Bonneville, with an unknown error around these numbers (ODFW 2009, Oregon Recovery Plan).

Impacts on MCR steelhead from treaty-Native American fall fisheries are limited by harvest rate limits for B-run steelhead and Upper Columbia River bright fall Chinook (NMFS 2008b). The harvest rate on MCR summer-run steelhead in spring, summer, and fall Zone 6 treaty-Native American fisheries combined averaged 11.7 percent since 1985 and 6.64 percent since 1998 (NMFS 2008b, Table 8.8.5.5-1). The impacts resulting from the treaty- Native American fisheries are expected to be similar to the 1998-2006 average of 6.64 percent. The harvest rate is less for populations that pass fewer dams in Zone 6 and are therefore subject to fewer non- Native American and treaty Native American fisheries (e.g., Klickitat steelhead pass only one dam and would experience a harvest rate less than 6.64 percent).

5.4.2 Columbia River Hydro Operations

Hydropower system construction and operation (flow regulation) in the Columbia River basin has been a major cause of changes in the Columbia River and estuary from historical conditions.

Within the Klickitat subbasin, steelhead and salmon were affected by creation of the Bonneville Dam pool on the mainstem Columbia River, which effectively inundated the lower 1.19 miles of the Klickitat River. This resulted in the loss of riparian, spawning, and rearing habitat and increased predation by native and non-native fish in the lower river. A lack of historical data inhibits quantitative evaluation of the impacts of Bonneville pool inundation on native fish, plant and wildlife species.

In the mainstem Columbia River, changes in river flow, circulation, water quality, contaminants, channel alterations, and predation have negative impacts on adult and juvenile fish. Hydro operations have changed flow conditions in the Columbia River and through the estuary. Before the development of the hydrosystem, Columbia River flows were characterized by high spring runoff from snowmelt and regular winter and spring floods. Dam construction and operation have altered Columbia River flow patterns substantially throughout its basin. Historical flow records at The Dalles, Bonneville Dam, and Beaver, Oregon, demonstrate that annual peak flows have been reduced by about 50 percent, as water is stored for power generation and irrigation, and winter flows have increased about 30 percent.

The Columbia River Estuary Module, at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery -Plans/upload/Estuary-Module.pdf provides more information on factors that limit viability of Klickitat steelhead in the Columbia River Estuary.

5.4.3 Ocean Conditions

The effects of ocean conditions on abundance of Pacific salmon and steelhead vary among species and populations within species. Migration patterns in the ocean may differ dramatically and expose different stocks to different conditions in different parts of the ocean. Some species have broad, offshore migration patterns that may extend as far as the Gulf of Alaska (steelhead, chum, some Chinook). Others have migration patterns along the Washington, British Columbia, Oregon and California coasts (Chinook, coho, cutthroat). Thus, ocean conditions do not have coincident effects on survival across species or populations.

Ocean survival of steelhead has been dramatically affected by widespread changes in ocean conditions. Cooper and Johnson (1992) showed that variation in steelhead run sizes and smolt-to-adult survival was highly correlated between runs up and down the West Coast. Smolt-to-adult survival rates generally varied 10-fold between good and bad years. Ocean survival rates for three West Coast steelhead populations where good annual index data were available showed high variability and a generally declining trend since the late 1970s.

5.4.4 Climate Change

Climate change represents a potentially significant threat to recovery of Mid-Columbia steelhead populations. The Independent Scientific Advisory Board (ISAB) for the Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and NMFS reviewed the potential effects of climate change on salmonids in the Columbia River basin (ISAB 2007). The ISAB report shows that changes in climate may adversely affect steelhead in freshwater habitats across the DPS by exacerbating existing problems with water quantity (lower summer stream flows) and water quality (higher summer water temperatures). Consistently identified types of impacts on snow pack, stream flow, and water quality in the Columbia Basin are the following (ISAB 2007 p. 15-17):

- Warmer temperatures will result in more precipitation falling as rain rather than snow.
- Snow pack will diminish, and the timing of stream flow will be altered.
- Peak river flows will likely increase.
- Water temperatures will continue to rise.

These changes may affect steelhead more than other salmonids because of their long rearing period in freshwater.

Changing conditions could also affect salmonid health and survival in the ocean through a variety of mechanisms, including increased ocean temperatures, increased stratification of some waters, changes in the upwelling season, shifts in the distribution of salmonids, long-term variability in winds and ocean temperatures, increased acidity, and increased atmospheric and oceanic variability (NMFS 2007, 2008a; ISAB 2007).

All other threats and conditions remaining equal, future deterioration of water quality, water quantity, and/or physical habitat can be expected to cause a reduction in the number of naturally produced adult steelhead returning to these populations across the DPS. This possibility further reinforces the importance of achieving survival improvements throughout the entire steelhead life cycle. Recent research also indicates that neighboring populations with differences in habitat may show different responses to climate changes (Crozier and Zabel 2006; Crozier et al. 2008). This research reinforces the importance of maintaining habitat diversity. Ongoing efforts to develop models of future climate effects should be considered in adaptive management.

5.4.5 Other Large-Scale Threats

Projected continued population growth will increase pressures for conversion of forestry and agricultural land uses to residential uses, with potential impacts on habitat and water conditions.

- Increase in exotic invasive species that potentially compete with native flora and fauna, and provide food and/or cover to species that potentially compete with, prey on or carry diseases which could affect native species.
- New disease and/or pathogen introductions (e.g. from marine aquaculture operations on steelhead ocean migration routes, illegal stocking of out-of-subbasin species).
- Natural catastrophic events (e.g. earthquake, volcanic eruption and related effects).

6. Recovery Strategy and Actions

The preceding chapters summarize recovery goals, biological criteria and threats criteria, current status assessment, and the major limiting factors and threats identified for the Klickitat River steelhead population. How will we reach recovery?

In this chapter, a recovery strategy is laid out to address the significant data gaps and uncertainties regarding the status of the Klickitat steelhead population and to address the potential limiting factors based on the existing, best available science; i.e. hatchery-related effects and degraded habitat, including natural barriers to fish passage. The strategy includes maintaining low harvest impacts and improving monitoring to verify those impacts. Fish passage and survival issues in the mainstem Columbia River and estuary are addressed in more detail in the Middle Columbia River Steelhead DPS ESA Recovery Plan; in Section 6.5, these are summarized as most directly related to the Klickitat population.

Lack of information about the Klickitat River steelhead population is a major problem for recovery planning for the Middle Columbia River steelhead DPS. The Klickitat population's moderate risk rating was assigned primarily on the basis of uncertainty and lack of data, particularly with respect to the influence of hatchery fish on the wild steelhead population. Therefore, the first importance for a recovery strategy is to reduce the uncertainties by obtaining more information through monitoring and research. Monitoring and research needs are summarized here and described in greater detail in Chapter 8.

Improvements in hatchery management and the construction of a new facility 26 river miles downstream of the major spawning area in the middle mainstem are designed to address the potential limiting factor of competition with hatchery fish.

To address habitat degradation in the Klickitat watershed, the plan proposes to protect and improve ecosystem functions and restore ecological processes, first, by protecting and maintaining existing high quality and/or unimpaired habitats and ecosystem functions; and, second, by restoring degraded habitat where appropriate, through passive and active measures.

Managing harvest for low impacts from both mainstem and tributary fisheries, and to reduce any adverse impacts that may be occurring, also is an important contribution to the population's viability.

For a species to achieve both ESA and broad-sense recovery, it would need to get on a definitive trajectory of improvement. The recovery strategies and actions are designed to work synergistically to improve survival throughout the steelhead life cycle, from egg to smolt to returning adult. Monitoring results will inform us of the progress the species has made toward recovery goals.

6.1 Strategies and Actions to Address Data Gaps

A research, monitoring, and evaluation plan should be designed collaboratively in the implementation phase of this plan to address the additional information needs that stakeholders and scientists have identified, as follows:

- Determine abundance and productivity of natural steelhead spawners
- Determine the impacts of Skamania hatchery steelhead releases on viability of the Klickitat population, if any.
- Determine the effects of non-native coho and fall Chinook released from the hatcheries and naturalized in the river, if any.
- Continue study and further refine understanding of habitat limiting factors.

Strategy 1. Determine abundance and productivity of natural steelhead spawners

<u>Actions</u>

- *Fin clipping of hatchery fish* **–** Continue fin clipping 100 percent of the hatchery released fish to facilitate the development of population estimates.

- *Adult counts at Lyle Falls Fishway adult trap* – Continue to monitor the number of steelhead passing through the Lyle Falls adult trap.

- *Estimates of trap efficiency* **–** Continue to monitor adult trap efficiencies with floy tags recovered in sport fisheries or during spawner/carcass surveys. Testing trap efficiency may be improved by releasing floy tagged fish downstream of the trap and identifying the percentage that re-enter the trap as they move upstream. Develop and publish annual estimates of trap efficiency.

- *Abundance estimates* – Based on the number of fish caught in the Lyle Falls Fishway adult trap and the estimates of trap efficiency, develop and publish annual estimates of the number of natural spawners.

- *Juvenile counts at the smolt trap locations* – Continue to monitor and report the number of fish caught in the three rotary screw trap locations currently operated by Yakama Nation Fisheries in cooperation with WDFW.

- *Productivity estimates* – Based on the number of fish caught at the rotary screw trap locations and the estimates of trap efficiency, develop and publish annual estimates of the number of naturally spawned steelhead smolts migrating out of the Klickitat basin.

Strategy 2. Determine impacts of Skamania Hatchery steelhead releases on viability of Klickitat steelhead population.

Actions

- *Spawner Surveys* -Continue to conduct and report annual spawner surveys to track adult steelhead distribution in the MaSAs and MiSAs.

- *Portion of Natural Spawners of Hatchery-Origin* - Estimate natural/hatchery adult spawner ratios by sampling carcasses on spawning grounds, or through other appropriate methods.

- *Estimates of Genetic Introgression* - Based on the estimated proportion of hatchery-origin steelhead spawning naturally each year, develop estimates of the amount of genetic introgression that has likely occurred over the 40 years of hatchery operations.

- *Genetic Sampling* - Increase juvenile and adult genetic sampling and analysis at spawning grounds and at various trap locations to help assess the level of domestication and interbreeding between hatchery and natural steelhead.

- *Stock Distribution* - Focus radio-tagging studies to determine spatial and temporal distribution of natural Klickitat steelhead population and Skamania Hatchery steelhead, and the overlap between summer and winter-run steelhead in the Klickitat River.

Strategy 3. Determine impacts of non-native coho and fall Chinook releases on viability of Klickitat steelhead population.

Actions

- *Fin clipping of hatchery fish* **–** Continue fin clipping 100 percent of the hatchery released coho and fall Chinook to identify the number of hatchery released fish that spawn naturally in the Klickitat River.

- *Adult counts at Lyle Falls Fishway adult trap –* Continue to monitor the number of coho and Chinook passing through the Lyle Falls adult trap.

- *Estimates of trap efficiency* **–** Estimate the efficiency of the trap in intercepting coho, fall Chinook, and spring Chinook. Publish annual estimates.

- *Abundance estimates –* Based on the number of fish caught in the Lyle Falls Fishway adult trap and the estimates of trap efficiency, make annual estimates of the number of adult coho, fall Chinook, and spring Chinook entering the Klickitat basin.

- *Juvenile counts at the smolt trap locations* – Continue to monitor and report the number of coho and Chinook caught in the three rotary screw trap locations currently operated by the Yakama Nation Fisheries in cooperation with WDFW.

- *Productivity estimates* - Based on the number of coho and Chinook caught at the rotary screw trap locations and the estimates of trap efficiency, develop and publish annual estimates of the number of coho and Chinook smolts migrating out of the Klickitat basin.

- *Spawner surveys* - Continue to conduct annual spawner surveys to track adult coho and fall Chinook distribution in the MaSAs and MiSAs, but expand the program to cover the entire area in which steelhead are known to spawn.

- *Estimate number of naturally spawning fish of hatchery-origin* - Sample carcasses on spawning grounds to estimate natural/hatchery adult spawner ratios.

- *Overlap in distribution of spawning habitats* - Assess the amount of overlap in the habitat occupied by steelhead and the introduced species.

- *Productivity of introduced species* - Determine the productivity of the naturally spawned coho and fall Chinook, using the same methods used to determine the productivity of steelhead.

- *Competition between species* – Evaluate the effects of competition with introduced species on rearing juveniles (differences in growth and survival with and without introduced species present) in a properly controlled experiment.

- *Estimate displacement of steelhead* - Determine the area of steelhead spawning and rearing habitat displaced by coho and fall Chinook.

- *Effects of introduced species on productivity* - Estimate the effect of introduced species on the productivity of steelhead in the basin.

Strategy 4. Continue study and further refine understanding of habitat limiting factors.

Actions

- Continue habitat study and incorporate new data into EDT, AHA, and/or other appropriate models.

- Continue biological studies and incorporate new data into models.

- Use adaptive management to adjust actions according to new information.

6.2 Hatchery-Related Strategies and Actions

The following strategies and actions address potential limiting factors and threats to Klickitat steelhead viability from hatchery-related effects.

Strategy 1. Minimize adverse impacts of large-scale hatchery releases of *U.S. v. Oregon* production stocks (coho and fall Chinook) on Klickitat steelhead population.

A satellite Wahkiacus Hatchery/Acclimation Facility (WHAF) at RM 17.0 on the Klickitat River is under development. Existing *U.S. v. Oregon* production of fall Chinook and coho will be transferred from the Klickitat Hatchery to the new facility. The 26 miles of river between Klickitat Hatchery (RM 42.6) and WHAF (RM 17) contain EDT reaches in the upper end of the Lower Klickitat, Middle Klickitat, and Upper Middle Klickitat MaSAs (See Appendix II, Table II-1 for correlation between ICTRT and YN MaSAs and MiSAs). Physical habitat surveys and resulting EDT output identify these reaches as having the highest potential for restoration and preservation. Annual steelhead spawner surveys indicate that 60 percent of the mainstem spawning occurs in these reaches.

The program is identified in the Klickitat Anadromous Fishery Master Plan (Sharp et al. 2008). Transferring *U.S. v. Oregon* production stocks (coho and fall Chinook) to the WHAF accomplishes two primary objectives. First, it frees up critical water and space at the Klickitat Hatchery, ensuring that optimal rearing densities and protocols (YKFP and HSRG guidelines) are met for the two endemic stocks (Klickitat spring Chinook and Klickitat summer steelhead). Second, transferring coho and fall Chinook production 26 miles downriver minimizes the impacts of large-scale hatchery releases on wild spring Chinook and steelhead rearing between the two facilities. Additionally, release of well-acclimated coho and fall Chinook from WHAF imprinted to the local groundwater signature will concentrate natural production in the immediate vicinity of the facility.

Actions

- Develop satellite Wahkiacus Hatchery/Acclimation Facility at RM 17.0.
- Transfer existing *U.S. v. Oregon* production of fall Chinook and coho from the Klickitat Hatchery to Wahkiacus facility.

Strategy 2. Minimize adverse impacts from hatchery program on the Klickitat steelhead population.

The Yakama Nation has been working with, the HSRG, NMFS, WDFW, Tribal fish and wildlife leaders, BPA, and others to develop a master plan for an integrated hatchery program for the Klickitat River (Sharp et al. 2008). The program will minimize adverse impacts on the natural steelhead spawning population. One option being explored by hatchery program managers is to replace the current program, which releases out-of-basin Skamania hatchery-origin smolts in the Klickitat River system, with a hatchery program that relies entirely on the use of natural-origin, summer steelhead from the Klickitat River for broodstock (Sharp et al. 2008). The new program would continue to provide harvest opportunities for treaty and non-treaty fisheries. A feasibility study will be conducted as part of the program to investigate broodstock collection and juvenile rearing strategies, expected smolt-to-adult survival rates, and the risks associated with current steelhead hatchery practices.

Actions

- Develop and implement Klickitat steelhead integrated hatchery program (Sharp et al. 2008).
- Conduct feasibility study to gain needed information on broodstock collection, rearing strategies and expected smolt-to-adult survival rates, and to assess risks associated with current and proposed hatchery practices.
- Evaluate out-of-basin steelhead strays.

Strategy 3. Improve steelhead passage at Lyle Falls Fishway.

Passage for summer and winter steelhead at Lyle Falls (RM 2.2 on the Klickitat River) can become difficult during low flow conditions. At low flows, minimal water passes through the fishway, whose exit channel is often shallow with exposed bedload, resulting in fish reluctant to enter and exit the fishway. New fish passage technology provides solutions to remedy problems with the fishway and facilitate increased passage through a wider range of flows, particularly during low flow conditions. Increased passage through a properly functioning fishway will not only facilitate the monitoring of returns and enable the collection of steelhead broodstock for the integrated hatchery program but will also ease steelhead migration.

Actions

- Reconstruct Lyle Falls fishway to Federal design criteria to ease steelhead migration, facilitate the monitoring of returns, and function as a site for broodstock collection for the integrated hatchery program.

Strategy 4. Assess steelhead natural recolonization of upper Klickitat watershed and the potential use of artificial propagation to accelerate recolonization.

In 2005, full anadromous fish passage was restored into the Upper Klickitat watershed as a result of improvements to the Castile Falls Fishway. Analysis conducted by the Yakama Nation and ICTRT indicates that the current habitat potential above Castile Falls could substantially increase the abundance of Klickitat River steelhead once fully seeded. Efforts need to be implemented to adequately assess the natural recolonization of steelhead in the upper watershed and to explore the potential use of artificial propagation as a means to accelerate recolonization.

The Yakama Nation is working with the HSRG, NMFS, WDFW, tribal leaders, BPA, and others to examine whether a conservation hatchery program could be used to accelerate recolonization of the Upper Klickitat watershed (Sharp et al. 2008). The program may also be used to provide harvest opportunities. The need for, and use of, artificial production to accelerate recolonization would be contingent upon the rate and extent that natural recolonization occurs in the upper watershed now that passage has been restored at Castile Falls. The decision to implement an artificial propagation program would likely imply that natural recolonization has been minimal and/or is occurring at an extremely slow rate.

Actions

- Monitor annual natural escapement of steelhead into the upper subbasin.
- Use Castile Fishway trap to collect biological data on *O. mykiss* migrating into the upper watershed, and to monitor trends in the genetic composition and diversity of the upper basin population.
- Explore need for a conservation hatchery program to accelerate recolonization of upper Klickitat watershed.

Strategy 5. Determine and minimize impacts of hatchery trout releases in the Klickitat subbasin.

The continued release of Goldendale Hatchery trout in the Little Klickitat River should be evaluated by WDFW, because of the potential for adverse interactions with naturally spawning steelhead that are known to escape above the falls. WDFW planting records for 2006 show 5,214 hatchery rainbow trout were released into the upper Little Klickitat River and 844 hatchery rainbow trout were released into Bird Creek, a tributary to Outlet Creek in the Glenwood Valley. Goldendale Hatchery rainbow trout have been cultured to be "fall spawners" to minimize genetic impacts. However competition, predation, disease, and harvest impacts should be evaluated.

Potential evaluations include investigating the use of triploid trout (sterile) releases into streams where steelhead directly reside, or where outplants can colonize downstream. Because of potential for negative interaction, the Yakama Nation releases only triploid hatchery trout in lakes for recreational fisheries within the reservation boundaries. At a minimum, mark all hatchery trout and require release of unmarked juveniles.

Actions

- Investigate impacts of WDFW hatchery trout plants into the Klickitat subbasin.

6.3 Freshwater Habitat Strategies and Actions

This plan proposes a strategy to protect and improve ecosystem functions and restore normative ecological processes. The components of the strategy are, first, to protect and maintain existing high quality and/or unimpaired habitats and ecosystem functions; and, second, to restore degraded habitat where appropriate, through passive and active measures.

- Protection and maintenance of existing high quality habitats is a broad, economical approach to species recovery. Many objectives are likely to be met through habitat protection and the associated natural recovery of upland and riparian areas. Protection and maintenance includes compliance with existing rules and regulations, such as the State Forest Practices Act, Klickitat County

Shorelines Master Plan and Critical Areas Ordinance, and other state and county regulations designed to protect aquatic habitat. Protection may also incorporate a wide range of voluntary actions such as fencing riparian areas, participation in the various agricultural land reserve programs, and voluntarily implementing programs that help to avoid impacts to aquatic resources. Land acquisitions, conservation easements, cooperative agreements, and protective land designations can also be used to facilitate high quality habitat protection.

- Restoration and enhancement of habitat conditions for salmon and steelhead populations should improve population production. The value of these actions to the viability of the population will depend on whether or not they address the factors currently limiting the population or threats associated with factors that are now, or are trending toward, becoming limiting, e.g. climate change. The success of these strategies is further enhanced when actions build from existing restoration efforts and incorporate a range of project types that address the many interrelated habitat impairments related to the limiting factors.

The overall strategy is further differentiated into the following types of action to address potential limiting factors and threats for Klickitat steelhead production: 1) protect stream corridor structure and function; 2) restore passage and connectivity between habitat areas; 3) restore floodplain function and channel migration processes; 4) restore riparian condition; 5) restore altered hydrographs to enhance instream flows during critical periods; and 6) restore degraded water quality, including water temperatures. Finally, more specific management actions are described.

Priority Geographic Areas

Geographical areas within the Klickitat subbasin that may have greater restoration value than others for the health and productivity of Klickitat steelhead were identified through three related efforts: the Northwest Power and Conservation Council's 2004 subbasin planning process; the Klickitat Lead Entity process performed under the Washington State Salmon Recovery Planning process SB2496; and Yakama Nation's 2005 and 2006 EDT model runs (unpublished), which incorporated major spawning areas.

- The purpose of the Northwest Power and Conservation Council's subbasin planning process was to "provide a basin-wide approach to developing locally informed fish and wildlife protection and restoration priorities," and to "bring people together in a collaborative setting to improve communication, reduce conflicts, address problems, and, wherever possible, reach consensus on biological objectives and strategies that will improve coordinated natural resource management on private and public lands." One of the subbasin goals, similar to the broad-sense goal proposed by the Yakama Nation for this recovery plan, was "to restore and maintain sustainable, naturally producing populations of spring Chinook and stelhead that support tribal and non-tribal harvest and economic practices while protecting the biological integrity and the genetic diversity of the subbasin."

The 2004 Klickitat Subbasin Plan ranked geographic areas based on analysis of EDT model outputs of environmental and survival attributes, and the potential benefit to population parameters that the model identified. Various EDT outputs, such as a reach analysis and a breakdown of relative importance of geographic areas for protection and restoration measures (both standard outputs as well as outputs normalized to correct for weighting of reach length), rank population performance parameters by individual life stage, as well as averaged across all life stages.

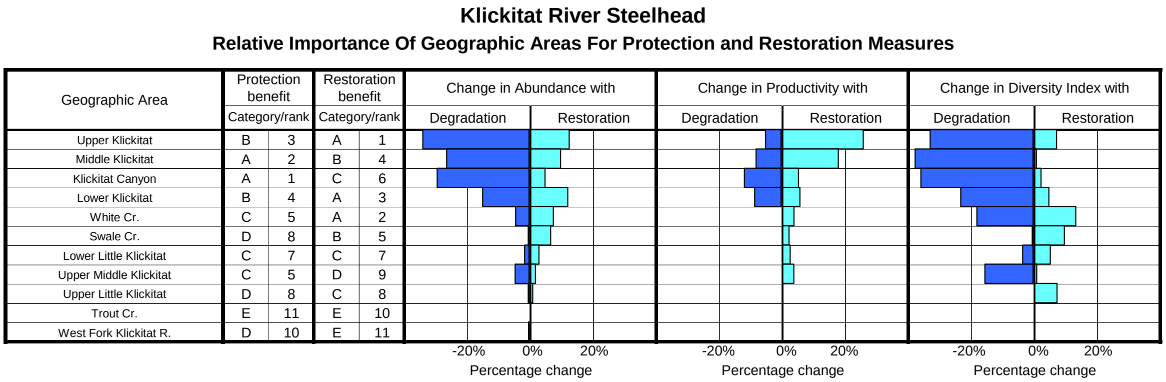
- The Klickitat Lead Entity's Citizens Committee also identified the equivalent of broad-sense goals and, with assistance of the Lead Entity's Technical Committee, identified and prioritized reaches with corresponding habitat and restoration actions for the purpose of prioritizing projects for grant funding and assisting with voluntary conservation efforts of priority basin fish species (steelhead, rainbow trout, mountain whitefish, Chinook salmon, bull trout, etc.). The Klickitat Lead Entity Strategy was developed for use by the Lead Entity Organization for non-regulatory purposes and has not been subject to peer review or other quality assurance processes appropriate for regulatory application of its contents (Klickitat Lead Entity, 2006, 2007, 2008). The Lead Entity Organization developed a matrix of priority areas considering community interests and used a mix of existing data from habitat assessments, fish distribution surveys, and spawning ground surveys, as well as knowledge of professionals familiar with the subbasin. Data sources included published reports from Yakama Nation Fisheries, WDFW, WDOE, consulting firms, as well as unpublished databases maintained by these agencies and professional judgment.

Identification of Potential Projects

Actions to address limiting factors in the Klickitat basin were identified using EDT modeling, other processes, and best professional judgment. The 2005 and 2006 EDT models were also used to identify primary limiting factors by life stage and reach and to rank the relative restoration and protection potential of the six major spawning areas and five minor spawning areas identified by Yakama Nation Fisheries in the Klickitat drainage (Figure 6-1). This information, as well as costs, quantitative and qualitative assessments of project time frames, implementability, time to implement, time to realize benefits and impact of those benefits on limiting factors and VSPs at 10 and 25 years out, were all fed into a custom-built relational database for prioritizing salmon recovery actions in the Klickitat subbasin. It is important to note that the accuracy of any modeling effort depends on the assumptions and information put into the model. This and other modeling will be revisited as more data are collected on habitat conditions in the basin through ongoing and proposed monitoring and research.

The delineations of the spawning areas identified by the Yakama Nation differ from those identified by the ICTRT in a few areas (see Appendix II, Table II-1). Nevertheless, findings from the EDT analysis were useful in developing the suite of freshwater habitat strategies and actions.

Figure 6-1. EDT Estimate of Relative Importance of Major and Minor Spawning Areas for Protection and Restoration Measures for Klickitat Steelhead (2005 YN EDT model analysis, unpublished data).



Freshwater habitat strategies and actions to improve the viability of the Klickitat steelhead population are described in Tables 6-1 through 6-6. The strategies address the key factors and threats potentially limiting population viability and are based on results from EDT analysis and other assessments, including the ICTRT's viability assessment for the populations. [3]

Primary freshwater actions identified for steelhead focus on restoring ecological functions in the watershed. These actions include: increasing floodplain channel and roughness, reconnecting side-channels, improving floodplain connectivity, relocating floodplain infrastructure and roads, improving maintenance, rehabilitating and decommissioning roads as appropriate, re-establishing and/or enhancing native vegetation within floodplain, implementing practices that leaves naturally occurring sources of large woody debris instream, and/or artificially introduce large debris or other structure. The tables also identify priority locations where implementation of actions under each strategy will reap the greatest benefits.

Results from Ecosystem Diagnosis and Treatment (EDT) modeling in 2005 by Yakama Nation Fisheries (unpublished) provide some indication of the change in steelhead production that might be expected to occur if all historical habitat areas above Castile Falls were fully seeded. The modeling effort measured intrinsic productivity, equilibrium abundance, and capacity of the system for steelhead within spawning locations defined by resource specialists. Two scenarios were developed: 1) full blockage, with Castile Falls completely blocking upstream fish passage — as was the case from the early 1960s until modifications were completed in 2005 — and 2) full passage, with 100 percent passage at Castile Falls and assuming that all habitat above it had been fully seeded with anadromous fish (currently passage is open, but the area is only beginning to be re-colonized, a process that might require years to fully take place unaided).

[3] Tables 6-1 through 6-6 were not developed through the Klickitat Lead Entity Strategy or the Lead Entity process.

Modeling results for the full blockage scenario suggest that the theoretical intrinsic productivity (current with harvest) of the system with no passage above Castile is 3.6, and equilibrium abundance is 1,064 steelhead. In contrast, under the full passage scenario, with 100 percent passage and habitat seeding above Castile, intrinsic productivity increased to 3.7 and equilibrium abundance to 1,628. The potential increase in capacity of fully opening habitat above Castile rose from 1,475 to 2,222 steelhead. These EDT projections, however, do not represent the return for any given year, but rather the potential return if the population is not limited by density-dependent factors, natural disasters or other mortality factors. The projections represent the potential for a population to recover when conditions improve. It is possible that some factors might be under- or overestimated. It is always necessary to adjust the results after comparing with actual observations, other data, and expert opinion.

Table 6-1. Strategy 1: Protect Stream Corridor Structure and Function.

Protect stream corridor structure and function					
Actions	**Limiting Factors Addressed**	**Threats Addressed**	**VSP Parameters Addressed**	**Life Stages Affected**	**Discussion**
a) Protect existing habitat from future degradation through conservation easements, acquisitions, reclassification of lands as natural areas, enforcement of land use regulations. b) Riparian forest management and planning: plan to leave buffer strips in riparian forest zones. c) Limit riparian livestock grazing. d) Assess effects of groundwater development on tributary flow. e) Manage diversions to maximize instream summer flows.	Many factors, including key habitat quantity, habitat diversity, sediment load, water quality, altered flow regimes, predation	Floodplain infrastructure; timber, agricultural and grazing practices; habitat fragmentation due to land development	Productivity, abundance, spatial structure	All	Protecting functioning floodplains and channels that are in balance with their ability to transport water and sediment is one of the highest priorities. All streams will have some level of erosion, because a stream channel is never static. Having some erosion is essential for recruitment of spawning gravel and other important ecological functions (such as distributing fine sediments needed for riparian plant growth). Existing quality habitat may be protected through land acquisition and/or conservation easements by WDFW or a land trust. WDNR parcels that are currently in State Lands in the upper Klickitat could be reclassified as Natural Areas. Protecting base stream flows from further appropriations is a very important function of protecting existing high quality habitats.
Priority Locations (geographic areas)					
Mainstem Klickitat and throughout MaSA watersheds. Highest priorities: Klickitat River from RM 70.5 to RM 87.05, Piscoe Creek, Diamond Fork, Butte Meadows Creek, Chaparral Creek.					

Table 6-2. Strategy 2: Restore Passage and Connectivity between Habitat Areas.

Restore passage and connectivity between habitat areas					
Actions	**Limiting Factors Addressed**	**Threats Addressed**	**VSP Parameters Addressed**	**Life Stages Affected**	**Discussion**
a) Replace culverts. b) Monitor effectiveness of passage improvements at Castile Falls. c) Improve passage at Lyle Falls. d) Study passage at mouths of spawning tributaries relative to flow and alluvial fan morphology. e) Monitor and continue restoration efforts in Snyder Creek mill reach (flume passage improvements and riparian re-vegetation.) f) Determine extent of problem for inadequately screened intakes. g) Ensure that pump intakes are adequately screened.	Passage obstructions, altered flow regimes, key habitat quantity, water withdrawals	Inundation by Bonneville Pool, undersized/ inadequate culverts, irrigation diversions, instream structures, past riparian logging and stream cleaning, floodplain infrastructure, insufficient flow at tributary mouths	Spatial structure, abundance, productivity	All, particularly adults and age 0-2 juveniles	Partial-barrier culverts exist near the mouth and upstream on Piscoe Creek, near the mouth of McCreedy Creek, and on some Little Klickitat tributaries (numerous), on White Creek and its tributaries limiting upstream movement of juveniles from rearing habitat to perennial refugia. Passage at mouths of some tributaries restricts access to spawning areas due to alterations in flow and alluvial fan morphology (research is needed). Steelhead and spring Chinook are expected to begin re-colonizing spawning and rearing habitat above Castile Falls now that passage has been improved; monitoring of effectiveness of passage improvements is needed. Disconnecting roads can improve watershed and water retention.

Restore passage and connectivity between habitat areas					
Actions	**Limiting Factors Addressed**	**Threats Addressed**	**VSP Parameters Addressed**	**Life Stages Affected**	**Discussion**
Priority Locations (geographic areas)					
Piscoe Creek, McCreedy Creek, White Creek and tributaries, Little Klickitat tributaries, upper Klickitat mainstem, West Fork Klickitat, Trout Creek. Highest priorities: Castile Falls and culverts on several tributary streams					

Table 6-3. Strategy 3: Restore Floodplain Function and Channel Migration Processes.

Restore floodplain function and channel migration processes					
Actions	**Limiting Factors Addressed**	**Threats Addressed**	**VSP Parameters Addressed**	**Life Stages Affected**	**Discussion**
a) Place LWD or other structures to stop headcutting. b) Restore stream length. c) Restore cross-sectional morphology and roughness. d) Augment gravel. e) Increase pool quantity and quality; pool: riffle ratio. f) Improve pool cover and hiding refugia. g) Restore floodplain and side-channel connectivity. h) Increase floodplain and channel roughness. i) Re-vegetate riparian areas. j) Relocate/ soften floodplain infrastructure. Modify historical railroad grade. k) Disconnect roads from stream network to improve watershed and water retention. l) Improve surface and drainage characteristics of roads in tributary watersheds. m) Perforate roads to allow peak flows to move onto floodplain. n) Relocate/ abandon mid-slope roads where possible; relocate/abandon valley-bottom roads where possible. o) Close/relocate ORV trails. p) Limit riparian livestock grazing. q) Investigate off-channel livestock watering. r) Promote no-till cropping and riparian buffers in agricultural areas, s) Modify land-uses and/or implement structures to retain storm flow and decrease time of concentration from watershed upstream of canyon (Swale Creek).	Habitat diversity, key habitat quantity, sediment load, altered flow regimes, altered food web, water temperature, predation	Hydroconfinement; floodplain infrastructure; timber and grazing management activities; habitat fragmentation due to subdivision, land-clearing and development	Productivity, abundance, spatial structure	All	There has been a loss of off-channel and side-channel habitats that once provided habitat for spawning and rearing, and refugia from high flows. Instream structures can improve channel stability, trap sediments and raise the stream bed so that the stream can more effectively interact with the floodplain. Typical structures include debris jams, rootwads, boulder clusters, whole trees, and rock weirs where appropriate. Any restoration actions will be ineffectual unless floodplain clearing and grading can be restricted, regulated or eliminated.

Restore floodplain function and channel migration processes					
Actions	**Limiting Factors Addressed**	**Threats Addressed**	**VSP Parameters Addressed**	**Life Stages Affected**	**Discussion**
Priority Locations (geographic areas)					
Highest priorities: Chaparral Creek, Coyote Creek, McCreedy Creek, Butte Meadows Creek, Klickitat R. from Castle Falls (RM 65.75) to RM 87.05, upper Diamond Fork					

Table 6-4 Strategy 4: Restore Riparian Condition.

Restore riparian function and condition.					
Actions	**Limiting Factors Addressed**	**Threats Addressed**	**VSP Parameters Addressed**	**Life Stages Affected**	**Discussion**
a) Re-vegetate riparian areas. b) Limit riparian livestock grazing. c) Monitor and continue restoration efforts in Snyder Creek mill reach (flume passage improvements and riparian re-vegetation.) d) Investigate off-channel livestock watering. e) Control/eradicate noxious invasive plant species from priority habitats..	Habitat diversity, key habitat quantity, sediment load, altered flow regimes, altered food web, water temperature	Floodplain infrastructure; timber and grazing management activities; habitat fragmentation due to subdivision; channel incision	Productivity, abundance, spatial structure	All	Primary methods of riparian enhancement include riparian corridor fences to exclude livestock, changes in grazing management that promote riparian recovery, and planting of native vegetation. The ecological effects of restoration actions include increased floodplain roughness, bank stability, nutrients and recruitment opportunity for future large wood.
Priority Locations (geographic areas)					
Trout Creek, Upper Little Klickitat, Lower Little Klickitat, Klickitat Canyon, Swale Creek, Lower Klickitat, Middle Klickitat, White Creek, Upper Klickitat. Highest priorities: Chaparral Creek, McCreedy Creek, Piscoe, Diamond Fork, Coyote, Butte Meadows, Klickitat R. from Castile Falls (RM 65.75) to RM 87.05					

Table 6-5. Strategy 5: Restore Altered Hydrographs to Enhance Instream Flows during Critical Periods.

Enhance instream flow during critical periods.					
Actions	**Limiting Factors Addressed**	**Threats Addressed**	**VSP Parameters Addressed**	**Life Stages Affected**	**Discussion**
a) Obtain instream flow right for mainstem Klickitat. b) Restore floodplain connectivity in tributaries. c) Assess effects of groundwater development on tributary flow. d) Manage diversions to maximize instream summer flows. e) Re-introduce beaver.	Habitat diversity, key habitat quantity, sediment load, altered flow regimes, water temperature, water withdrawals	Floodplain infrastructure; road, timber, agricultural and grazing management activities; hydroconfinement; water withdrawals, beaver removal	Abundance, productivity, spatial structure	All, particularly 0-1 age life stages	Hydrologic routing in watershed has been modified, and flow timing, discharge, distribution of LWD and sediment altered. Shortened flow paths for storm flow, changes associated with reduced canopy interception, and changes in the upland plant community due to land management have reduced precipitation infiltration rates, resulting in higher peak flows and lower base flows. Removal of large wood, reduced ability for large wood recruitment and

Enhance instream flow during critical periods.					
					incision in streams also increases water velocities and reduces the ability of the stream to hold water for gradual release.
Priority Locations (geographic areas)					
Lower Klickitat, Middle Klickitat, Lower Little Klickitat, Upper Little Klickitat, White Creek, Trout Creek, Swale Creek Highest priorities: streams in the lower and middle Klickitat watersheds, including Knight Canyon, Dillacort, Wheeler, upper Canyon, Beeks Canyon, and Dead Canyon creeks, and portions of White Creek.					

Table 6-6. Strategy 6: Restore Degraded Water Quality, including Water Temperatures.

Restore degraded water quality, including water temperatures.					
Actions	**Limiting Factors Addressed**	**Threats Addressed**	**VSP Parameters Addressed**	**Life Stages Affected**	**Discussion**
See actions for Strategy 3. a) Short-term fertilization of stream with carcasses or carcass analogs. b) Improve road drainage characteristics and surfacing. c) Re-vegetate riparian areas to reduce stream temperatures. d) Conduct pathogen sampling and monitoring. e) Investigate off-channel livestock watering f) Assess nutrient and dissolved oxygen levels in the Little Klickitat River, particularly downstream of Goldendale.	Sediment load, altered flow regimes, water temperature, water quality, altered food web, pathogens	Road, timber and grazing management activities, particularly in riparian areas; incision	Abundance, productivity, spatial structure	All life stages	Riparian vegetation is limited in many parts of the drainage. Roads and other infrastructure have altered floodplain, confined river and tributaries and contribute fine sediment to stream channel. Loss of LWD and other structure limits availability of pools and other thermal refugia. Reduced sediment inputs will increase aquatic insect production for food. Carcasses will provide temporary food source for juveniles.
Priority Locations (geographic areas)					
Highest priorities: Klickitat River from RM 70.5 to RM 87.05, Chaparral Creek, Diamond Fk., Piscoe Creek					

6.4 Harvest-Related Strategies and Actions

WDFW will continue to manage Klickitat tributary sport fisheries for selective fisheries that target marked hatchery summer steelhead. Tributary fisheries will be managed under a Fisheries Management and Evaluation Plan for Middle Columbia River steelhead submitted to NMFS by WDFW, which is currently going through NMFS review. Columbia River mainstem harvest of steelhead will continue to be managed through the *U.S. v. Oregon* process, and will be subject to consultations with NMFS. Enhanced public education and fisheries enforcement will be incorporated along with new selective fisheries regulations to ensure understanding and compliance.

Treaty Native American fishing rights in the Columbia basin are under the continuing jurisdiction of the U.S. District Court for the District of Oregon in the case of *United States v. Oregon*, No. 68-513 (filed in 1968). The parties to *U.S. v. Oregon* are the United States acting through the Department of Interior (USFWS and Bureau of Indian Affairs) and Department of Commerce (NMFS), the Warm Springs, Umatilla, Nez Perce, Yakama, and Shoshone-Bannock Tribes, and the states of Oregon, Washington, and Idaho. In *U.S. v. Oregon*, the Court affirmed that the treaties reserved for the tribes 50 percent of the harvestable surplus of fish destined to pass through their usual and accustomed fishing areas.

Starting in 1977, tribal and state fisheries subject to *U.S. v. Oregon* have been regulated pursuant to a series of court orders reflecting court-approved settlement agreements among the parties. The last long-term agreement, known as the Columbia River Fishery Management Plan (CRFMP) was adopted and approved by the Court in 1988 and expired in 1999. Since 1999, Columbia River mainstem fisheries have been managed via short term settlement agreements adopted by the Court. Artificial propagation programs upstream of Bonneville Dam have also been incorporated into these agreements, because of their importance to providing fish for harvest. Harvest plans for tributary fisheries are developed cooperatively by the management entities with primary management responsibility in the respective subbasin. A new *U.S. v Oregon* Management Agreement has been completed and NMFS has completed a Section 7 Biological Opinion addressing the impacts of the fisheries management action and hatchery production in the new agreement (https://pcts.nmfs.noaa.gov/pls/pcts-pub/biop_results_detail?reg_inclause_in=('NWR')&idin=107547). The new management agreement will cover Columbia River fisheries management and hatchery production actions for the period from 2008 to 2017.

During the last 10-15 years, harvest has been managed pursuant to the CRFMP and successor agreements that contain restraints on the fisheries necessitated by ESA listings. The agreements quantify and allocate harvest between tribal and non-tribal fishing subject to ESA-imposed constraints for listed species. The current *U.S. v. Oregon* harvest constraint for steelhead is set to protect Group “B” index fish returning to Idaho with impacts from Non-Native American fisheries limited to 2 percent and tribal fisheries to 15 percent. Group “A” index fish (including those returning to the Klickitat River) are affected by tribal fisheries at a substantially lower rate than Group “B” index fish. The new agreement sets an impact limit on naturally produced Mid-Columbia River steelhead of no more than 2 percent in non-treaty fisheries but does not set a limit for treaty fisheries. However, NMFS expects impacts from the treaty fisheries to continue to be in the range observed since 1998, averaging around 6.64 percent.

In 2002, WDFW instituted a sport fishing rule change for the Klickitat River proposed by the Yakama Nation. The rule change closed fishing for rainbow trout in lower subbasin tributaries of the Klickitat River (Swale, Wheeler, and Snyder Creek). The purpose was to protect rearing steelhead juveniles from take and harassment.

Strategy 1. Study and limit impacts of harvest practices on Klickitat steelhead population.

Enforcement of sport and tribal fishing regulations and control of illegal fishing on and off the reservation is a priority. Poaching and harassment of steelhead in the Klickitat subbasin occurs at an unknown rate.

Actions

- Enforce tribal and sport regulations to eliminate illegal harvest.

6.5 Mainstem Columbia Hydrosystem and Estuary -- Strategies and Actions

The plan for current mainstem hydro operations, as summarized in the Hydro Module (NMFS 2008c), and any further improvements for fish survival that may result from the ongoing Federal Columbia River Power System (FCRPS) collaborative process, represent the hydropower recovery strategy for all listed salmonids that migrate through the mainstem Columbia River, including the Middle Columbia steelhead populations.

The Hydro Module summarizes the general effects of Columbia River mainstem hydropower projects on all 13 ESA-listed salmonids in the Columbia basin, including the limiting factors and threats and expected actions (including site-specific management actions), or strategy options, to address those threats. This module is a synthesis of information that has undergone public processes for review, including, but not limited to, the Federal Columbia River Power System (FCRPS) 2008 Biological Opinion (NMFS 2008b), Federal Energy Regulatory Commission (FERC) licensing proceedings, and Habitat Conservation Plans (HCPs). It may be updated as additional information becomes available.

The Reasonable and Prudent Alternative (RPA) for the FCRPS (2008b) takes a comprehensive approach to ESA protection that includes hydro, habitat, hatchery, harvest and predation measures to address the biological needs of salmon and steelhead in every life stage. The RPA is the product of the collaboration between NMFS and the Action Agencies ordered by the court. It is based on a comprehensive analysis of the salmon life cycle conducted down to the level of the populations that make up the listed species. Section 8.8 and the "Reasonable and Prudent Alternative Table" in the 2008 FCRPS

Biological Opinion describe actions that should positively affect Middle Columbia River steelhead.

The current plan for operation of the FCRPS through 2018 (NMFS 2008a) contains the following actions intended to address the needs for survival and recovery of ESA-listed salmon and steelhead:

- Continue adult fish passage operations that have resulted in improved survival.
- Improve juvenile fish passage: install removable spillway weirs or similar surface bypass devices at John Day and McNary dams, an extended tailrace spill wall at The Dalles Dam, and various modifications at Bonneville Dam. Passage for steelhead smolts at each of the four Lower Columbia River mainstem projects must reach 96 percent survival.
- Continue and enhance spill for juvenile fish passage.
- Continue reservoir operations and river flows to benefit spring migrating juveniles.
- Develop dry water year operations to better protect migrating juveniles.
- Develop and implement a kelt management plan.

The Estuary Module, which NMFS prepared in collaboration with the Lower Columbia Estuary Partnership (NMFS 2007), focuses on habitat in the lower Columbia River below Bonneville Dam and how that habitat affects the survival of ESA-listed chum, steelhead, Chinook, and coho from throughout the Columbia River basin. It identifies and prioritizes limiting factors and threats in the estuary, then identifies 23 broad actions whose implementation would reduce the threats and thus increase survival of salmon and steelhead during their time in the estuary. The module also estimates the cost of implementing each action over a 25-year period. A description of monitoring, research, and evaluation needs that are appropriate to the management actions is included as an appendix to the module.

6.6 Potential Effects of Proposed Recovery Actions

This section presents an analysis of the potential effects of proposed recovery actions on the abundance and productivity of the Klickitat population of Middle Columbia River steelhead, based on the 2005 and 2006 EDT modeling done by Yakama Nation Fisheries (unpublished). Estimated levels of effectiveness for the proposed actions were generated and used as inputs into quantitative models to project the potential impacts of those changes on the population. This quantitative analysis provides an opportunity to evaluate the efficacy of proposed recovery strategies in light of current knowledge regarding population functioning, including relationships with habitat conditions. Equally important, the quantitative models used in the assessment provide a framework for productively targeting evaluation efforts as well as for revisiting key assumptions in the future as more information becomes available (e.g., from monitoring responses to initial implementation or from evaluation efforts targeting key uncertainties).

The analysis was performed sequentially, first by projecting effects for tributary habitat actions alone, then sequentially adding in hatchery, hydro, predation, estuary, and harvest actions. The results at each step provide a means for comparing estimated relative benefits of the proposed suites of actions, and, finally, the potential benefit of all the proposed actions to the Klickitat steelhead population.

Two models were used: Ecosystem Diagnosis and Treatment (EDT) and the All-H-Analyzer (AHA). The EDT model has commonly been used in regional planning efforts to evaluate potential responses to tributary habitat restoration efforts. The EDT model uses derived relationships between habitat characteristics and fish survival to calculate changes in survival, abundance, and productivity that could result from changes in the habitat. Use of the EDT model requires a set of inputs that describe current habitat conditions and the expected changes in habitat conditions that would result from a proposed action scenario. This model could be used, for example, to calculate the improvement that would be expected from a 10 percent drop in water temperature during the period of egg incubation in a certain tributary reach. The AHA model encompasses prospective relationships between all the "H" factors: habitat, hatcheries, hydro, and harvest. Thus, the results of the EDT model become one set of information fed into the AHA model to produce an estimate of the benefits of all the proposed actions.

It is important to note that the modeling results relative to recovery criteria are a function of the input information and key assumptions associated with the translation of actions into habitat changes, habitat and life-stage survival relationships, and population dynamics. Although the modeling provides valuable insight into the potential responses to recovery actions, the estimated potential responses are dependent on the assumptions and information put into the models.

Abundance and productivity are projected to increase for all scenario combinations analyzed for Klickitat River steelhead (Table 6-7; note that performance values in the table are direct output from EDT/AHA). The largest contribution to performance improvements results from the combination of tributary habitat actions throughout the basin and recolonization of the upper watershed (recolonization of the upper watershed is possible because of passage improvements at Castile Falls). In contrast, relatively small increases are attributable to mainstem actions.

Table 6-7 shows estimated population performance (productivity and abundance) of Klickitat River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly from EDT/AHA and were not converted to ICTRT-equivalent performance values (the ICTRT was unable to empirically estimate baseline performance measures for this population because of a lack of data). Results are shown with and without recolonization of the upper watershed. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario.

Table 6-7. Estimated Productivity and Abundance of Klickitat River Steelhead Associated with Combinations of all Priority Tributary and Out-of-Subbasin Actions.

Performance period	Scenario combination	Performance metric			
		Productivity		Abundance	
		Actions without recolonization of upper watershed	Actions with recolonization of upper watershed	Actions without recolonization of upper watershed	Actions with recolonization of upper watershed
Base		1.77		939	
Base-Current		1.92	1.92	1,118	1,118
Current-Prospective	Habitat	2.12	2.38	1,319	2,320
	Hydro	2.24	2.50	1,468	2,572
	Predation	2.29	2.56	1,538	2,692
	Estuary	2.36	2.62	1,630	2,850
	Harvest	2.36	2.62	1,630	2,850
	Ocean ±25%	2.01-2.64	2.27-2.90	1,181-2,026	2,088-3,539

This is a rough estimate, given the current data gaps and uncertainties, useful simply as an indication that if recovery actions are implemented, the population is likely to trend toward viable status. As we learn more about this population, implement proposed actions, and improve modeling methods, the analysis will be refined.

7. Implementation and Preliminary Cost Estimates

NMFS recognizes that there are significant uncertainties about the underlying biology and the best approaches to improving conditions for steelhead. NMFS is committed to an ongoing effort to address these uncertainties and work through associated disagreements over management approaches as part of implementing this recovery plan. This will require rigorous application of an adaptive management process that identifies key uncertainties, proposes competing hypotheses, and uses recovery actions and appropriate research and monitoring to test these hypotheses and adjust management accordingly.

Implementation of this plan depends on the voluntary actions and cooperation of local entities and citizen groups. An important part of implementation will be working cooperatively to develop a detailed research, monitoring, and evaluation plan addressing the additional information needs described in Chapter 8. It will be essential that a collaborative implementation structure be set up to improve communication and work on a shared sense of priorities.

7.1 Implementation

NMFS has worked independently with the Yakama Nation, Washington Department of Fish and Wildlife, Klickitat County, and other local entities to develop the recovery plan for the Klickitat steelhead population. NMFS encourages the formation of a planning group for the Washington Gorge Management Unit, a forum or entity that would take responsibility for coordinating implementation of the plan. Implementing the proposed recovery actions for steelhead in the Washington Gorge Management Unit, including the Klickitat subbasin, would be a primary task for a Washington Gorge Area Regional Board, subject to concurrence by state, tribal and local governments and the opportunity for involvement and comment by the public.

The Washington Gorge Area Regional Board could consist of representatives from Klickitat, Yakima and Benton counties, local landowners, and the Yakama Nation. The Board could also provide an opportunity for coordination with the Lower Columbia River Fish Recovery Board (LCFRB), since the Washington Gorge Management Unit includes both the Middle Columbia River Steelhead DPS and the Willamette/Lower Columbia ESUs for Chinook, coho, and chum ESA-listed populations, which are covered by the LCFRB.

The Washington Gorge Area Regional Board could use the considerations identified in Chapter 6 to prioritize recovery actions in the Klickitat subbasin and other areas within the Washington Gorge Management Unit to respond to the interests identified by various stakeholders in the area.

The prioritization of projects for funding should be based on a balance between the biological benefit of the project, its cost, and feasibility of implementation. Projects that

address primary limiting factors, have high biological benefit, are relatively inexpensive, and are feasible should receive highest funding priority. Projects that have high cost, low biological benefit to listed fish species, and relatively low feasibility should receive lowest funding priority.
Funding sources for salmon and steelhead recovery actions in the Columbia Basin are varied. They include:

- Pacific Coastal Salmon Recovery Fund (PCSRF) (states and tribes)
- Salmon Recovery Funding Board (SRFB) (a combination of PCSRF and Washington State funds)
- Columbia Basin Fish Accords
- Congressional appropriations (Federal agencies)
- State appropriations (state agencies)
- Northwest Power and Conservation Council Fish and Wildlife Program (states and tribes)
- Federal / state grants
- Non-profit organization programs and grants

The 2008 Columbia River Fish Accords Memorandum of Agreement (MOA) between the Three Treaty Tribes and FCRPS Action Agencies (Columbia Basin Accords 2008) identifies funds for hatchery planning and operations and maintenance covering some of the existing and expanded activities in the Klickitat River basin. The MOA identifies hatchery capital funds for the design and construction of the hatchery and passage facilities in the Klickitat River basin except the Wahkiacus Hatchery facility, and includes language that states that the Action Agencies will work toward finding funding for this facility.

7.2 Preliminary Cost Estimates

Preliminary cost estimates are provided for the three major categories of strategies and actions: RM&E, hatcheries, and habitat. The highest priority strategies for the Klickitat basin address data gaps (see Section 6-1). As such, these priority strategies fall into the category of research, monitoring, and evaluation. The costs associated with these efforts are detailed in Chapter 8. Table 8-1 estimates the cost of ongoing and expanded RM&E activities to be up to $4,484,402 for years 1 through 3, and up to $15,142,783 for years 4 through 10. Information gained through filling the priority data gaps will help to refine the actions needed to reach recovery.

Costs for actions to address hatchery-related effects are distributed among research, monitoring and evaluation, detailed in Chapter 8, and capital costs and operations and maintenance costs that have been included in programs proposed under the NPCC Fish and Wildlife Program or are ongoing under that program or the Mitchell Act administered by NMFS. Capital costs for hatchery and fish passage improvements are shown in Table 7-1, which is drawn from the Klickitat River Anadromous Fisheries Master Plan. The plan was submitted by the Yakama Nation to the NPCC to fulfill the requirements for step one of a three-step process for the approval of major projects

(Sharp et al. 2008). The costs are estimated based on the current status of the design and may change as the design is finalized. Since these operations and maintenance costs are ongoing, they were not included in the future costs of recovery actions (Plummer 2006).

Table 7-1 Klickitat Subbasin capital construction costs estimates in FY07 dollars (Sharp et al. 2008).

Description	Estimated Cost
Lyle Falls Fishway Passage Improvements and R, M&E Station	$5,750,000
Castile Falls Enumeration Facility	$1,149,000
Klickitat Hatchery Infrastructure Upgrades with Reform Measures[4]	$16,100,000
McCreedy Creek Steelhead (Conservation) Acclimation Site	$234,000
Wahkiacus Hatchery & Acclimation Facility Construction[5]	$18,400,000
TOTAL	*$41,633,000*

Habitat recovery actions, estimated costs, and time frames based on current information are listed in Table 7-2. The cost estimates are based on a number of efforts: the recommendations and priorities from the NPCC subbasin planning process; expert opinion of resource professionals working in the watershed; local knowledge; current cost estimates of YN project dollars (e.g., Klickitat Watershed Enhancement Project activities); and land values derived in conjunction with the Columbia Land Trust. It should be noted that the habitat cost estimates below are for Yakama Nation-defined MaSAs. For correlation with the ICTRT-defined MaSAs, see Appendix II, Table II-1.

The total estimated cost for completing all of the habitat projects identified inTable 7-2 is estimated to be up to $129,451,630 ($25,890,326.00 for years 1-10, and $103,561,304.00 for years 11-50). Estimates are expressed in 2007 dollars. Estimated costs are general range summaries arranged to align with the Klickitat River Anadromous Fisheries Master Plan (Sharp et al. 2008) and Yakima/Klickitat Fisheries Project.

The actions listed in Table 7-2 do not include or account for out-of-subbasin effects or future degradation or damage to the watershed.

[4] In July 2009, BPA initiated the EIS process for the Klickitat Hatchery Program and Step III of the Klickitat River Anadromous Fisheries Master Plan, with an anticipated final EIS document in early 2011.

[5] Fish Accord Agreement language states that the Action Agencies will work toward finding funding for the Wahkiacus Hatchery Facility (Columbia Basin Accord 2008, Attachment B).

Table 7-2. Habitat actions and costs for Klickitat steelhead by Major and Minor Spawning Areas.

MaSA	Type/Subtype[a]	Unit[a]	# Units	Cost / Unit	Cost
Upper Klickitat MaSA	Fish Passage - Culvert Replacement	# of installations	7	$100,000	$700,000
	Instream - Streambank Stabilization	length treated in miles	2	$100,000	$200,000
	Instream - Channel Connectivity	length treated in miles	12	$65,000	$780,000
	Instream - Channel reconfiguration (includes channel roughening)	length treated in miles	4	$475,200	$1,900,800
	Instream - Deflectors/ barbs	length treated in miles	1	$35,000	$35,000
	Instream - Off channel habitat	length treated in miles	1	$105,600	$105,600
	Instream - Spawning Gravel Placement	length treated in miles	1	$90,000	$90,000
	Instream - Log (control) weirs	# of structures	10	$2,500	$25,000
	Instream - Rock (control) weir	# of structures	14	$2,500	$35,000
	Instream - Large Woody Debris	# of structures	20	$1,000	$20,000
	Instream - Structure/ Log Jam	# of structures	125	$15,000	$1,875,000
	Instream - Beaver Introduction	# of beavers introduced	20	$350	$7,000
	Riparian - Livestock Water Development	# of installations	3	$6,000	$18,000
	Riparian - Water Gap Development	# of installations	0	$1,200	$0
	Riparian - Fencing	miles	25	$10,000	$250,000
	Riparian - Planting	species; area treated (acres)	200	$2,000	$400,000
	Riparian - Weed Control	species; area treated (acres)	200	$1,000	$200,000
	Sediment Reduction - Road Reconstruction	miles			
	Sediment Reduction - Road Relocation	miles	8	$120,000	$960,000
	Sediment Reduction - Road Stream Crossing Improvements (=Rocked Ford)	miles	4	$1,800	$7,200
	Sediment Reduction - Road Drainage System Improvements	miles	60	$6,000	$360,000
	Sediment Reduction - Road Obliteration	miles	1	$7,000	$7,000

MaSA	Type/Subtype[a]	Unit[a]	# Units	Cost / Unit	Cost
	Sediment Reduction - Erosion Control Structures	# of erosion structures	15	$1,400	$21,000
	Sediment Reduction - Sediment Traps and Upland Erosion Control (sediment control basins, windbreaks, planting, conservation land management)	# of erosion structures	60	$600	$36,000
	Upland- Agriculture - Fencing	miles	2	$8,800	$17,600
	Upland- Agriculture - Water Development	# of installations	3	$2,400	$7,200
	Upland- Vegetation - Planting	area treated (acres)	35	$2,000	$70,000
	Upland- Vegetation - Invasive Plant Control	area treated (acres)	20	$250	$5,000
	Upland- Vegetation - Slope Stabilization	area treated (acres)	80	$180	$14,400
	Land Protected, Acquired, or Leased - Streambank Protected	miles	4	$320,000	$1,280,000
	Nutrient Enrichment - Carcass Analog	area treated (acres)	10	$4,000	$40,000
	Nutrient Enrichment - Carcass Placement	area treated (acres)			
	Project maintenance - Site Maintenance	miles	12	$4,000	$48,000
					$9,514,800
	Fish Passage - Culvert Replacement	# of installations	9	$100,000	$900,000
	Instream - Channel reconfiguration (includes channel roughening)	length treated in miles	14	$475,200	$6,652,800
	Instream - Spawning Gravel Placement	length treated in miles	5	$90,000	$450,000
	Instream - Large Woody Debris	# of structures	150	$1,000	$150,000
	Instream - Structure/ Log Jam	# of structures	150	$15,000	$2,250,000
	Instream - Beaver Introduction	# of beavers introduced	10	$350	$3,500
White Creek MaSA	Riparian - Water Gap Development	# of installations	3	$1,200	$3,600
	Riparian - Fencing	miles	6.5	$10,000	$65,000
	Riparian - Planting	species; area treated (acres)	400	$2,000	$800,000
	Riparian - Weed Control	species; area treated (acres)	2	$1,000	$2,000
	Sediment Reduction - Road Reconstruction	miles	4	$8,000	$32,000
	Sediment Reduction - Road Relocation	miles	12	$60,000	$720,000

MaSA	Type/Subtype[a]	Unit[a]	# Units	Cost / Unit	Cost
	Sediment Reduction - Road Stream Crossing Improvements (=Rocked Ford)	miles	0.1	$950,400	$95,040
	Sediment Reduction - Road Drainage System Improvements	miles	50	$6,000	$300,000
	Sediment Reduction - Road Obliteration	miles	5	$7,000	$35,000
	Sediment Reduction - Erosion Control Structures	# of erosion structures	50	$1,400	$70,000
	Sediment Reduction - Sediment Traps and Upland Erosion Control (sediment control basins, windbreaks, planting, conservation land management)	# of erosion structures	40	$600	$24,000
	Upland- Vegetation - Invasive Plant Control	area treated (acres)	40	$250	$10,000
	Land Protected, Acquired, or Leased - Streambank Protected	miles	2	$160,000	$320,000
	Nutrient Enrichment - Carcass Analog	area treated (acres)	15	$4,000	$60,000
	Project maintenance - Site Maintenance	miles	14	$4,000	$56,000
					$12,998,940
Middle Klickitat MaSA	Fish Passage - Culvert Replacement	# of installations	1	$250,000	$250,000
	Instream - Channel Connectivity	length treated in miles	4.5	$475,200	$2,138,400
	Instream - Off channel habitat	length treated in miles	2.5	$422,400	$1,056,000
	Instream - Spawning Gravel Placement	length treated in miles	1	$90,000	$90,000
	Instream – Large Woody Debris	# of structures	25	$1,000	$25,000
	Instream - Structure/ Log Jam	# of structures	45	$35,000	$1,575,000
	Riparian - Fencing	miles	2	$10,000	$20,000
	Riparian - Planting	species; area treated (acres)	110	$5,000	$550,000
	Riparian - Weed Control	species; area treated (acres)	30	$1,600	$48,000
	Sediment Reduction - Road Stream Crossing Improvements (=Rocked Ford)	miles	0.05	$950,400	$47,520
	Sediment Reduction - Road Drainage System Improvements	miles	15	$6,000	$90,000

MaSA	Type/Subtype[a]	Unit[a]	# Units	Cost / Unit	Cost
	Sediment Reduction - Road Obliteration	miles	13	$80,000	$1,040,000
	Sediment Reduction - Erosion Control Structures	# of erosion structures	60	$1,400	$84,000
	Sediment Reduction - Sediment Traps and Upland Erosion Control (sediment control basins, windbreaks, planting, conservation land management)	# of erosion structures	35	$600	$21,000
	Upland- Vegetation - Planting	area treated (acres)	1280	$450	$576,000
	Upland- Vegetation - Invasive Plant Control	area treated (acres)	20	$1,600	$32,000
	Upland- Vegetation - Slope Stabilization	area treated (acres)	10	$1,800	$18,000
	Land Protected, Acquired, or Leased - Streambank Protected	miles	2	$640,000	$1,280,000
	Project maintenance - Site Maintenance	miles	15	$8,000	$120,000
					$9,060,920
Lower Klickitat MaSA	Fish Passage - Culvert Replacement	# of installations	1	$350,000	$350,000
	Instream - Channel Connectivity	length treated in miles	0.9	$844,800	$760,320
	Instream - Channel reconfiguration (includes channel roughening)	length treated in miles	2	$1,161,600	$2,323,200
	Instream - Deflectors/ barbs	length treated in miles	35	$35,000	$1,225,000
	Instream - Off channel habitat	length treated in miles	0.4	$1,161,600	$464,640
	Instream - Spawning Gravel Placement	length treated in miles	2.5	$90,000	$225,000
	Instream - Log (control) weirs	# of structures	10	$2,500	$25,000
	Instream - Rock (control) weir	# of structures	8	$2,500	$20,000
	Instream - Structure/ Log Jam	# of structures	25	$45,000	$1,125,000
	Riparian - Water Gap Development	# of installations	4	$1,200	$4,800
	Riparian - Planting	species; area treated (acres)	320	$4,500	$1,440,000
	Riparian - Weed Control	species; area treated (acres)	80	$1,600	$128,000
	Sediment Reduction - Road Drainage System Improvements	miles	15	$4,200	$63,000

MaSA	Type/Subtype[a]	Unit[a]	# Units	Cost / Unit	Cost
	Sediment Reduction - Road Obliteration	miles	3.5	$60,000	$210,000
	Sediment Reduction - Erosion Control Structures	# of erosion structures	15	$1,400	$21,000
	Sediment Reduction - Sediment Traps and Upland Erosion Control (sediment control basins, windbreaks, planting, conservation land management)	# of erosion structures	35	$600	$21,000
	Upland- Vegetation - Invasive Plant Control	area treated (acres)	120	$1,600	$192,000
	Land Protected, Acquired, or Leased - Streambank Protected	miles	4	$800,000	$3,200,000
	Project maintenance - Site Maintenance	miles		$4,000	
					$11,797,960
Swale Creek MiSA	Instream- Wetland - Wetland Restoration	area treated (acres)	3200	$5,000	$16,000,000
	Instream - Channel Connectivity	length treated in miles	1.2	$475,200	$570,240
	Instream - Channel reconfiguration (includes channel roughening)	length treated in miles	17	$950,400	$16,156,800
	Instream - Spawning Gravel Placement	length treated in miles	8.5	$90,000	$765,000
	Instream - Structure/ Log Jam	# of structures	55	$15,000	$825,000
	Instream - Beaver Introduction	# of beavers introduced	10	$350	$3,500
	Riparian - Planting	species; area treated (acres)	250	$2,000	$500,000
	Riparian - Weed Control	species; area treated (acres)	250	$1,600	$400,000
	Sediment Reduction - Road Drainage System Improvements	miles	4	$2,200	$8,800
	Sediment Reduction - Road Obliteration	miles	4	$60,000	$240,000
	Sediment Reduction - Erosion Control Structures	# of erosion structures	25	$1,400	$35,000
	Sediment Reduction - Sediment Traps and Upland Erosion Control (sediment control basins, windbreaks, planting, conservation land management)	# of erosion structures	40	$600	$24,000
	Upland- Vegetation - Planting	area treated (acres)	800	$450	$360,000

MaSA	Type/Subtype[a]	Unit[a]	# Units	Cost / Unit	Cost
	Upland- Vegetation - Invasive Plant Control	area treated (acres)	800	$1,600	$1,280,000
	Land Protected, Acquired, or Leased - Streambank Protected	miles	17	$320,000	$5,440,000
	Nutrient Enrichment - Carcass Analog	area treated (acres)	50	$4,000	$200,000
	Project maintenance - Site Maintenance	miles	17	$4,000	$68,000
					$42,876,340
Klickitat Canyon MiSA	Sediment Reduction - Road Stream Crossing Improvements (=Rocked Ford)	miles	0.1	$316,800	$31,680
	Sediment Reduction - Road Drainage System Improvements	miles	55	$4,500	$247,500
	Sediment Reduction - Road Obliteration	miles	2	$15,000	$30,000
	Sediment Reduction - Erosion Control Structures	# of erosion structures	50	$1,400	$70,000
	Sediment Reduction - Sediment Traps and Upland Erosion Control (sediment control basins, windbreaks, planting, conservation land management)	# of erosion structures	35	$600	$21,000
	Project maintenance - Site Maintenance	miles	55	$4,000	$220,000
					$620,180
Lower Little Klickitat MiSA	Instream - Channel reconfiguration (includes channel roughening)	length treated in miles	6	$844,800	$5,068,800
	Instream - Spawning Gravel Placement	length treated in miles	3	$90,000	$270,000
	Instream - Large Woody Debris	# of structures	20	$1,000	$20,000
	Instream - Structure/ Log Jam	# of structures	18	$15,000	$270,000
	Instream - Beaver Introduction	# of beavers introduced	10	$350	$3,500
	Riparian - Planting	species; area treated (acres)	160	$2,000	$320,000
	Riparian - Weed Control	species; area treated (acres)	20	$1,600	$32,000
	Sediment Reduction - Road Stream Crossing Improvements (=Rocked Ford)	miles	0.1	$950,400	$95,040
	Sediment Reduction - Road Drainage System Improvements	miles	10	$4,500	$45,000
	Sediment Reduction -	# of erosion	35	$1,400	$49,000

MaSA	Type/Subtype[a]	Unit[a]	# Units	Cost / Unit	Cost
	Erosion Control Structures	structures			
	Sediment Reduction - Sediment Traps and Upland Erosion Control (sediment control basins, windbreaks, planting, conservation land management)	# of erosion structures	20	$600	$12,000
	Upland- Vegetation - Planting	area treated (acres)	800	$450	$360,000
	Upland- Vegetation - Invasive Plant Control	area treated (acres)	200	$1,600	$320,000
	Land Protected, Acquired, or Leased - Streambank Protected	miles	12	$80,000	$960,000
	Nutrient Enrichment - Carcass Analog	area treated (acres)	50	$4,000	$200,000
	Project maintenance - Site Maintenance	miles	6	$4,000	$24,000
					$8,049,340
Upper Little Klickitat MaSA	Fish Passage - Culvert Replacement	# of installations	1	$125,000	$125,000
	Instream - Channel Connectivity	length treated in miles	0.5	$475,200	$237,600
	Instream - Channel reconfiguration (includes channel roughening)	length treated in miles	22	$475,200	$10,454,400
	Instream - Spawning Gravel Placement	length treated in miles	11	$90,000	$990,000
	Instream - Large Woody Debris	# of structures	55	$1,000	$55,000
	Instream - Structure/ Log Jam	# of structures	35	$9,000	$315,000
	Instream - Beaver Introduction	# of beavers introduced	15	$350	$5,250
	Riparian - Livestock Water Development	# of installations	40	$3,200	$128,000
	Riparian - Water Gap Development	# of installations	40	$1,200	$48,000
	Riparian - Fencing	miles	36	$10,000	$360,000
	Riparian - Planting	species; area treated (acres)	800	$2,000	$1,600,000
	Riparian - Weed Control	species; area treated (acres)	400	$1,600	$640,000
	Sediment Reduction - Road Reconstruction	miles	0.5	$3,000,000	$1,500,000
	Sediment Reduction - Road Stream Crossing Improvements (=Rocked Ford)	miles	10	$1,800	$18,000
	Sediment Reduction - Road Drainage System Improvements	miles	30	$11,000	$330,000

MaSA	Type/Subtype[a]	Unit[a]	# Units	Cost / Unit	Cost
	Sediment Reduction - Erosion Control Structures	# of erosion structures	20	$1,400	$28,000
	Sediment Reduction - Sediment Traps and Upland Erosion Control (sediment control basins, windbreaks, planting, conservation land management)	# of erosion structures	40	$1,600	$64,000
	Upland- Vegetation - Planting	area treated (acres)	12800	$450	$5,760,000
	Upland- Vegetation - Invasive Plant Control	area treated (acres)	300	$800	$240,000
	Land Protected, Acquired, or Leased - Streambank Protected	miles	22	$80,000	$1,760,000
	Nutrient Enrichment - Carcass Analog	area treated (acres)	5	$4,000	$20,000
	Project maintenance - Site Maintenance	miles	38	$4,000	$152,000
					$24,830,250
Upper Middle Klickitat MiSA	Instream - Structure/ Log Jam	# of structures	30	$28,000	$840,000
Upper Middle Klickitat MiSA	Riparian - Planting	species; area treated (acres)	40	$5,000	$200,000
Upper Middle Klickitat MiSA	Sediment Reduction - Road Reconstruction	miles	2	$26,000	$52,000
Upper Middle Klickitat MiSA	Sediment Reduction - Road Stream Crossing Improvements (=Rocked Ford)	miles	6	$1,800	$10,800
Upper Middle Klickitat MiSA	Sediment Reduction - Road Drainage System Improvements	miles	16	$3,600	$57,600
Upper Middle Klickitat MiSA	Upland- Vegetation - Invasive Plant Control	area treated (acres)	115	$1,600	$184,000
Upper Middle Klickitat MiSA	Project maintenance - Site Maintenance	miles	18	$1,500	$27,000
				$1,371,400	Assumes River Route remains in place with only drainage improvements; estimates do not include roads falling under Forest & Fish jurisdiction
Trout Creek MiSA	Fish Passage - Culvert Replacement	# of installations	3	$250,000	$750,000
Trout Creek MiSA	Instream - Channel reconfiguration (includes channel roughening)	length treated in miles	10	$475,200	$4,752,000
Trout Creek MiSA	Instream - Spawning Gravel Placement	length treated in miles	10	$90,000	$900,000
Trout Creek MiSA	Instream - Large Woody Debris	# of structures	15	$1,200	$18,000
Trout Creek MiSA	Instream - Structure/ Log Jam	# of structures	30	$9,000	$270,000

MaSA	Type/Subtype[a]	Unit[a]	# Units	Cost / Unit	Cost
	Instream - Beaver Introduction	# of beavers introduced	10	$350	$3,500
	Riparian - Planting	species; area treated (acres)	60	$3,900	$234,000
	Sediment Reduction - Road Reconstruction	miles	18	$26,000	$468,000
	Sediment Reduction - Road Stream Crossing Improvements (=Rocked Ford)	miles	5	$1,800	$9,000
	Sediment Reduction - Road Drainage System Improvements	miles	25	$3,800	$95,000
	Sediment Reduction - Erosion Control Structures	# of erosion structures	25	$1,400	$35,000
	Sediment Reduction - Sediment Traps and Upland Erosion Control (sediment control basins, windbreaks, planting, conservation land management)	# of erosion structures	15	$600	$9,000
	Upland- Vegetation - Invasive Plant Control	area treated (acres)	40	$1,600	$64,000
	Project maintenance - Site Maintenance	miles	10	$4,000	$40,000
					$7,647,500
West Fork Klickitat MaSA	Sediment Reduction - Road Reconstruction	miles	0.5	$1,200,000	$600,000
	Sediment Reduction - Road Drainage System Improvements	miles	15	$5,200	$78,000
	Project maintenance - Site Maintenance	miles	0.5	$12,000	$6,000
					$684,000

[a] from Table 1 in Plummer guidance document

8. Monitoring, Research, and Adaptive Management

This chapter summarizes current monitoring and research efforts in the Klickitat subbasin and also lists additional RM&E needs. Part of the recovery strategy for this subbasin is the collaborative development of a monitoring plan to address the additional information needs that statkeholders and scientists have identified.

Comprehensive, empirical monitoring data on fish populations and habitat are needed to identify appropriate projects and locations, populate habitat/production capacity modeling efforts (such as EDT, AHA, or other appropriate models), and inform adaptive management for the salmonid recovery plan. Information on fish distribution, abundance, productivity, habitat conditions, genetic diversity, pathogen levels, and other population parameters, as well as on population limiting factors, is necessary to help direct and evaluate these efforts. A coordinated monitoring program is needed to ensure that these various needs, including salmonid recovery planning, are met.

As part of implementing the Klickitat steelhead recovery plan, a detailed monitoring and evaluation program will be designed and incorporated into an adaptive management framework based on the principles and concepts laid out in the NMFS' guidance document, *Adaptive Management for ESA-Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance* (NMFS 2007) http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/upload/Adaptive_Mngmnt.pdf.

8.1 Adaptive Management

Adaptive management in salmon recovery planning is a method of decision making in the face of uncertainty. It is a process of adjusting management actions and/or directions based on new information. It means taking an experimental approach to a complex task, making one's assumptions clear, and continuously evaluating them in light of new information. It works best when the collection of performance data and methods of evaluation are designed to get the information managers need to make sound decisions.

As outlined in the NMFS *Adaptive Management* guidance document, several types of monitoring are needed to support adaptive management: (1) implementation and compliance monitoring, which is used to evaluate whether the recovery plan is being implemented; (2) status and trend monitoring, which assesses changes in the status of an ESU and its component populations, as well as changes in status or significance of the threats to the ESU; and (3) effectiveness monitoring, which tests hypotheses and determines (via research) whether an action is effective and should be continued. (These three types of monitoring are discussed in more detail below.) In addition, it is important to build in some research to illuminate the many unknowns in salmon recovery—the "critical uncertainties" that make management decisions all the harder. Critical uncertainty research may seem expensive or unnecessary in light of basic information needs; however, in the long run, it may reduce monitoring and implementation costs.

NMFS' guidance document presents a decision framework that can guide the design of a research, monitoring, and evaluation plan. The framework (Figure 8-1) contains two basic sorts of questions: (1) questions regarding ESU status (biological viability criteria) and (2) questions regarding statutory listing factors and factors limiting recovery (limiting factor and threats criteria). Evaluating a species for potential delisting requires an explicit analysis of both types of criteria.

The guidance document contains a more detailed discussion of the framework and identifies the specific questions that should be answered to evaluate ESU status. These specific questions take the form of a series of decision-question sets that address the status and change in status of a salmonid ESU and the risks posed by threats to the ESU. The decision-question sets are designed to elicit the information NMFS needs to make delisting decisions. For recovery planners, the framework can guide future decisions about strategies and actions aimed at achieving recovery goals.

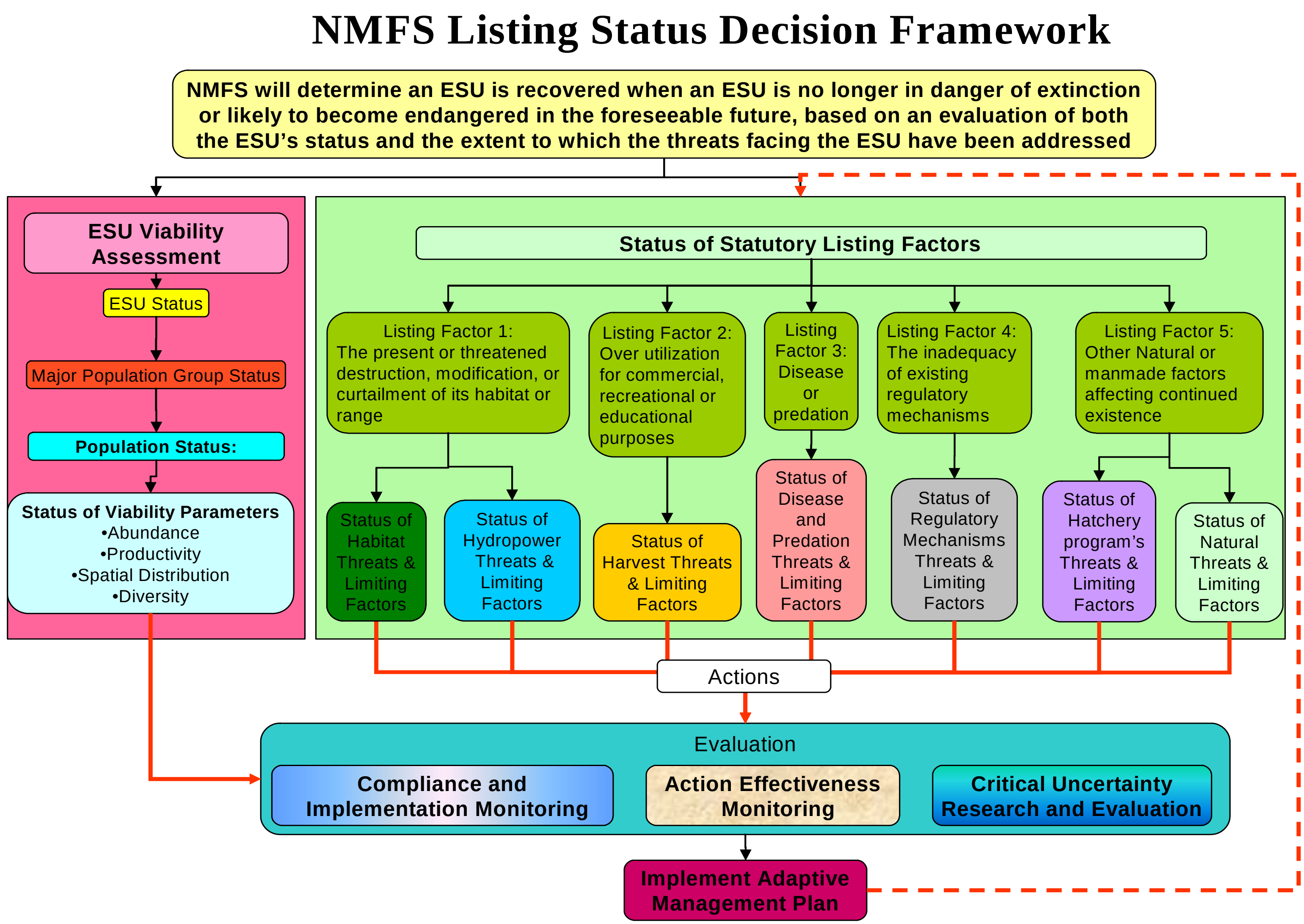


Figure 8-1 NMFS Listing Status Decision Framework.

8.2 Designing a Monitoring and Evaluation Program to Support Adaptive Management

Because of the length and complexity of the salmonid life cycle, there are many uncertainties involved in improving salmonid survival. Simply identifying cause-and-effect relationships between any given management action and characteristics of salmon populations can be a scientific challenge. It is essential to design a monitoring and evaluation program that will answer these basic questions: How will we know we are making progress? How will we get the information we need? And how will we use the information in decision making?

Designing an effective monitoring program for salmon recovery involves the following initial steps:

1. Clarify the questions that need to be answered for policy and management decision making. Include the full ESU and the full salmonid life cycle.
2. Identify entity or entities responsible for coordinating development of this program.
3. Identify:
    - Which populations and associated limiting factors to monitor
    - Metrics and indicators
    - Frequency, distribution, and intensity of monitoring
    - Tradeoffs and consequences of these choices
4. Assess the degree to which existing monitoring programs are consistent with NMFS guidance.
5. Identify needed adjustments in existing programs, additional monitoring needs, and strategy for filling those needs.
6. Develop a data management plan (See Appendix B of *Adaptive Management for ESA-Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance (May 1, 2007)* http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/upload/Adaptive_Mngmnt.pdf.
7. Prioritize research needs for critical uncertainties, testing assumptions, etc.
8. Identify entities responsible for implementation.

A monitoring and evaluation program will provide (1) a clear statement of the metrics and indicators by which progress toward achieving goals can be assessed, (2) a plan for tracking such metrics and indicators, and (3) a decision framework through which new information from monitoring and evaluation can be used to adjust strategies or actions aimed at achieving the Plan's goals.

Implementation and compliance monitoring simply check on whether activities were carried out as planned, and whether specified criteria are being met as a direct result of an implemented action. For example, if a fence is planned for 20 miles of stream corridor to keep livestock off the stream banks so that riparian vegetation will rebound, implementation monitoring would verify the presence of the fence. Compliance monitoring would take note of the presence or absence of livestock in the fenced-off area.

Status and trend monitoring is a simple compilation of data-based descriptions of existing conditions. To be useful in decision-making, the raw data, or metrics, must be reduced to a more directly applicable form or indicator. For example, if the question is "What is the annual spawning population size of steelhead in the X River?" the indicator would be total spawning numbers of steelhead over one season for the entire river basin; however, the metric, or directly measured thing, would be something quite different, perhaps steelhead redds sighted on weekly passes over known spawning grounds. Thus, the metric must be processed to translate it from the metric data type (e.g., redds) into the indicator data type (e.g., spawners), and then reduced to generate the indicator required (e.g., list of weekly counts on spawning grounds to annual total for watershed). The ICTRT identified deficiencies in the currently available data and/or data-gathering techniques for Middle Columbia River steelhead. These are described in Section 10.4, below.

Effectiveness monitoring specifically addresses cause-and-effect questions. Demonstrating the direct and indirect impact of management actions requires supporting all steps in the logical chain that connects the action to its expected impact. This chain is rarely short and usually contains several hypotheses. For this reason, it's better to build the effectiveness monitoring into the recovery action strategies, with, for example, pilot-scale tests or other methods carefully thought out beforehand. Monitoring and evaluation will only provide the answers to the questions they were designed to address; they do not provide the framework for revising these questions if they are ill-posed, evaluating the assumptions upon which the strategy was built, or incorporating learning into future decisions on actions and strategies—this is the role of adaptive management.

8.3 Existing Monitoring and Research

The development of the Klickitat Recovery RM&E Plan should begin by evaluating existing monitoring and research programs to determine if they are sufficient to answer the questions identified in NMFS' *Adaptive Management for Salmon Recovery: Evaluation Framework and Monitoring Guidance*. Research, monitoring and evaluation activities currently underway in the Klickitat Basin address the following categories:

Current/Recently Completed M&E Tasks	Purpose
1. Status and Trends Monitoring	Compilation or data-based description of existing conditions and long-term trends
2. Effectiveness Monitoring	Address cause and effect questions
3. Critical Uncertainty Research	Gather information to test critical assumptions or theories

There follows more specific information regarding current monitoring and research programs being conducted by the Yakama Nation, the WRIA 30 Watershed Planning Implementing Governments, and other parties. WRIA 30 Implementing Governments are state and local agencies tasked with implementing the WRIA 30 watershed management plan; the Governor has designated the Washington Department Ecology (Ecology) to represent state agencies (e.g., WDNR, WDFW, WDOH). These programs should be reviewed further when developing the final RM&E Plan for recovery, in the context of the NMFS' guidance.

8.3.1 Status and Trends Monitoring

- Temporal outmigration patterns and relative abundance for wild and hatchery salmon and steelhead populations are being monitored annually at 3 rotary screw trap locations (upper, middle, and lower mainstem Klickitat).
- Length frequency and age composition for wild salmon and steelhead populations are being monitored at 3 rotary screw trap locations.
- Temporal and spatial redd distribution for steelhead has been variably monitored throughout the subbasin since 1990.
- Global Positioning System (GPS) locations have been recorded for redds since 2003 by the Yakama Nation.
- Sport harvest is monitored by WDFW and tribal harvest is reported annually by the Yakama Nation.
- Habitat surveys have been conducted by State and private timberland owners using the Timber, Fish, and Wildlife (TFW) Ambient Monitoring Protocol since 1996. To date, approximately 80 sites on 40 streams have been surveyed by the Yakama Nation, including all major tributaries (many with multiple sites) and, multiple sites on the upper mainstem Klickitat. Some sites have been surveyed a second time; most sites are planned for resurvey on a 5 to 10-year basis.
- Klickitat County recently completed a study that provides baseline information regarding current shade levels throughout the Little Klickitat and Swale subbasins (Aspect and WPN 2009). This information will serve as baseline information to support long-term trend monitoring by Klickitat County Ecology, and the WRPAC.
- In cooperation with WDFW, an adult monitoring/trapping facility at Lyle Falls has been in operation since the summer of 2004.
- Gravel samples have been collected and analyzed annually from 12 sites distributed over the mainstem and major tributaries since 1999.
- Water temperature has been monitored continuously by the Yakama Nation since 1996 at 28 sites (36 sites since 2003) distributed throughout the subbasin.
- Basic water quality parameters have been monitored on a seasonal basis by the Yakama Nation since 2000 at most of these sites.
- Water quality (numerous parameters, including temperature) monitoring is conducted annually by the City of Goldendale, Central Klickitat Conservation District, and Ecology.
- Flow in the mainstem has been continuously monitored by the USGS for 82 years.
- Flow in the Little Klickitat is monitored by Ecology, the Central Klickitat Conservation District, the City of Goldendale, and Klickitat County. Flow was previously monitored in the Little Klickitat by the USGS, but was discontinued in 1968. The Yakama Nation is also monitoring flow at various sites.
- A SNOTEL snow monitoring station was established in the Simcoe Mountains in 2008 by NRCS and the WRIA 30 Implementing Governments http://www.or.nrcs.usda.gov/snow/maps/Washington_sitemap.html
- Groundwater quality is monitored by Ecology and the City of Goldendale. In addition, a study of groundwater quality was conducted in 2005 by Klickitat County.
- A well database is maintained by Ecology.
- Groundwater levels have been monitored in Swale Creek since 2001 by the City of Goldendale and Klickitat County (Germiat and Flynn 2007).

- The status and trends of fish habitat on state and private forest lands are being monitored under the State of Washington's Forest and Fish Agreement.
- In 2002-2004, approximately 1000 pathogen samples were collected from various sites throughout the subbasin; samples were analyzed by the U.S. Fish and Wildlife Service (USFWS) using protocols of the National Wild Fish Health Survey.

8.3.2 Effectiveness Monitoring

- Preliminary rotary screw trap efficiency estimates are being evaluated by the Yakama Nation.
- Preliminary adult trap efficiency at Lyle falls is being evaluated by the Yakama Nation.
- The effectiveness of the State Forest Practices rules are being evaluated under Washington State's Forest and Fish Agreement.
- Cameras to support video monitoring of passage at Lyle and Castile falls are being installed.

8.3.3 Critical Uncertainty Research

- Genetic sampling and analysis to date has yielded information regarding genetic divergence between hatchery and natural spawning summer steelhead and information on potential subpopulations of *O. mykiss* within the basin (Narum et al. 2006).
- Critical uncertainties regarding the effectiveness of the State Forest Practices rules are being researched under Washington State's Forest and Fish Agreement.
- A groundwater availability study was completed by Klickitat County in Swale Creek subbasin in 2007.
- Presence/absence surveys for juvenile and resident salmonids have been completed in the majority of subbasin tributaries and in the upper mainstem by the Yakama Nation.
- Abundance estimates have been completed in numerous tributaries by the Yakama Nation.
- An EDT reach analysis of spring Chinook was completed in the summer of 2000 and multiple EDT model iterations for steelhead were conducted in 2002-2005. EDT was utilized to run Proper Functioning Condition (PFC) within the Klickitat by the Yakama Nation.

8.4 Additional Needs

The following information is a list of preliminary monitoring and research needs that have been identified in the Klickitat subbasin. These preliminary needs may be further refined as the recovery plan RM&E Program evolves.

Five primary objectives of future RM&E have been identified:

A. *Monitor Klickitat subbasin fish population's viability attributes*
B. *Monitor Klickitat subbasin habitat conditions*
C. *Evaluate Klickitat subbasin in relation to habitat limiting factor status*
D. *Evaluate Klickitat subbasin hatchery actions in relation to limiting factor status*
E. *Answer key questions/uncertainties*

A. Monitor Klickitat subbasin fish population's viability attributes

Adult counts

- *Redd counts* (spawner surveys) - Regular foot and/or raft surveys will be conducted within the known geographic range for each species. Individual redds will be counted and their locations recorded using handheld GPS units. Counts of live fish of all salmonid species and carcasses will also be recorded. Carcasses will be examined for sex determination, egg/milt retention, and presence of CWT or PIT-tags or external experimental marks. Scale samples will also be taken from carcasses. Spawning ground surveys will be conducted for steelhead from late January through early June. Attempts will be made to cover the entire known spawning range. Stream reaches will be surveyed multiple times during the spawning periods, with most reaches receiving 3 passes.

- *Adult counts at Lyle Falls Fishway adult trap* – Trap is currently in operation with WDFW as partner. Salmonid species are counted as they are released from trap within the Lyle Falls Fishway on lower Klickitat. Trap efficiencies will be estimated from floy tagging of fish and recapture in sport fisheries or resighting during spawner/carcass surveys. Genetic and scale samples, along with fish length, will also be collected.

- *Adult counts at Castile Falls Fishway* – Adult trap, video monitoring, and PIT-tag detection equipment will be installed at Castile Falls Fishway (RM 64). Adult counts will be used for upper subbasin production estimates, fish-per-redd estimates, and Castile Fishway improvement effectiveness monitoring. Genetic and scale samples, along with fish length, may also be collected.

- Additional methods for adult enumeration should be investigated.

Juvenile production and survival estimation

- *Juvenile production estimation* – Floating rotary screw traps located just above Lyle Falls (RM 2.8) and at the Klickitat Hatchery (RM 43) will be operated on a year-round basis. A rotary trap located above Castile Falls (RM 64.6) will be fished seasonally from early summer through fall. Environmental and trap data (weather conditions, water temperature and clarity, trap revolution speed, and debris load) will be recorded along with bio-data (fork lengths, weights and smoltification stage), and additional fish will tallied by species. Trap efficiencies will be estimated regularly by mark/recapture trials using fin clips, fin markings, and/or PIT-tags. Feasibility of intermittent juvenile trapping on lower White Creek will also be investigated (in conjunction with an instream PIT-tag detector; juvenile production estimates may be possible).

- *Smolt-to-Adult Return estimation* – PIT-tagging of wild and hatchery smolts. Detection will be at instream detectors (White Creek), screw traps, and Bonneville Dam as smolts; at Bonneville Dam, adult traps, and on spawner surveys as adults.

<u>Age structure and sex ratio sampling</u>

- *Adult scale, sex, origin (i.e., HOF or NOF), and length sampling* – at adult traps and spawner surveys
- *Juvenile scale and length sampling* – at screw traps
- *Scale analysis* – Scale age will be determined by technicians trained in WDFW methodology.

<u>Juvenile and resident fish monitoring</u>

- *Presence/absence surveys* – Electrofishing and snorkel surveys will be used to determine presence/absence of fish species in selected tributaries.
- *Abundance estimates* – Multiple pass electrofishing sampling and snorkel surveys will be used to estimate abundance in selected stream reaches, including selected habitat enhancement sites.

B. Monitor Klickitat subbasin habitat conditions

<u>Stream habitat monitoring</u>

- *Stream habitat surveys* – Habitat surveys will be conducted on approximately 5-10 stream reaches per year using TFW methodology, Reference Point Survey, and Large Woody Debris Survey.
- *Spawning gravel/sediment sampling* – core samples will be collected from approximately 12 sites (in the Klickitat mainstem and major tributaries) per year.
- *Stream temperature and water quality monitoring* – Water temperature will be continuously monitored at approximately 36 sites throughout the subbasin using thermographs plus approximately 29 sites in the Little Klickitat and Swale Creek subbasins. Basic water quality parameter measurements (pH, conductivity, dissolved oxygen, turbidity) will be recorded seasonally (4-6 times per year) at approximately the same sites. Riparian vegetation and effective shade will be monitored (approximately every five years, depending on availability of new aerial photography) in the Little Klickitat Basin and Swale Creek.

C. Evaluate Klickitat subbasin in relation to habitat limiting factor status

Limiting factors identification and assessment of anthropogenic effects on limiting factors identified

- To date, not all the factors limiting steelhead production in the Klickitat basin have been quantitatively assessed. Limiting factors identification and assessment of possible anthropogenic effects need to continue in order to ensure that actions taken are adequately addressing the factors and threats.

Fish passage improvement effectiveness monitoring

- *Radio telemetry study* – This study will radio-tag and monitor movements of steelhead and spring Chinook salmon; passage at Lyle Falls, Castile Falls, Little Klickitat Falls, and other passage impediments will be evaluated.

- *Reach-scale spawner surveys (redd counts)* – Spawner surveys in reaches upstream of passage improvements will be conducted, as a part of the larger ongoing subbasin-wide spawner survey effort, to evaluate culvert replacement projects, and passage upstream of impediments (e.g., Castile Falls).

Instream habitat enhancement effectiveness monitoring

- *Subbasin-scale juvenile production estimation* – Screw trapping and resulting wild smolt production estimates will be used for comparison of before and after habitat actions. The general hypothesis to be tested is that wild smolt production will increase following habitat restoration/ enhancement actions (although multiple years of data will likely be necessary to detect any real trends in abundance over year-to-year variations). Additionally, in conjunction with redd counts and fecundity estimates (derived either from literature or proposed hatchery production in the Klickitat), the feasibility of generating valid and precise egg-to-smolt survival estimates (before and after habitat actions) will be investigated.

- *Tributary-scale juvenile production estimation* – The feasibility of juvenile trapping in lower White Creek for production/abundance estimation (in conjunction with instream PIT-tag detector) will be investigated.

- *Reach-scale abundance estimates* – Will conduct multiple-pass electrofishing removal sampling and snorkel surveys in selected reaches or localized sites that receive habitat actions. The general hypothesis to be tested is that instream habitat actions increase abundance of fish locally.

- *Reach, tributary, and subbasin scale habitat quality and quantity estimates* – The effectiveness of actions designed to improve instream habitat needs to be evaluated to determine if actions are effectively improving habitat. If not, actions should be modified based on the results of the monitoring and assessment to improve effectiveness.

Local technical review panel involvement

- *Klickitat Technical Committee* – a local technical review panel is part of the Washington Salmon Recovery Funding Board process for reviewing and funding habitat restoration/enhancement projects.

EDT modeling and/or other appropriate models (e.g., Habitat Assessment Model)

- *Incorporate new habitat data* – Data from ongoing habitat surveys will be incorporated for future model runs.

- *Incorporate new biological data* – Data from adult trap facilities, genetic analysis, scale age analysis, and harvest estimates will be incorporated for future model runs.
- *Perform model runs* – To assist in identifying sites and/or potential benefits of future habitat restoration/enhancement projects.
- *Validate Model***.**

D. Evaluate Klickitat subbasin hatchery actions in relation to limiting factor status

Smolt-to-adult return estimation

- *PIT-tagging of hatchery and wild smolts* – detection at screw traps and Bonneville Dam and comparison of wild to hatchery survival rates. In general, the hypothesis to be tested is that smolt-to-adult return rates of hatchery steelhead adults are not significantly different than wild steelhead adults. Differences between hatchery rearing strategies will also be tested. Tagging numbers for steelhead are as follows:

    - 10,000 hatchery steelhead smolts (from native broodstock for rearing study)

    - 10,000 Skamania Hatchery steelhead smolts (feasibility and contract development will be coordinated with WDFW)

    - Approx. 2000 wild steelhead smolts (see also additional PIT-tagging on White Creek)

Adult spawner monitoring

- *Spawner surveys* – sampling of steelhead, coho, and fall Chinook salmon carcasses on spawning grounds and estimation of wild/hatchery ratios.

Demographic characteristic comparisons

- *Age structure, sex ratio, and length-at-age* – Using scale, sex, and length sampling that occur at adult traps and on spawner surveys, comparisons of these demographic characteristics will be made between hatchery and wild returning adults. The hypothesis to be tested is that hatchery adults are not significantly different than wild adults in these characteristics.

Genetic sampling and analysis

- *Genetic sampling* –To gain a thorough understanding of the genetic make-up of target stocks in order to maintain long-term genetic variability (within- and between-population) and minimize the impacts of domestication on supplemented stocks (spring Chinook salmon and summer steelhead), samples will be collected at adult traps, screw traps, and via electrofishing.

- *Genetic analysis* – DNA analysis will be carried out by CRITFC geneticists under subcontract. Results will help assess the level of domestication and interbreeding between hatchery and wild stocks pre- and post-supplementation. As identified in the draft Klickitat subbasin Anadromous Fishery Master Plan, summer steelhead will be collected for broodstock at Lyle Falls. A thorough knowledge of baseline genetic conditions and dip-in rates by out-of-subbasin adults is important in order to adhere to the YKFP genetic guidelines.

Fish health sampling and analysis

- *Pathogen sampling* – A baseline data set will be augmented by describing existing levels of pathogens in wild resident trout and naturally produced steelhead in order to determine if supplementation increases the incidence of pathogens. YN field crews will collect samples within the range of anadromy within the Klickitat subbasin. Samples will be examined for pathogens by the USFWS Lower Columbia River Fish Health Center.

Hatchery releases of introduced Species

- Identify the abundance of naturally spawning coho and fall Chinook utilizing the spawner surveys, redd counts, and trap data. Ensure that spawner surveys for coho and Chinook are extended to cover the full distribution of known steelhead spawning.
- Develop estimates of abundance and productivity of naturally spawning coho and fall Chinook.
- Evaluate the overlap in habitats utilized by steelhead, coho, and fall Chinook for spawning and rearing.
- Evaluate the effects of competition between steelhead, coho, and fall Chinook.
- Estimate the amount of steelhead habitat displaced by hatchery released and naturally spawning coho and fall Chinook.
- Estimate the effects of coho and fall Chinook on steelhead viability.

EDT and AHA modeling and/or other appropriate models (e.g., Habitat Assessment Model)

- *Incorporate new habitat data* – Data from ongoing habitat surveys will be incorporated for future model runs.
- *Incorporate new biological data* – Data from adult trap facilities, genetic analysis, scale age analysis, and harvest estimates will be incorporated for future model runs.
- *Perform model runs* – To guide supplementation efforts.
- *Validate the models***.**

E. Answer key questions/uncertainties

Determine migration behavior, passage delays, habitat use, and life history characteristics of steelhead and spring Chinook salmon

- *Radio telemetry study* – Using radio telemetry techniques, the travel times, passage delays, tributary usage, and spawning and holding locations of steelhead and spring Chinook salmon will be described. Differences in these traits between wild and hatchery steelhead, and summer and winter steelhead, will be determined and will provide a baseline to assess any changes that occur following proposed supplementation, and to provide proportional use information for abundance estimates that result from redd counts. Effectiveness of passage improvements at certain sites can also be evaluated. Specific questions that can be addressed include:

1) Tributary use vs. mainstem use.
2) Spawning areas, holding phase locations.
3) Migration behavior/migration phase travel times/spawning site search phase distances traveled.
4) Frequency and consequences of fallback at Lyle Falls.
5) Amount of delay at Klickitat Hatchery weir.
6) Amount of delay/passage at Castile Falls.
7) Post-spawn kelt survival, movement, and emigration.

Methods that will be used are as follows: Fish will be captured at Lyle Falls adult trap and implanted with radio tags and PIT-tags; fixed telemetry receiver sites will be installed at various locations in the Klickitat subbasin (potential passage impediments and major tributary confluences) to detect fish locations; mobile tracking (via foot, raft, or automobile) will be employed on a weekly or biweekly basis, fish locations will be recorded using GPS receivers, and PIT-tags will allow for fish identification after the radio-tag battery expires, Bonneville Dam detection, and returning kelt detection. Approximate number of steelhead tagged per year would be as follows:

- 2007 – 50 wild steelhead, 50 hatchery steelhead
- 2009 – 50 wild steelhead, 50 hatchery steelhead

This project will be conducted as a cooperative project between YN/YKFP and USGS Columbia River Research Laboratory. USGS staff would perform radio tag implanting and radio tracking (with assistance from YN staff), as well as most data management and analysis, under a subcontract with YN. USGS staff would provide and install fixed telemetry receiver site equipment as an in kind contribution.

<u>Determine migration and rearing patterns in White Creek watershed</u>

- *Install instream PIT-tag detector on lower White Creek* – An instream PIT-tag detector would be installed on lower White Creek to detect outmigrating juveniles and determine outmigration timing and relative abundance. The White Creek watershed has been the most heavily used Klickitat tributary watershed by adult steelhead in recent years, yet many reaches go dry due to lack of base flows and pool habitat. Determining migration and rearing patterns will help assess importance of White Creek vs. mainstem Klickitat rearing habitat and help evaluate habitat improvement actions. USGS Columbia River Research Laboratory staff would install PIT-tag detector and assist with data management (under subcontract with YN). PIT-tagging would be conducted by YN staff, with approximately 1500 fish tagged per year via electrofishing in the White Creek watershed.

Evaluate Little Klickitat passage frequency

- *Reach-scale spawner surveys (redd counts)* – Additional reaches in the upper Little Klickitat River watershed will be targeted for spawner surveys in an ongoing attempt to describe passage frequency of adult steelhead over Little Klickitat Falls (RM 6). Adult steelhead have been observed above the falls during high flow years, but passage frequency is unknown. This information will assist in EDT modeling purposes, and for evaluation of potential future habitat projects.

Steelhead rearing study

- *Assessment of survival and residualism in hatchery-raised steelhead using differential growth regimes* – Abundance of wild indigenous summer steelhead within the Klickitat subbasin has been depressed for a number of decades. Continued releases of a domesticated, non-endemic (Skamania) stock poses unacceptable risks to the native Klickitat summer steelhead population. Future management actions are proposing to phase out Skamania-origin releases in favor of developing a new, integrated hatchery program using Klickitat indigenous steelhead as a broodstock source. Goals for the long-term development of the program include:

- Conserve and restore indigenous stock to historical distribution and abundance levels
- Minimize residualism rates
- Maximize survival and adult return rates
- Mimic natural growth patterns and size of wild counterparts
- Improve tribal and sport fishing opportunities

Table 8-1 Summary of ongoing and expanded RM&E cost estimates (Sharp et al. 2008, Klickitat County, personal communication 2009).

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY2017
YN RM&E Ongoing	$520,000	$533,000	$546,325	$559,983	$573,983	$588,332	$603,041	$618,117	$633,570	$649,409
WRIA 30 RM&E Ongoing	$111,200	$131,500	$41,000	$81,000	$41,000	$41,000	$41,000	$41,000	$81,000	$41,000
On-going RM&E Subtotal	**$631,200**	**$664,500**	**$587,325**	**$640,983**	**$614,983**	**$629,332**	**$644,041**	**$659,117**	**$714,570**	**$690,409**
YN RM&E Expanded	$365,642	$374,783	$857,452	$878,888	$900,861	$923,382	$946,467	$970,128	$994,381	$1,019,241
WRIA 30 RM&E Expanded	$ -	$85,000	$918,500	$909,000	$1,142,000	$890,000	$945,000	$10,000	$10,000	$10,000
RM&E Expanded Subtotal	**$365,642**	**$459,783**	**$1,775,952**	**$1,787,888**	**$2,042,861**	**$1,813,382**	**$1,891,467**	**$980,128**	**$1,004,381**	**$1,029,241**
Total	**$996,842**	**$1,124,283**	**$2,363,277**	**$2,428,871**	**$2,657,844**	**$2,442,714**	**$2,535,508**	**$1,639,245**	**$1,718,951**	**$1,719,650**

YN Staff cost estimates assume a 2.5% inflation rate (starting with FY 2008 dollars)
Klickitat County cost estimates do not apply an inflation rate

8.5 Data Management

A formal and documented approach to data management is essential to adaptive management. A well-designed data management plan can help to ensure that data of a specified quality and quantity is available, at a specified time, to meet specified data analysis needs.

Protocols, metrics, and other data standardization tools such as common data entry methods are a top priority for recovery plans. Coordination across existing monitoring programs and projects will be underpinned by an integrated monitoring and data management framework. The framework would, for example, require the use of common methodologies for sample design, data collection, data validation, and data sharing in order to address common questions. Data management systems should be developed and coordinated with national and regional efforts for consistency with regional and national data standards. Project implementation data management should be consistent with PCSRF protocols where appropriate and with guidance from PNAMP's effectiveness work group. Further guidance on data management is provided in the NMFS guidance document, *Adaptive Management for Salmon Recovery: Evaluation Framework and Monitoring Guidance*.

8.6 Consistency with Other Monitoring Programs

This recovery plan will utilize existing monitoring programs to evaluate the status/trend and effectiveness of recovery actions within the Klickitat Basin. Specifically, this approach should incorporate strategies, indicators, and protocols described in the Yakima Klickitat Fisheries Project, the WRIA 30 Watershed Management Plan, the Upper Columbia Monitoring Strategy, the Comprehensive Statewide Monitoring Strategy, and Collaborative Systemwide Monitoring and Evaluation Project (CSMEP). The development of other regional monitoring programs may result in modifications to the monitoring programs used in the Klickitat Basin. These other programs, in various states of development, include such approaches as Pacific Northwest Aquatic Monitoring Partnership (PNAMP). As these programs develop more fully, they will provide guidance on valid sampling and statistical designs, measuring protocols, and data management. This information may be used to refine and improve the existing monitoring and evaluation programs in the Klickitat Basin. The intent is to make monitoring and evaluation programs in the Klickitat Basin consistent with programs throughout the ESUs and Columbia Basin.

8.7 Coordination

Many entities have been or will be implementing recovery actions within and downstream from the Klickitat Basin. Monitoring programs to coordinate with include:

- Yakima Klickitat Fisheries Project,
- NOAA Fisheries RME Program,
- Washington Salmon Recovery Funding Board Program,
- PACFISH/INFISH Monitoring Program,
- Pacific Northwest Interagency Regional Monitoring Program,
- USFWS, USGS, and BOR Monitoring Programs,
- WDFW and WDOE Monitoring Programs,
- Local Underwood Conservation District Monitoring, and
- WRIA 30 Implementing Governments.

It is critical that these programs be consulted to emphasize utility, reduce redundancy, increase efficiency, and minimize costs.

8.8 Evaluation Schedule

Tracking progress or needs for adaptive management in the Klickitat subbasin by evaluating information from the recovery plan's research and monitoring programs could be one of the roles of the Washington Gorge Area Regional Board. Appropriate time intervals and triggers/goals need to be established to evaluate project implementation, compliance and effectiveness, the status and change in status of a population's viability attributes, the status of population's limiting factors and the evaluation of research identified in the recovery plan.

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Appendix I. Major Creek

Major Creek, a small tributary to the Columbia River, lies just downstream of the Klickitat River drainage (Figure I-1). Major Creek is believed to support Middle Columbia steelhead. This appendix provides an overview of the Major Creek watershed and current knowledge concerning steelhead use. Section 5 proposes further research.

1 Physical Setting

Major Creek drains directly into the Columbia River adjacent to the Klickitat subbasin. The Major Creek watershed covers about 28 sq. miles or 7,200 acres of land. Two forks of Major Creek, East and West Fork, converge, flowing 4.1 miles downstream to the Columbia River, dropping 620 feet in elevation. The West Fork originates at two catch basins at 2,100 feet, flowing 5 miles through a narrow box canyon, then through a valley to the confluence with the East Fork, losing 1,360 feet in elevation. The East Fork flows from a drainage basin 5.1 miles through a narrow, v-shaped valley, losing 1,490 feet in elevation, to join the West Fork.

The Major Creek watershed is under a mix of ownership, including U.S. Forest Service, BIA trust lands, Washington Department of Natural Resources, and private landowners. Most of the Major Creek drainage lies within the Columbia Gorge National Scenic Area and is managed by the USFS. It is one of the few riparian corridors connecting the Columbia River and the highlands (USFS 2005). Other riparian corridors in the area connecting the Columbia River to the highlands include the White Salmon, the Klickitat, and Rock Creek.

2 Ecosystem Conditions

The main channel of Major Creek in the anadromous reaches averaged 7 percent gradient to 8 percent at the confluence of the East and West forks. The average gradient in the fish-bearing reaches of the West Fork was measured at 8 percent, while the lower section of the East Fork had an average gradient of 15 percent. There is a 30-foot waterfall at RM 1.37 on the West Fork and another waterfall at RM 1.2 on the East Fork that likely limit upstream *O. mykiss* distribution, though precise extent of distribution remains to be determined.

Major Creek has a relatively straight, high energy, swiftly dropping channel incised into the Columbia River basalt layers. Streamside vegetation is relatively dense, and the rate of downcutting generally does not seem to be outstripping the rate at which the riparian vegetation can stabilize the stream banks. Water quality appears to be high. The Major Creek landscape is canyon-dominated with very little road contact, and except for the uppermost portion of the watershed, the watershed is very lightly managed. The vegetation is dominated by grasslands and oak woodlands in the lower sections, while the higher elevations are more forested, with Douglas and grand fir, and some intermittent

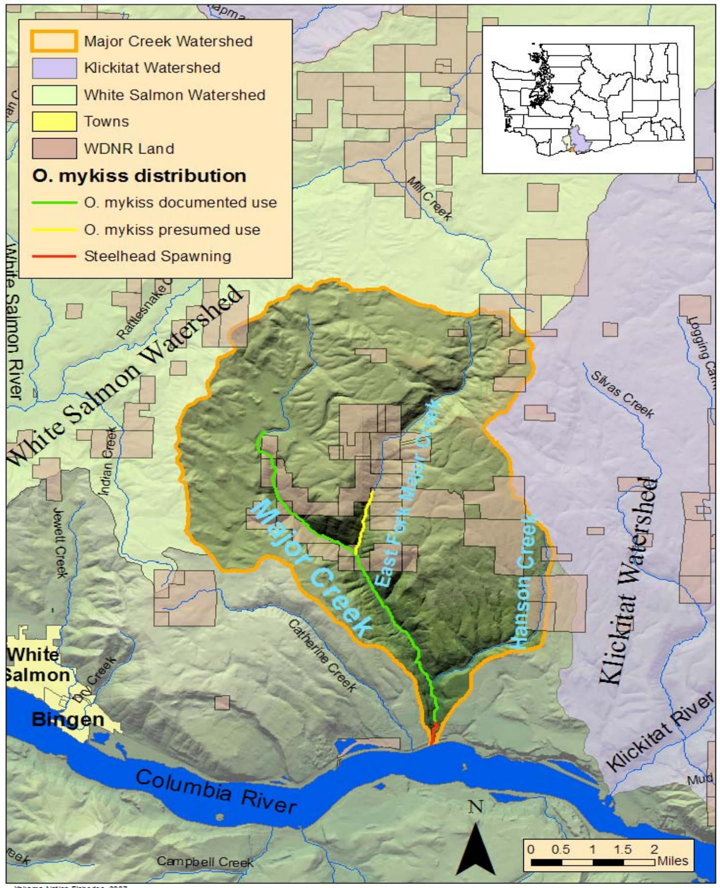

Figure I-1. Map of the Major Creek Subbasin in Southern Washington showing steelhead distribution. (YN Fisheries, personal communication 2007).

oak woodlands and hay lands. The riparian areas along the lower stretches of Major Creek have a good diversity of oak, ash, alder, willow and big leaf maple. Despite impact from human activities, most of the ecological functions are intact (USFS 1994).

Major Creek has a "flashy" hydrograph, especially during rain-on-snow events. Surface flow is at least 1 cfs throughout the driest portions of the summer in all but the first one-quarter mile. Low flow to sub-surface flow conditions exist in the bottom one-quarter mile above the confluence to the Columbia, mainly due to percolation through alluvial material in this reach.

Water temperatures in Major Creek exceed water quality standards during the summer; however, several springs and numerous large pools help provide cooler rearing habitat. Water temperatures in Major Creek range from 0.5ºC in the winter to 21.5°C during the summer in the upper watershed and from 0.1°C in the winter to 24°C during the summer in the lower watershed. Dissolved oxygen (DO) and pH in Major Creek are good year-round.

Habitat conditions in the Major Creek watershed display impacts from past and present land use activities. The largest human impacts on the Major Creek watershed are from SR 14, the railroad along the Columbia River, and, in the higher reaches, road and logging impacts. In the headwater sections of the West Fork of Major Creek, land clearing for farming and residential development has caused habitat fragmentation and loss of wetland functionality. The East Fork is still largely owned by commercial timber interests. Clearing, subdivision and development have not occurred with similar intensity; however, widespread habitat fragmentation has occurred as the result of timber harvest. Years of fire suppression, draining and ditching of wet meadows, and other land uses have changed the composition of the vegetation, resulting in an absence of large woody debris, a vital component of structure for fish habitat in the stream. It is also unclear what effect a seven-mile-long log flume, in operation in the early 1900s in Major Creek, had on the channel conditions and blockage at the barrier falls (USFS 2005).

The area of the watershed within the Columbia Gorge National Scenic Area (NSA) has been influenced more heavily by grazing and forest practices than by residential and agricultural uses. Wetlands have been drained and overgrazed, meadow areas converted to agricultural land, and large areas of forest cleared. Sedimentation, likely due in part at least to roads and timber harvest, has increased over historical conditions, while forest and agricultural practices, including the application of fertilizers and herbicides, have had a heavy impact on water quality (USFS 2005). Logging is likely to continue to the north and east of Major Creek. Grazing still occurs in private, BIA trust, and privately owned timber lands. Concomitant impacts of grazing — bank erosion, sedimentation, loss of fish habitat, and reduction in other aquatic life — are being documented with increasing frequency (USFS 2005).

3 Current Status

The ICTRT groups small downstream mainstem tributaries with the closest upstream population drainage, in this case the Klickitat River (ICTRT 2003). Thus, steelhead in Major Creek are considered part of the Klickitat population of Middle Columbia River steelhead.

The ICTRT has identified intrinsic habitat within Major Creek, but has not yet assessed the population because of lack of data. A barrier identified as a complete block at RM 0.32 in earlier subbasin reports and Salmonscape limited previous assessments of habitat in this watershed to the very lowest reaches. More recent information provided by the Yakama Nation and described in this section suggests that steelhead were able to maneuver this barrier under some flow conditions. If so, the ICTRT may conclude after further evaluation that the additional upstream habitat contains enough intrinsic spawning branch area to form an additional MiSA within the Klickitat population.

Steelhead, as well as fall Chinook salmon and coho salmon, spawning activity has been documented in the lower one-third mile of Major Creek (YN Fisheries, personal communication 2007; USFS 1994). Adult steelhead, some with adipose fins, have been observed in this same section in spring (R. Gerstenberger, written communication 2006) staging below each of the lower falls (E. Jones, personal communication 2006) and attempting to jump the triple step falls (R. Gerstenberger, written communication 2006). *O. mykiss* have been observed up to a natural fish barrier at RM 1.4 on the West Fork and to the natural barrier at RM 1.2 on the East Fork (USFS 1994). *O. mykiss* spawning has been observed up to the Old Hwy. 8 culvert/crossing, and fry have been observed as far as 0.5 to 1 mi. above the Acme Rd. crossing on the West Fork. Two steelhead redds were observed in the lower 0.25 miles of the creek in March 2007 (G. Morris, YN, unpublished data, 2007).

Above the first one-third mile, Major Creek is limited primarily to *O. mykiss* due to a triple step falls with a total drop of approximately 20 feet (G. Morris, YN unpublished data, 2007); each step appears to be less than 6 feet (R. Gerstenberger, written communication 2006). This barrier was originally used as a complete block in the ICTRT's intrinsic potential analysis. Winter and spring flows are sufficient to enable some steelhead to negotiate the obstacle, and steelhead have been seen above the falls, though passage frequency is unknown (YN, unpublished data). A steelhead carcass was observed in a pool above the step falls in May 2006 (R. Gerstenberger, written communication 2006).

Further field studies need to be conducted in the middle reaches to characterize the habitat and potential barriers, as well as to ascertain the uppermost limit of use of Major Creek by steelhead.

4 Potential Limiting Factors and Threats

This section summarizes potential limiting factors and threats for steelhead in Major Creek.

Apparent factors limiting steelhead productivity in the Major Creek system include lack of adequate spawning gravel in all but the lower 0.32 miles, a lack of large woody debris (except for a few large debris jams), and a low pool-to-riffle ratio. The triple falls on the main branch of the creek at RM 0.32 form at least a partial fish barrier, as do several falls higher up on the East and West forks (at RM 1.2 and 1.4, respectively). Water volume and temperature are possibly also issues, particularly in those reaches where the flow diminishes during the summer months. Although the canopy of riparian vegetation is intact in much of the watershed, there are areas where the vegetation is thin. An open canopy exists in the lowest, anadromous reach (RM 0.0-.32), with an estimated 19 percent shade cover, while in upper reaches shade ranges from approximately 20 percent (adjacent to private pasture land) to 60 percent in more densely wooded and/or steep canyon sections (USFS 1994). There is also a relative overall scarcity of large trees for future recruitment to provide stream structure and cover for adult fish. Lack of LWD, stream bank instability and siltation may also affect habitat in the East Fork (USFS 1994). A fairly extensive stream survey was conducted in 1994, and spawning surveys are conducted sporadically; however, an extensive survey is needed to determine the extent of anadromous fish use, and the extent of habitat change that may have occurred as the result of the 1996 flood and other floods (scouring, bank erosion, debris jams), effects of upland land use, roads, etc.

5 Management Actions

The Yakama Nation has proposed several actions to address limiting factors and threats for steelhead production in Major Creek. The actions propose biological, physical, and watershed assessments to gain needed baseline information to determine future restoration and protection needs in the Major Creek watershed (Table I-1).

Table I-1. Needed Actions, Estimated Time to Implement, and Cost for Assessment of Wild Major Creek Steelhead Provided by Yakama Nation Fisheries Staff.

Actions	Affected Sites	Time to Imple ment	Time to Real-ize Bene-fits	Imple-menting Entities	Esti-mated Cost	Imple-ment-ability (L-M-H)	Comment
Physical habitat assessment: assess flow and temperature regime, riparian cover, substrate, map and quantify stream habitat	Mainstem Major Creek, East Fork, West Fork	< 3 Years	5 - 10 Years	Yakama Nation, USFS, USGS	$0 -- 100,000	High-	Determine location and volume of any spring inputs
Biological assessment: assess use of watershed by steelhead; frequency of steelhead passage at lower falls; fish species composition, health, and life history; genetics and spawning distribution.	Entire watershed: below and above the falls (RM 0.3) into all of accessible upper watershed.	< 3 Years	5 - 10 Years	Yakama Nation, USFS, USGS	$0 -- 100,000	High	Actions will provide baseline information on Major Creek fish populations: distribution, productivity, life history, relationship between upper and lower watershed *O. mykiss* and relationship to ESU/MPG.
Watershed assessment: assess roads, passage structures, land use, water withdrawals and identify potential restoration sites.	Entire watershed.	< 3 Years	5 - 10 Years	Yakama Nation, USFS, USGS, private landowners	$0 -- 100,000	High	Investigate water withdrawal location and amounts, including legal maximum water rights.
Investigate feasibility of placing/place margin structures.	Entire watershed	3 - 5 Years	3 - 5 Years	Yakama Nation, USFS, USGS, private landowners	$500,000 – 1,000,000	Moderate	Margin structures would retain some spawning gravel patches, would create holding habitat (slow water pockets) and provide cover for adult fish heading upstream, as well as for juveniles moving downstream.

6 Cost Estimates

The Yakama Nation Fisheries staff provided estimated habitat action costs for research/evaluation and channel/floodplain modification for Major Creek. Costs over a 10-year period are estimated to be $0.45 million ($0.15 million for years 1-3 and $0.3million for years 4 to 10).

Appendix II. Potential Limiting Factors and Threats Identified by Yakama Nation Fisheries

This appendix describes the potential limiting factors and threats identified by Yakama Nation Fisheries staff for Middle Columbia River steelhead in the Klickitat subbasin. Limiting factors are described qualitatively in relation to the biological needs of the species and threats are described as those activities (natural or anthropogenic actions) that lead to the limiting factors.

Yakama Nation Fisheries biologists consider the following conditions to be the top habitat factors (physical and biological) limiting the viability of the threatened Klickitat *O. mykiss* population. The Yakama Nation staff identified the factors based on 10 years of fisheries and physical habitat data, EDT model outputs, and the professional opinion of biologists and other scientists working in the watershed.

- ***Degraded riparian condition.*** Riparian corridors have been affected and eroded by past, and in some cases current, timber practices, poor road construction and management, inadequately sized stream crossings, off-season use of wet roads, and cattle grazing in riparian areas. McCormick Meadows, in the tribally designated Primitive Area on the upper Klickitat River, was heavily grazed for approximately 60 years. Compromised riparian conditions reduce channel stability and pool frequency, and thus key habitat quantity and habitat diversity, degrading juvenile rearing habitat. Reduced riparian cover also affects fish survival and productivity by reducing stream shade, which leads to an increase in maximum water temperatures, and by limiting recruitment of large woody debris needed to provide future instream habitat complexity. Channel instability contributes significantly to increased sediment loads. Creation of Bonneville Pool inundated the lower reaches of the subbasin and resulted in the loss of critical wetland riparian habitat.

- ***Decreased floodplain function and channel migration processes.*** Abandoned and active roads, highways and a railroad prism in the floodplain along the lower Klickitat mainstem and lower Swale Creek, and active logging roads in the upper watershed confine and harden banks causing channelization, incision of tributaries, disconnection of side-channels and river meanders, and other disruption of natural hydrologic and riparian processes.

- ***Altered hydrology.*** Increased peak flows and diminished base flows in several parts of the subbasin have degraded habitat for fish. White Creek, Swale Creek, the Little Klickitat River and many of its tributaries have been identified as having insufficient instream flows to support fish populations (anadromous and resident). Swale Creek and six reaches on the Little Klickitat, Blockhouse, Bloodgood, Bowman and Mill creeks were considered "water quality impaired" on the 1998 state 303(d) list for instream flows.

- ***Degraded channel structure and complexity.*** In-channel large woody debris in the watershed has declined as a result of reduced recruitment potential (from bank hardening and historical riparian logging), historical "stream cleaning," and altered hydraulic conditions associated with increases in peak runoff and channel simplification. This reduction of in-channel structure and its concomitant effects has deprived fish of needed hiding, resting and rearing habitat.

- ***Obstructions to fish passage and connectivity.*** A number of culverts in the subbasin block fish passage. Reduced low flows have led to loss of connectivity of habitats in some streams, effectively cutting off migratory paths and isolating fish. High temperatures during low flow periods effectively act as barriers preventing fish from moving between spawning, rearing and migration habitats. Historical torrents associated with road crossing failures may have exacerbated passage difficulties in localized areas (e.g. lower Trout Creek).

- ***Altered sediment routing.*** Sediment loads (the percentage of fines in spawning gravel, embeddedness and turbidity) in the Klickitat have increased over historical conditions. Actions contributing to increased sediment delivery include forest practices (skidding and road building, clearing of upland forests and stream banks), agricultural practices (rill irrigation, streamside grazing) and land clearing and excavation in or near riparian areas related to residential and commercial construction. Increased sediment loads are a key problem for steelhead, particularly during the egg incubation stage. In addition, runoff from Mt. Adams' glaciers, carried downstream by such streams as Big Muddy Creek, is a significant source of natural sediment in the Klickitat River.

- ***Degraded water quality, including water temperatures.*** While most of the mainstem Klickitat and most tributaries maintain fairly healthy temperatures for anadromous fish, elevated summer and in certain reaches extremely low winter stream temperatures restrict steelhead production in several areas. Reaches on the East Prong, West Prong and mainstem Little Klickitat River, Butler Creek (a major tributary to the Little Klickitat) and Swale Creek were listed on WDOE's 1998 303(d) list for temperature (Anderson 2004; Brock and Stohr 2002). Nine reaches on these streams violated thermal water quality criteria. Degraded channel and riparian conditions, reduced summer low flows and lack of shading are presumed to exacerbate the elevated temperatures, though temperatures in some water bodies may naturally exceed state water quality criteria. Reduced flows, lack of pools and inadequate riparian cover also contribute to unfavorably low temperatures and the formation of anchor ice in some stream sections, particularly in the uppermost mainstem Klickitat and Diamond Fork.

- ***Altered food web — decreased salmon carcasses and subsequent reduction of nutrients.*** Diminishing run sizes limit salmon carcasses, a critical source for marine-derived nutrients, from enriching streams, negatively affecting food availability in the upper watershed.

Primary Limiting Factors identified through EDT Analysis

Yakama Nation Fisheries staff recently identified limiting factors for steelhead in 11 areas of the Klickitat subbasin based on EDT analysis. Results for summer and winter steelhead are combined due to difficulties in distinguishing run timing, abundance, and spawning and rearing areas for the two runs.

To conduct their analysis, Yakama Nation Fisheries scientists grouped EDT reaches that had been previously established during the subbasin planning process into larger spawning areas. They identified 6 major spawning areas and 5 minor spawning areas based on geomorphologic and biological considerations, as well as survey data representing habitat accessible or potentially accessible to anadromous and resident fish.

The spawning areas delineated by Yakama Nation Fisheries staff differ in some respects from those identified by the ICTRT for Middle Columbia River steelhead within the Klickitat subbasin. However, the differences are not substantial in terms of the distribution of relatively contiguous reaches with moderate to high historical production potential. Table II-1 compares the areas delineated by the ICTRT and Yakama Nation. The spawning area delineations diverge primarily in the Yakama Nation's Klickitat Canyon and Upper Middle Klickitat MiSAs. The ICTRT considers Surveyors Creek its own MiSA, which does not contain branched habitat from the mainstem Klickitat River, whereas the Yakama Nation includes lower Surveyors Creek with Klickitat River mainstem reaches above the hatchery in the Klickitat Canyon MiSA. The Yakama Nation's Upper Middle Klickitat MiSA overlaps with the ICTRT's Middle Mainstem MaSA (HUC boundaries) between the Summit and White Creek confluences with the mainstem Klickitat, but does not contain ICTRT-modeled branched intrinsic habitat.

Table II-1. Correlations between ICTRT Major and Minor Spawning Areas for Klickitat Steelhead, and Yakama Nation Fisheries Klickitat Spawning Areas in Order of Priority.

ICTRT Klickitat Steelhead Spawning Areas	YN Klickitat Steelhead Spawning Areas
Upper Mainstem MaSA[6]	Upper Klickitat MaSA
White Creek MaSA	White Creek MaSA
Middle Mainstem MaSA[7]	Middle Klickitat MaSA
Lower Mainstem MaSA	Lower Klickitat MaSA
Upper Little Klickitat MaSA	Upper Little Klickitat MaSA
West Fork Klickitat MaSA	West Fork Klickitat MaSA
Trout Creek MiSA	Trout Creek MiSA
Lower Little Klickitat MiSA	Lower Little Klickitat MiSA
Swale Creek MiSA	Swale Creek MiSA
Surveyors Creek MiSA[8]	*Klickitat Canyon MiSA*
	Upper Middle Klickitat MiSA

Yakama Nation Fisheries staff ran the EDT model using their newly defined MaSAs and MiSAs to identify those areas with the highest restoration or protection potential based on the primary limiting factors acting upon those areas. The EDT run confirmed that the dominant limiting factors by reach previously identified in other assessments were consistent. Table II-2 is a qualitative assessment of the relative combined impact of all limiting factors across all life history trajectories in all stream reaches by MaSA on steelhead survival based on EDT. The scenario modeled was that of "no passage" at Castile Falls, meaning that the habitat above Castile Falls is not yet seeded (current conditions).

In addition to EDT modeling results, field biologists and geomorphologists have identified physical degradations (such as in fluvial geomorphology) that may be contributing to limiting biological production of Klickitat steelhead and may need to be addressed to restore properly functioning conditions in the watershed.

[6] The MaSA identified by Yakama Nation Fisheries staff is similar, but begins at the top of Castile Falls (0.8 RM above the confluence with the West Fork Klickitat).
[7] The Middle Klickitat MaSA identified by Yakama Nation Fisheries staff is relatively congruent with the ICTRT's Middle Mainstem MaSA, but does not include the watershed area between the Summit and White Creek confluences with the mainstem Klickitat.
[8] The Klickitat Canyon MiSA as identified by Yakama Nation Fisheries encompasses the Klickitat River mainstem from the Klickitat Hatchery to the base of Castile Falls and includes Surveyors Creek.

Table II-2. EDT Strategic Priority Summary for Protection and Restoration of Klickitat Steelhead by the Yakama Nation's Identified MaSAs and MiSAs, and Primary Limiting Factors Note: The major and minor spawning areas used in the EDT analysis input were identified by the Yakama Nation Fisheries staff, and differ from those MaSAs and MiSAs identified by the ICTRT for recovery planning purposes (Table II-1 above).

Klickitat River Steelhead
Protection and Restoration Strategic Priority Summary

Spawning area priority			Attribute class priority for restoration																
Major or minor spawning area	**Protection benefit**	**Restoration benefit**	***Channel stability***	***Chemicals***	***Competition (w/ hatch)***	***Competition (other sp)***	***Flow***	***Food***	***Habitat diversity***	***Harassment/poaching***	***Obstructions***	***Oxygen***	***Pathogens***	***Predation***	***Sediment load***	***Temperature***	***Withdrawals***	***Key habitat quantity***
Klickitat Canyon	○ High	○ Low						● Low							● Low			
Lower Klickitat	○ Medium	○ Low			● Low		● Low	● Medium	● Medium	● Low				● Low	● Low	● Low		● Low
Lower Little Klickitat	○ Low	○ Low			● Low		● Low						● Low	● Low	● Medium	● Medium		
Middle Klickitat	○ High	○ Medium	● Low		● Low		● Low		● Low	● Low				● Low	● Medium			● Low
Swale Cr.	○ Low	○ Medium					● Low	● Medium	● Low				● Medium	● Low	● Medium	● High		● Medium
Trout Cr.							● Low	● Medium	● Low						● High	● Low		● Low
Upper Klickitat		○ High	● Low					● Low	● Low		● High				● Medium	● Low		● Low
Upper Little Klickitat	○ Low		● Low		● Low		● Low	● Low	● Low		● High		● Low	● Low	● Medium	● Medium		● Low
Upper Middle Klickitat	○ Medium		● Low		● Low		● Low		● Low					● Low	● Low			
West Fork Klickitat R.																		
White Cr.	○ Medium	○ High					● Low	● Low	● Low						● Medium	● Medium		● Medium

1/ "Channel stability" applies to freshwater areas only.

Key to strategic priority (corresponding Benefit Category letter also shown)

A	B	C	D & E
○ / ● High	○ / ● Medium	○ / ● Low	Indirect or General

Limiting Factors and Threats in ICTRT Spawning Areas

Tables II-3 through II-12 show the limiting factors and threats identified by Yakama Nation Fisheries biologists within each of the ICTRT's major and minor spawning areas. Information used to identify these factors and threats came from several sources: 1) the analysis completed through the Northwest Power and Conservation Council's 2004 subbasin planning process; 2) the Klickitat Lead Entity process performed under the Washington State Salmon Recovery Planning process, SB2496; 3) and a Yakama Nation 2005 EDT model run incorporating major spawning areas. The tables provide for each area: limiting factors, problem location, VSP parameters and life stages affected, threats, significance and severity of the problem, and actions needed to address the problems.

The "predation" limiting factor is generated from EDT model parameters. Specific predation studies that were used to develop the EDT "predation" attribute and rule making can be found at www.mobrand.com and include Weber and Fausch (2003).

Table II-3. Potential Limiting Factors for Middle Columbia River Steelhead in the Upper Mainstem MaSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor/s	VSP Parameters Impacted	Affected Sites	Threats	Life Stages Affected	Significance (Scope/Severity)	Actions
Blocked or impaired passage	Spatial structure	Culverts on several tributary streams	Obstruction of juvenile, and possibly adult, movement at culverts.	PM	At least one partial barrier culvert near the mouth of Piscoe Creek and 3 more possible barriers upstream, and a partial barrier near the mouth of McCreedy Creek may be replaced by BIA timber sale improvement plan.	Replace culverts.
Altered sediment routing	Abundance, productivity	Chaparral Creek, McCreedy Creek, Piscoe, Diamond Fork, Coyote, Butte Meadows, Klickitat R. from Castile Falls (RM 65.75) to RM 87.05	Increased road densities and drainage extension; ORV trail use.	E, F	Point source delivery of fine sediment from roads; stream bank mass wasting. High impact in McCreedy, mainstem from RM 71.49-75.36, RM 76.99- 87.05, and Diamond Fork RM 0 - 12.22, in Piscoe Creek and Butte Meadows; moderate impact on F from RM 8.76-12.22 of Diamond Fk., E and F stages in Coyote, and on E in Klickitat mainstem RM 65.78-68.82; extreme impact on E stage in Coyote Creek Actions will decrease run-off/peak flows and sediment introduction, decrease interception and incision of shallow groundwater flows, and restore valley-bottom morphology and potential for channel migration. Spawning and rearing habitat will be improved; egg-to-fry survival will increase.	Disconnect roads from stream network; relocate/ abandon mid-slope roads where possible; relocate/abandon valley-bottom roads where possible. Improve surface and drainage characteristics of roads in tributary watersheds. Riparian forest management and planning: leave buffer strips in riparian forest zones. Reduce fine sediment introduced from streambank mass wasting. Limit riparian livestock grazing.
Degraded water quality, water temperatures	Abundance, productivity	Piscoe Creek, Chaparral Creek, Diamond Fork, Coyote Creek	Road densities; floodplain roads; past grazing.	R0, I0-1, R1, R2+	Lack of riparian canopy and pool habitat. High temperatures during summer low flows and formation of anchor ice in winter caused by lack of cover and pools limit productivity. High impact on R0, R1 in Piscoe and Chaparral; moderate impact in Diamond Fk., in Klickitat mainstem RM 8.76-10.04)., and on I0-1 and R1 in Coyote; moderate impact on R1 and R2+ in upper Diamond Fk. Rearing habitat, juvenile survival will be improved.	Riparian re-vegetation. Restore channel morphology. Disconnect roads from streams. Limit riparian livestock grazing. Eradicate non-native invasive plant species from critical watershed areas.
Channel instability , loss of floodplain function and channel migration processes, degraded riparian condition	Abundance, productivity	Chaparral Creek, Coyote Creek, McCreedy Creek, Butte Meadows Creek, Klickitat R. from Castle Falls (RM 65.75) to RM 87.05, Upper Diamond Fork	Historical grazing; channel confinement due to armoring; streamside ORV trails (avulsion risk), roads, road failures.	S, E, F	Extreme impact on E in Coyote; high in Chaparral, upper Piscoe and upper Diamond Fk., and from RM 75.36 - 87.05; moderate on S and F, and on E in Butte Meadows, from Chaparral to McCreedy, McCreedy Creek and upper Diamond Fork. Actions will lead to improved floodplain connectivity, pool quality, gravel sorting and stability, thus increasing available refugia, improving rearing habitat, and juvenile and egg-to-fry survival.	Relocate/ soften floodplain infrastructure. Perforate roads to allow peak flows to move onto floodplain. Close/relocate ORV trails. Place LWD or other structures to stop headcutting. Vegetate riparian areas. Limit riparian livestock grazing. Eradicate non-native invasive plant species from critical watershed areas.
Reduced key habitat quantity from lost floodplain function and channel migration processes, degraded riparian condition	Abundance, productivity	Klickitat River from RM 70.5 to RM 87.05, Piscoe Creek, Diamond Fork, Butte Meadows Creek, Chaparral Creek	Hydroconfinement; floodplain roads; historical overgrazing. Potential habitat fragmentation.	S, E, F, R0, I0-1, M1, R1, R2+, M2+, PM, PH	High impact on all life stages except TR2+ in upper reach of Diamond Fk.; moderate impact on all except TR2+ (high impact on S, E, PH) in lower Diamond Fk.; moderate on all except TR2+ in upper Piscoe and high impact on PH; moderate impact on E stage in Chaparral and S and E stages in Butte Meadows. Improved side-channel habitat, pool quality and quantity will	Restore floodplain and side-channel connectivity. Restore stream length. Place LWD. Short-term introduction of spawning gravel. Protect existing habitat from future degradation. Limit riparian livestock grazing.

Limiting Factor/s	VSP Parameters Impacted	Affected Sites	Threats	Life Stages Affected	Significance (Scope/Severity)	Actions
					improve rearing habitat and juvenile growth and survival. Numerous private sections in the upper portion of the Diamond Fork watershed were purchased by a developer. WaDNR parcels that are currently in State Lands could be reclassified as Natural Areas.	
Reduced habitat diversity, riparian condition, floodplain function and channel migration processes	Abundance, productivity	Klickitat River from RM 70.5 to RM 87.05, Piscoe Creek, Diamond Fork, Butte Meadows Creek, Chaparral Creek	See above.	S, F, R0, I0-1, R1, M1, R2+	Moderate impact on S, F, I0-1, M1, R1 in upper Piscoe, lower Diamond Fork; high impact on F and moderate on all I0-1 stages in Coyote Creek, moderate impact on S in Diamond, and S and F in Chaparral.	See above.
Reduced food web	Abundance, productivity	Klickitat River from RM 70.5 to RM 87.05, Chaparral Creek, Diamond Fk., Piscoe Creek	Loss of salmon carcasses.	F, I0-1, R1	Greater impact of reduction in food web on fry colonization in mainstem than in tributaries. Moderate impact on F from Castile to Diamond Fk., lower Chaparral, upper Piscoe, also on I0-1 in lower Diamond Fk. Reducing sediment inputs will increase aquatic insect production for food. Carcass analogs may provide a temporary food source for juveniles. Actions will improve primary and secondary productivity by improving substrate conditions.	Improve channel complexity and connectivity (see above). Short-term fertilization of stream with carcasses or carcass analogs. Decrease fine sediment production and delivery from roads and other land uses.
Harassment/ poaching	Abundance	Upper Klickitat mainstem	Illegal harvest.	S, PH	Infrequent/episodic occurrence but with moderate to high impact when it does occur.	Eliminate illegal harvest by enforcing tribal regulations

* Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0,1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage.

Table II-4. Potential Limiting Factors for Middle Columbia River Steelhead in the White Creek MaSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor	VSP Parameter Impacted	Affected Sites	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Altered hydrology	Abundance, productivity, spatial structure	White Creek to RM 1.46, RM 9,59 - 13.88; Brush Creek; Tepee Creek, and NE tributary to Tepee Creek (less impact than the rest of Tepee Creek)	Past riparian logging; some stream cleaning; floodplain roads.	F, R0, I0-1, R1	Channel incision resulting in reduced perennial and hyporheic flows; scour of spawning gravels, incision related to increased peak flows. Reduced LWD. Moderate impact on F in White Creek RM 0 -1.46, RM 2.40 - 13.88, upper Tepee, in NE trib. and W. Fk.; moderate on R0 in White Creek RM 2.40 m – 10.6., in Brush and Tepee; moderate on I0-1 in Brush from RM 3.46 – 8.03, in White Creek RM 4.86-9.59, RM 10.42 – 13.88, in NE trib., to RM .19, in Tepee from RM 3.58-9.91; moderate on R1 in White Creek RM 4.86-9.59 and R, 10.42-10.60. Egg-to-smolt survival ratio is closely related to summer flow conditions.	Restore floodplain connectivity; increase floodplain and channel roughness. Disconnect road network to improve watershed and water retention.
Reduced key habitat quantity, floodplain function and channel migration processes, degraded riparian condition	Abundance, productivity, spatial structure	White Cr to RM 1.46, RM 2.4 - RM 16.3; Brush Creek; Tepee Creek	Past riparian logging; some stream cleaning; road densities and floodplain roads. Potential habitat fragmentation via subdivision, land-clearing, and development.	S, E, F, R0, I0-1, M1, R1, R2+, M2+, PM, PH	Channel simplification and disconnected floodplain side-channels due to incision. Reduced LWD. Increased run-off. High impact on S and E in White Creek RM 0 -1.46 and in Brush Creek to RM 3.46; on S, E, F and R0 in White RM 10.42-13.88, and E, F, R0 in Brush Creek RM 3.46-8.03, , in Tepee (also on PH) and upper White; moderate impact on other affected stages in Brush, upper White and Tepee. Loss of spawning gravel (habitat) below Brush Creek due to scouring. Rearing limited from Brush Creek to above the IXL road. Lack of perennial flows. Actions would reduce incision; restore channel roughness and complexity to better handle peak flows and augment base flows; increase pool abundance and rearing capacity; improve sorting of sediments and gravel retention. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Disconnect road network to improve watershed and water retention. Place LWD. Augment gravel. Excavate pools. Restore floodplain connectivity. Limit riparian livestock grazing. Protect existing habitat from future degradation.
Reduced habitat diversity, lost floodplain function and channel migration processes	Abundance, productivity	White Creek to RM 1.46, RM 4.86 - 16.3; Tepee Creek; W. Fork White Creek	Primarily road densities and floodplain roads. Potential habitat fragmentation via subdivision, land-clearing, and development.	S, F, R0, I0-1, R1, M1, R2+, M2+	Channel simplification and disconnected floodplain due to incision. Reduced LWD, increased run-off. High impact on F in White Creek RM 4.86 - 9.59; moderate impact on S, F, R0 and I0-1 in White Creek to RM 1.46 and RM 2.40 – 4.86; moderate also on I0-1, R1, M1, R2+, M2+ RM 4.86-9.59. Loss of spawning and rearing habitat.	Investigate off-channel livestock watering in Tepee Creek Improve pool: riffle ratio; add LWD; increase riparian cover; add spawning gravel. Increase floodplain connectivity by correcting channel incision and relocating or modifying floodplain roads. Protect existing habitat from future degradation.

Limiting Factor	VSP Parameter Impacted	Affected Sites	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Blocked or impaired passage	Abundance, spatial structure	White Creek RM 4.86 -9.59; Tepee Creek; NE tributary to Tepee Creek; Fork White Creek	Inadequate culvert sizing and installation at 2.7 miles upstream of IXL road crossing in upper White Creek	E, R0, R1, R2+, (to a lesser degree M1, M2+), TR2+	Upstream movement of juveniles from rearing habitat to perennial refugia limited. Moderate impact.	Culvert replacement.
Altered sediment regime	Abundance, productivity	White Creek to RM 1.46, RM 9– headwaters; Brush Creek; NE tributary to Tepee Creek; W. Fork White Creek	Point source delivery of fine sediment associated with road drainage.	S, E, I0-1	High impact on E in upper Brush, White Creek RM 9 - headwaters, in Tepee, NE Trib., and W. Fork, moderate in upper White and lower Brush. Potential additional minor contribution of sediment from aerial deposition due to road traffic.	Improve road drainage characteristics and surfacing. Disconnect roads from stream. Riparian forest management and planning: plan to leave buffer strips in riparian forest zones. Address fine sediment introduction from streambank mass wasting by modifying channel morphology and restoring floodplain connectivity
Degraded water quality, water temperature	Abundance, productivity, spatial structure	White Creek to RM 1.46; RM 4.86 - RM 16.3; Brush Creek; Tepee Creek; W. Fork White Creek	Past riparian logging; some stream cleaning; Land use practices that increased run-off (primarily from road densities) and floodplain roads; channel incision.	S, E, F, R0, R1, R2+	Reduced perennial and hyporheic flows, reduced riparian canopy. Reduced LWD. Extreme impact on E in upper Brush; high impact on E in the mouth of White Creek and from Brush Creek to ~16 mi. upstream, in W. Fork, Tepee, and upper Brush; also extreme on S and R0 and high impact on E, F, R1 and R2+ life stages in W. Fork White to RM 1.91	Restore floodplain connectivity. Re-vegetate riparian zone and floodplain. Eradicate non-native invasive plant species from critical watershed areas.
Reduced food web	Abundance, productivity	White Creek to RM 1.46, RM 9.59 - RM 13.88; Brush Creek; Tepee Creek; NE tributary; W. Fork White Creek	Reduced LWD from past riparian logging, some stream cleaning; increased run-off (primarily from road densities) and floodplain roads.	F, R0, I0-1, R1	Potential reduction in macroinvertebrate densities due to low flows or lack of perennial flow upstream and high fine sediment load. High impact on F in upper Tepee; moderate impact on F in lower White, lower Brush, lower Tepee, White from Brush to ~16 mi. upstream and in lower W. Fork; moderate on I0-1 from bottom of 1st meadow to Tepee, (also on R1) in upper Tepee	Restore floodplain connectivity. Disconnect road network to improve watershed and water retention. Improve road drainage characteristics and surfacing. Place LWD. Increase pool quantity and quality; improve pool/riffle ratio. Augment gravel. Riparian forest management and planning: plan to leave buffer strips in riparian forest zones. Investigate off-channel livestock watering in Tepee Creek Place carcass analogs.
Reduced floodplain function and channel migration processes, channel stability	Abundance, productivity	Mainstem White from ~RM 3 to IXL Road; Tepee Cr from mouth to ~RM 10; Brush Creek from mouth to ~RM 8.	Channel incision.	E, F, I0-1	Moderate impact on affected life stages.	Restore floodplain connectivity, profile and cross-sectional morphology. Decrease amount of water delivered to stream network by roads.

* Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0,1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage.

Table II-5. Potential Limiting Factors for Middle Columbia River Steelhead in the Middle Mainstem MaSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor	VSP Parameters Impacted	Affected Sites	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Altered sediment routing	Abundance, productivity	Klickitat R. from Little Klickitat River to Dead Canyon. (RM 20.44 – RM 31.46); Dead Canyon; Beeks Canyon; Summit Creek; Klickitat R. from Summit Creek to White Creek (RM 37.73 – 40.27)	Increased road densities and drainage extension; delivery of fine sediment from upstream tributaries (primarily glacial, but also from road runoff).	E, F, I0-1, R0, R1, R2+, TR2+	High impact on E, F, I0-1 in mainstem from Beeks to Summit, Dead Canyon, Summit; moderate from Little Klick to Beeks. Road densities contribute to turbidity and clog interstitial spaces, interfering with rearing and feeding.	Disconnect road network from streams. Improve road surface and drainage. Riparian forest management and planning: plan to leave buffer strips in riparian forest zones.
Reduced key habitat quantity, reduced floodplain function and channel migration processes	Abundance, productivity	Klickitat R. from Little Klickitat R. to Summit Creek (RM 20.44-RM 37.73), Summit Creek to Hatchery (RM 37.73 – 42.5); Dead Canyon, Summit Creek	Hydroconfinement. Habitat fragmentation via subdivision, land-clearing, and development.	S, E, F, R0, I0-1, M1, R1, R2+, M2+, PH	Channel simplification and disconnected side-channels. Reduced LWD. High impact on S and E in Beeks and Summit, on E, F and R0 in Dead Canyon; moderate impact in Klickitat R. from RM 20.44-31.46; moderate on S and F in lower Dead Canyon, on R1, PM and holding in Dead Canyon RM 5-3.54, moderate on PH from RM 20.44-37.73 in mainstem Klickitat. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Restore floodplain and side-channel connectivity. Restore stream length. Short-term introduction of spawning gravel. Place LWD. Protect existing habitat from future degradation.
Reduced habitat diversity, loss of floodplain function and channel migration processes	Abundance, productivity	Klickitat R. from Little Klickitat River to Summit Creek (RM 20.44-RM 37.73) and Summit Creek to Hatchery (RM 37.73 – 42.5); Dead Canyon	Hydroconfinement; floodplain infrastructure; historical overgrazing. Habitat fragmentation via subdivision, land-clearing, and development.	S, F, R0, I0-1, R1, M2+	Channel simplification and disconnected side-channels. Moderate impact on S and F in mainstem Klickitat RM 20.44- 25.95 and Summit Creek, moderate on F in lower Dead Canyon; moderate on F, R0 and I0-1 in Dead Canyon RM 2.55-3.54. Actions would create refugia. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Restore floodplain and side-channel connectivity. Restore stream length. Short-term introduction of spawning gravel. Place LWD. Protect existing habitat from future degradation.
Degraded water quality, water temperature	Abundance, productivity	Beeks Canyon; Dead Canyon to RM 2.55	Road densities, floodplain roads; possibly some grazing and past riparian logging impacts.	S, E, F, R0	Lack of riparian canopy and pool habitat; reduced perennial and hyporheic flows, sediment load. High impact on E in Beeks, moderate in Dead Canyon, moderate on S from RM 31.46-37.73 in the mainstem Klickitat	Riparian re-vegetation. Eradicate non-native invasive plant species from critical watershed areas. Restore channel morphology. Disconnect roads from streams. Obtain instream flow right for mainstem Klickitat.
Harassment/ poaching	Abundance	Klickitat R. from Little Klickitat R. to	Post-release mortality from fishing, poaching of wild fish, by-	S, PH, PM	Moderate impact	Enforcement of fishing regulations, tackle restrictions, shorter sport

Limiting Factor	VSP Parameters Impacted	Affected Sites	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
		Summit Creek (RM 20.44-RM 37.73);	catch during whitefish season			season
Altered hydrology	Abundance, productivity	Dead Canyon; Summit Creek (also Beeks Canyon historically)	Reduction in forest canopy; incision of headwater (non-fish-bearing) reaches; reduced forest and floodplain storage.	F, R0	Altered watershed hydrology; shorter flow duration (low flows), higher peak flows, and increased incision. High impact on R0 in lower Dead Canyon, moderate on F and R0 in Dead Canyon RM 2.55-3.54 (low flows); I0-1 stages affected by higher peak flows.	Restore floodplain connectivity. Disconnect road network to improve watershed and water retention.
Predation	Abundance, productivity	Little Klickitat River to Summit Creek (RM 20.44-RM 37.73); Summit Creek to Hatchery (RM 37.73 – 42.5)	High density of hatchery-origin smolts; dewatering.	F, R0	Dewatering intensifies impact from avian and terrestrial predators. Moderate impact	Change stocking practices with regards to numbers, location and timing of smolt outplanting. Research interaction with hatchery fish, native and non-native predators.
Competition with hatchery fish	Abundance, productivity	Klickitat R. from Little Klickitat R., to Summit Creek (RM 20.44-RM 37.73), Summit Creek to Hatchery (RM 37.73 – 42.5)	High density of hatchery-origin smolts (coho, fall Chinook salmon and steelhead); size of *O.mykiss* smolts released; fall Chinook salmon releases may also be an issue.	R0, R1, R2+	Moderate impact. R0 affected by fall Chinook salmon releases.	See above.
Channel instability, loss of floodplain function and channel migration processes; degraded riparian condition	Abundance, productivity	Klickitat R. from Little Klickitat River to Summit Creek (RM 20.44-RM 37.73), Summit Creek to Hatchery (RM 37.73 – 42.5)	Channel confinement; armoring of embankment adjacent to road.	S, E	Channel confinement: stream too (artificially) stable laterally causing vertical instability. Moderate impact	Relocate/soften floodplain infrastructure. Perforate roads to allow peak flows to move onto the floodplain. Place LWD or other structures to stop headcutting. Vegetate riparian areas. Eradicate non-native invasive plant species from critical watershed areas. Close/relocate ORV trails.
Blocked or impaired passage	Abundance	Tributary mouths	Lack of access to spawning tributaries.	PM	High impact in low water years; likely occurred naturally, but human impacts have likely increased frequency	Study passage at tributary mouths relative to flow and alluvial fan morphology.

* Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0,1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage.

Table II-6. Potential Limiting Factors for Middle Columbia River Steelhead in the Lower Mainstem MaSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor	VSP Parameters Impacted	Affected Sites	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Reduced key habitat quantity, loss of floodplain function and channel migration processes; degraded riparian condition	Abundance, productivity	Klickitat R. to top of Bonneville Pool (to RM 1.19); Snyder Creek to RM 1.57	Inundation by Bonneville Pool, anthropogenic influences e.g. hydroconfinement, alteration of riparian zone by road, railroad prism and Snyder Creek mill complex; habitat fragmentation via subdivision, land-clearing, and development.	S, E, F, I0-1, R1, R2+, M2+, PH, PM	Extreme impact on I0-1, R1, R2+ in impounded lower reach of Klickitat R. to RM 1.19; extreme impact on PH and high impact on F, I0-1, R1, R2+, M2+ and PM in Snyder Creek to RM .58; high impact on S, E and PH in Snyder within mill flume reach. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Encourage dam operations that mimic natural flow regimes. Restore floodplain and channel connectivity. Place LWD. Monitor and continue restoration efforts in Snyder Creek mill reach (flume passage improvements and riparian re-vegetation). Protect existing habitat from future degradation. Eradicate non-native invasive plant species from critical watershed areas.
Reduced habitat diversity, loss of floodplain function and channel migration processes; degraded riparian condition	Abundance, productivity	Klickitat R. to top of Bonneville Pool (to RM 1.19), RM 5.72 – 9.72, RM 11.29 - 20.44; Snyder Creek	Inundation by Bonneville Pool, channel simplification due to hydroconfinement by road and railroad prism; habitat fragmentation via subdivision, land-clearing, and development.	S, F, R0, I0-1, M1, R1, R2+ and M2+	Extreme impact on I0-1 and R1 and high impact on R2+ and moderate on M1 and M2+ in the Klickitat R. below RM 1.19; high impact on S and F between Snyder and Swale Cr RM 14.63-17.88; and on F in Snyder to RM .58; moderate on S, F, R0 in the Klickitat R. RM 11.29 - 14.63 , and for M1 and M2+ in the mainstem to RM 1.19; moderate on I0-1 and R1 from Lyle Falls to Logging Camp Canyon RM 2.61 – 9.72, and on S, F, and R0 from Wheeler to Snyder RM 11.29 – 14.63; moderate on S, R0, I0-1, R1, R2+, and M2+ in Snyder to RM .58, and on S, F and R0 RM .58 – 1.57 ; moderate on R0, I0-1, M1, R1 and M1 from Snyder to Swale Creek RM 14.63 – 17.88. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	See above.
Reduced food web	Abundance, productivity	Snyder Creek; Klickitat R. to top of Bonneville Pool (to RM 1.19)	Inundation by Bonneville Pool; hydroconfinement.	F, R0, I0-1, R1	Reduced benthic community; channel simplification. Extreme impact on F, R0, I0-1, R1 in Snyder Creek; moderate impact on I0-1 and R1 from mouth of Klickitat to top of Bonneville Pool at RM 1.19.	Encourage dam operations that mimic natural flow regimes. Restore floodplain and side-channel connectivity. Place LWD.
Degraded water quality, water temperatures	Abundance, productivity	Snyder Creek	Mill site; roads and past grazing practices in headwaters.	F, R0	Reduced riparian canopy in mill reaches and reduced hyporheic flows. High impact on affected life stages in Snyder Creek	Restore channel morphology. Re-vegetate riparian areas. Eradicate non-native invasive plant species from critical watershed areas.
Altered sediment routing	Abundance, productivity	Mainstem Klickitat from Snyder Creek to Little Klickitat R.	Headwater forest practices and roads.	E	Moderate increase in fine sediment delivery over background levels. High impact from Snyder to Little Klickitat RM 14.63 – 20.44, upper Snyder; moderate	Disconnect roads from stream network; relocate/ abandon mid-slope roads where possible; relocate/abandon

Limiting Factor	VSP Parameters Impacted	Affected Sites	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
		(RM 14.63 – 20.44), Snyder Creek (RM .58 – RM 1.57)			impact Wheeler to Snyder RM 11.29-14.63.	valley-bottom roads where possible. Improve surface and drainage characteristics of roads in tributary watersheds. Riparian forest management and planning: plan to leave buffer strips in riparian forest zones.
Predation	Abundance, productivity	Klickitat R. to top of Bonneville Pool (to RM 1.19), from Wheeler Canyon to Little Klickitat R. (RM 11.29-20.44)	Increased densities of native and non-native predators in Bonneville Pool reach; hatchery stocking practices.	F, I0-1, M1, R1, M2+	High densities of hatchery outplants. Moderate impact on affected life stages in Klickitat mouth; and on F from Wheeler to Little Klickitat R.	Change stocking practices with regards to numbers, location and timing of smolt outplanting. Research interaction with hatchery fish, native and non-native predators.
Competition with hatchery fish	Abundance, productivity	From top end of Bonneville pool to Little Klickitat R. (RM 1.19 – 20.44)	High densities of hatchery outplants.	R1, R2+	Moderate impact	See above.
Blocked or impaired passage	Abundance, spatial structure	Mouths of spawning tributaries	Altered hydrograph; channel morphology	R0, R1, R2+	In low precipitation years there is often insufficient flow for adult passage through alluvial fans of spawning tributaries.	Study passage relative to flow and alluvial fan morphology.
Channel instability, loss of floodplain function and channel migration processes	Abundance, productivity	Mainstem Klickitat	Roads	E, F, I0-1	Confinement has contributed to incision and bed coarsening.	Restore floodplain connectivity.
Impaired passage	Productivity	Mainstem Klickitat	Unscreened pump intakes	F, R0, R1	Increases juvenile mortality	Ensure that pump intakes are adequately screened. Determine extent of problem for inadequately screened intakes.
Altered hydrology	Abundance, productivity, spatial structure, diversity	Mainstem Klickitat and tributaries	Dewatering in tributaries. Future water demand for out-of-channel use in mainstem.	S, R0, R1, R2+	Dewatering is currently a problem in tributaries and potential future problem in mainstem.	Obtain instream flow right for mainstem Klickitat. Restore floodplain connectivity in tributaries. Assess effects of groundwater development on tributary flow.
Harassment/ poaching	Abundance	Mainstem, tributaries	Poaching.	PM	Moderate and periodic problem	Reduce/eliminate poaching by both sport and tribal fishermen. Further restrict sport fishing in lower basin tributaries, e.g. Logging Camp Creek.

Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0,1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage.

Table II-7. Potential Limiting Factors for Middle Columbia River Steelhead in the Upper Little Klickitat MaSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor	VSP Parameters Impacted	Affected Sites	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Reduced habitat diversity, degraded floodplain function and channel migration processes	Abundance, productivity	Spring Creek, W. Prong, E. Prong, Little Klickitat R. from Spring Creek to Cozy Nook (RM 9.02 – 20.34)	Hydroconfinement and channel incision; roads; grazing and forest practices; habitat fragmentation via subdivision, land-clearing, and development.	S, F, R0, I0-1, M1, R1, M2+	Disconnected side-channels and channel simplification; reduction in LWD. Moderate impact on affected life stages. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Restore side-channel and floodplain connectivity. Excavate pools. Place LWD. Augment gravel. Protect existing habitat from future degradation. Eradicate non-native invasive plant species from watershed areas.
Altered hydrology	Abundance, productivity	Little Klickitat R. from Spring Creek to W. Prong (RM 9.02-26.61); Spring Creek to RM 3.53; Bloodgood Creek; W. Prong; E. Prong; Butler Creek; Dry Creek	Diversions; road densities.	F, R0, I0-1, R1	Channel simplification, channel incision and disconnected floodplain side-channels; reduced perennial and hyporheic flows. Moderate impact on affected life stages in lower Spring Creek and upper Little Klickitat watershed	Manage diversions to maximize instream summer flows. Disconnect roads from stream. Improve road drainage characteristics and surfacing.
Altered sediment routing	Abundance, productivity	Spring Creek, Bloodgood Creek to RM 2.23, W. Prong; E. Prong; Little Klickitat R. from Spring Creek to W. Prong (RM 9.02-26.61); Butler Creek; Dry Creek	Increased road densities in headwater tributaries and untreated forest road segments; runoff from agricultural lands.	S, E	Runoff, surface and re-distribution of in-channel fine sediment in the form of bank mass wasting; delivery of fine sediment from upstream tributary sources; agricultural sediment in Spring Creek, unnamed tributaries to Spring Creek, and Little Klickitat R. from Spring Creek to Bloodgood (downstream of Goldendale). Extreme impact on E in lower Spring and lower Bloodgood, in lower Klickitat R. from Cozy Nook to ~RM 24, W. Prong, and E. Prong from Dry Creek to Idlewild Canyon RM 2.73 – 4.81, Butler and Dry Creek; high impact on E RM 15.46 – 20.34, from ~RM 24 to W. Prong; mouth of E. Prong	Disconnect roads from stream. Reduce sediment inputs. Improve road drainage characteristics and surfacing. No-till cropping. Promote riparian buffers. Restore floodplain connectivity/channel morphology; decrease mass wasting of banks.
Degraded water quality, water temperatures	Abundance, productivity	Little Klickitat R. from falls to Hwy 97 (RM 6.38 – RM 26.68); Spring Creek; E. Prong; W. Prong	Roads; grazing; lack of riparian cover.	F, R0, R1, R2+, TR2+	Reduction in base flows and canopy cover, change in channel morphology (width to depth ratio). High to extreme impact on F and R0 in mainstem Little Klickitat from Spring Creek to W. Prong; high impact on R1 from Cozy Nook to ~RM 24; moderate impact on S from Spring Creek to Hwy. 97	Re-vegetate riparian areas. Increase riparian cover. Leave riparian buffer. Limit riparian grazing. Eradicate non-native invasive plant species from critical watershed areas. Restore floodplain connectivity and channel morphology.

Limiting Factor	VSP Parameters Impacted	Affected Sites	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Reduced key habitat quantity, floodplain connectivity and function	Abundance, productivity	Little Klickitat R.; W. Prong; E. Prong; Butler Creek	Primarily past riparian management; habitat fragmentation via subdivision, land-clearing, and development.	S, E, F, I0-1, PH,	Channel simplification and disconnected floodplain side-channels due to incision. High impact on S, E ~RM 24 to 26.6 and in W. Prong, E. Prong and Butler to Hwy. 97; rearing stages affected downstream of approximately Cozy Nook Creek; impact on S upstream of there. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Restore side-channel and floodplain connectivity. Excavate pools. Place LWD. Augment gravel. Protect existing habitat from future degradation.
Degraded water quality, pathogens	Abundance	Little Klickitat R. from Spring Creek to Idlewild Canyon (RM 9.02 – RM 4.81 on E. Prong); Spring Creek to RM 3.53; Butler Creek	Hatchery stocking; riparian grazing; anecdotal indications of illegal stocking of rainbow trout in tributaries to the Little Klickitat R.	R0, R1, R2+, TR2+	Presence of hatchery fish. Elevated stream temperatures. High impact in Little Klickitat from Cozy Nook to ~RM 24, in E. Prong from Butler to Dry Creek, moderate impact elsewhere	Re-vegetate riparian areas to reduce stream temperatures. Increase riparian cover. Leave riparian buffer. Limit riparian grazing. Restore floodplain connectivity and channel morphology. Curtail hatchery releases.
Predation	Abundance, productivity	Spring Creek to RM 3.53, Little Klickitat from Spring Creek to Idlewild (RM 9.02 – RM 4.81 on E. Prong); W. Prong; Bloodgood Creek to RM 2.23; Butler Creek	Increased number of fish taxa present; hatchery outplants and dewatering may be factors in the mainstem.	F, R0	Reduced summer base flows (stranding); lack of refugia, cover habitat. Moderate impact on F in all affected reaches; also on R0 from Butler to Dry Creek	Change stocking practices with regards to numbers, location and timing of smolt outplanting. Research interaction with hatchery fish, native and non-native predators.
Blocked or impaired passage	Abundance, spatial structure	West Prong at RM .07, RM 21.16; E. Prong at RM 25.41, RM 18.4 on Jenkins Cr;., RM 21.35 on Butler Creek, RM 23.99 on Dry Creek, and RM 25.59 on Idlewild Canyon Creek	Box culverts under highway impede upstream fish passage.	PM, R0, R1, R2+, TR2+,	Extreme impact at box culvert barrier under Hwy. 97 at RM .07; varying passage at other culverts may present limited impediments to fish passage in good water years.	Replace culverts.
Reduced food web	Abundance, productivity	Little Klickitat R. from Spring Creek to Idlewild (RM 9.02 – RM 4.81 on E. Prong); Spring Creek to RM 3.53; Bloodgood Creek; W. Prong, Butler Creek; Dry Creek	Agriculture and grazing practices.	F, I0-1, R0, R1	Reduction in benthic community; nutrient enrichment, elevated temperatures and fine sediment delivery. High impact on F in mouth of Bloodgood, and from there to Cozy Nook in mainstem L. Klickitat; high also on F in Dry Creek from Hwy. 97 to ~ RM 2.5 and in E. Prong from Dry Creek to Idlewild.	Restore floodplain connectivity and channel morphology. Disconnect roads from stream. Reduce sediment inputs. Improve road drainage characteristics and surfacing. No-till cropping. Promote riparian buffers. Increase riparian cover. Investigate off-channel livestock watering.

Limiting Factor	VSP Parameters Impacted	Affected Sites	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Competition with hatchery fish	Abundance, productivity	Little Klickitat R. from Bloodgood Creek to Cozy Nook Creek (RM 15.46 – 20.34); Bloodgood Creek to RM 2.23	Resident rainbow stocking from Goldendale Hatchery.	R0, R1, R2+	Moderate impact on active rearing life stages	Modify hatchery outplant practices with regard to number, location and timing of smolt releases.
Channel instability, loss of floodplain function and channel migration processes; degraded riparian condition	Abundance, productivity	Spring Creek, Little Klickitat R. from Spring Creek to Cozy Nook (RM 9.02 – 20.34); Bloodgood Creek to RM 2.23, W. Prong; E. Prong from W. Prong to Idlewild (RM 0 – 4.81)	Hydroconfinement, active historical stream clearing in upper tributaries; hardened banks on road segments, infrastructure and bank armoring in agricultural lands.	E, F	High impact on E in lower Spring Creek, mouth of Bloodgood, W. Prong to RM 1.93, and in E. Prong from Dry Creek to Idlewild	Restore floodplain connectivity and channel morphology. Place LWD or other structures to stop headcutting. Vegetate riparian areas. Perforate roads to allow peak flows to move onto floodplain.
Impaired fish passage	Productivity	Throughout MaSA	Unscreened pump intakes.	F, R0, R1	Extent of problem needs to be researched.	Ensure that pump intakes are adequately screened. Determine extent of problem for inadequately screened intakes.
Degraded water quality, oxygen	Abundance, productivity, spatial structure	Primarily downstream of Goldendale	Insufficient oxygen in mainstem Little Klickitat River.	R0, R1, R2+	Needs to be monitored and assessed.	Assess nutrient and dissolved oxygen levels in Little Klickitat River, primarily downstream of Goldendale

* Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0,1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage.

Table II-8. Potential Limiting Factors for Middle Columbia River Steelhead in the West Fork Klickitat MaSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor	VSP Parameters Impacted	Sites Affected	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Blocked or impaired passage	Abundance, spatial structure	Natural barriers at RM .45 and 4.43	Naturally occurring	PM	Passage and spawning frequency of this watershed largely undocumented, assumed to be minimal	Collect more data on passage frequency and spawner distribution
Altered sediment routing	Abundance, productivity	Roaded portions of MaSA	Sediment delivery from upstream road failures	E, I0-1	Protect streams from adverse effects of forest practices (particularly roads).	Prevent introduction of road-derived sediment; replace undersized crossings; disconnect roads from streams.

* Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0,1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage.

Table II-9. Potential Limiting Factors for Middle Columbia River Steelhead in the Swale Creek MiSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor	VSP Parameters Impacted	Sites Affected	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Degraded water quality, water temperatures	Abundance, productivity	Swale Creek mouth to S. tributary at RM 12	Railroad prism in floodplain.	S, E, F, R0, M1, R1, M2+, PM	Reduced riparian canopy, reduced perennial and hyporheic flows due to altered channel morphology and disconnected floodplain. Extreme impact on E stages and high on F and R0 in whole section; high on M1, R1 to RM 8, moderate there to RM 12; moderate impact on spawners throughout	Re-vegetate riparian areas. Eradicate non-native invasive plant species from critical watershed areas. Restore channel morphology.
Reduced key habitat quantity, floodplain function and channel migration processes	Abundance, productivity	Swale Creek mouth to S. tributary at RM 12	Railroad prism in floodplain. Habitat fragmentation via subdivision, land-clearing, and development.	All stages except TR2+	Channel simplification and lack of riparian vegetation to provide cover and recruit wood (creates pools for holding and rearing habitat and sorts substrate for spawning habitat).High impact on F and R0 to RM 4 (moderate on all other life stages in this reach); extreme on F and high on E, R0, M1,R1 and PH RM ~4-8, high impact on S, E, F and R0 ~RM 8-12. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Place LWD. Excavate pools. Augment gravel. Restore floodplain connectivity. Protect existing habitat from future degradation.
Altered sediment routing	Abundance, productivity	Swale Creek mouth to NW tributary at ~RM 8	Sediment delivery from agricultural sources in the highlands of the Swale Creek Basin.	E	High impact to RM 8	Promote no-till cropping and riparian buffers in agricultural areas.
Degraded water quality, pathogens	Abundance	Swale Creek mouth to S. tributary at RM 12	Hatchery stocking practices: presence of hatchery-origin fish (spawning and rearing coho/steelhead); railroad prism in floodplain.	R0	High density of hatchery-origin fish. Elevated stream temperatures due to lack of canopy cover, instream structure. Reduction in LWD related to railroad prism. High impact throughout the section	Re-vegetate riparian areas to reduce stream temperatures. Change stocking practices with regards to numbers, location and timing of smolt outplanting. Conduct pathogen sampling and monitoring.

Limiting Factor	VSP Parameters Impacted	Sites Affected	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Reduced food web	Abundance, productivity	Swale Creek mouth to S. tributary at RM 12	Railroad prism in floodplain.	F, R0, I0-1, R1	Potential reduction in macroinvertebrate densities; channel simplification, intermittent flows and high temperatures. High impact on F from ~RM 4-8 and moderate impact in other reaches; moderate impact on other affected stages from ~RM 4-8	Re-vegetate riparian areas. Eradicate non-native invasive plant species from critical watershed areas. Restore channel morphology. Place LWD. Excavate pools. Augment gravel. Restore floodplain connectivity.
Reduced habitat diversity, degraded floodplain function and channel migration processes	Abundance, productivity	Swale Creek mouth to S. tributary at RM 12	Hydroconfinement; railroad prism in floodplain; habitat fragmentation via subdivision, land-clearing, and development.	S, F, R0, I0-1, M1, R1, TR2+ M2+	Disconnected side-channels and channel simplification; channel incision; reduction in LWD. High impact on F between ~RM4-; moderate impact on S and F to RM ~4; moderate on S, R0, I0-1, M1, R1, and M2+ ~RM 4-8; moderate on S, F and R0 ~RM 8-12. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Restore floodplain and side-channel connectivity. Place LWD. Excavate pools. Augment gravel. Protect existing habitat from future degradation.
Predation	Abundance, productivity	Swale Creek mouth to S. tributary at RM 12	Hatchery stocking practices; loss of cover.	F, R0	High density of hatchery-origin fish; reduction in LWD and pools for cover. Moderate impact in whole section	Increase LWD and pool hiding cover. Change stocking practices with regards to numbers, location and timing of smolt outplanting. Research interaction with hatchery fish, native and non-native predators.
Altered hydrology	Abundance, productivity	Swale Creek mouth to S. tributary at RM 12	Upstream diversions (irrigation season); railroad prism in floodplain.	F, R0, I0-1, R1	Reduced summertime base flows, channel incision, reduced perennial and hyporheic flows; increased peak flows. Reduced LWD. Moderate impact on F and R0 to ~RM 4; moderate on F, R0, I0-1, and R1 ~RM 4-8; moderate on F ~RM 8-12	Reconnect floodplain. Manage diversions to maximize instream summer flows.
Channel instability, loss of floodplain function and channel migration processes	Abundance, productivity	Canyon reach.	Incision and channel instability.	I0-1, R0, R1, R2	Degraded habitat, low pool frequency and quality.	Restore cross-sectional morphology and roughness. Modify historical railroad grade. Modify land-uses and/or implement structures to retain storm flow and decrease time of concentration from watershed upstream of canyon.

* Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0,1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage.

Table II-10. Potential Limiting Factors for Middle Columbia River Steelhead in the Surveyor's Creek MiSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor	VSP Parameters Impacted	Location of Impacts	Threats	Life stages affected*	Significance (Scope/Severity)	Actions
Altered sediment routing	Abundance, productivity	Klickitat R. from Big Muddy Creek to Castile Falls step pool habitat (RM 54.87– 65.42); Trout Creek to RM 1.09, Bear Creek, Surveyors Creek	Increased road densities and drainage extension.	S, E, F, I0-1	Point source delivery of fine sediment from upstream tributary sources. Moderate impact on S & E from Big Muddy to Surveyors, on S in Surveyors from cascade barrier to Cedar Creek and from Surveyors to step pool habitat within Castile cascades; and on E in Trout Creek from mouth to cascades	Disconnect roads from stream network; relocate/ abandon mid-slope roads where possible; relocate/abandon valley-bottom roads where possible. Improve surface and drainage characteristics of roads in tributary watersheds. Riparian forest management and planning: plan to leave buffer strips in riparian forest zones.
Reduced food web	Abundance, productivity	Klickitat R. from Trout Creek to Castile step pool habitat (RM – 65.42); W. Fork Klickitat below falls (RM .45)	Reduction in salmon carcasses (spring Chinook salmon).	F, R1, I0-1	Moderate impact from Trout Creek to Surveyors and from Soda Springs to step pool habitat within Castile cascades, lower W. Fork	Fertilize stream with carcasses or carcass analogs

* Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0-1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage

Table II-11. Potential Limiting factors for Middle Columbia River Steelhead in Lower Little Klickitat MiSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor	VSP Parameters Impacted	Sites Affected	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
Degraded water quality, water temperatures	Abundance, productivity	Little Klickitat R. to RM 1.24, from Mill Creek to L. Klickitat Falls (RM 3.75-6.38); Canyon Creek; Bowman Creek	Upstream diversions and channel morphology; past grazing; floodplain road; upper watershed grazing; possible dewatering in upper reaches of Canyon Creek	S, E, F, R0, R1	Reduction in base flows. Reduced canopy cover upstream and in lowermost section of Little Klickitat R. around Hwy. 142 bridge and where road parallels Bowman Creek High impact on R0, R1 and E in lower Little Klickitat, on S, E and F between Canyon and Little Klickitat Falls, high on E in Bowman from mouth to falls. Moderate impact on S in Little Klickitat to falls.	Restore floodplain connectivity and channel morphology, riparian vegetation in upper watershed.
Degraded water quality, pathogens	Productivity	Little Klickitat R. to L. Klickitat Falls (RM 6.38); Bowman Creek	Hatchery stocking; grazing in upper watershed.	R0	Elevated stream temperatures exacerbated by lack of riparian cover. Moderate impact	Re-vegetate riparian areas to reduce stream temperatures in upper watershed. Change stocking practices with regards to numbers, location and timing of smolt outplanting. Conduct pathogen sampling and monitoring.
Altered sediment routing	Abundance, productivity	Little Klickitat R. to L. Klickitat Falls (RM 6.38); Canyon	Increased road densities in headwater tributaries and untreated forest road segments,	E	Runoff, surface and re-distribution of in-channel fine sediment in the form of bank mass wasting; delivery of fine sediment from	Disconnect roads from stream. Reduce sediment inputs. Improve road drainage characteristics and surfacing. No-till cropping. Promote riparian

Limiting Factor	VSP Parameters Impacted	Sites Affected	Threats	Life Stages Affected*	Significance (Scope/Severity)	Actions
		Creek; Bowman Creek	agricultural run-off.		upstream agricultural and tributary sources. Extreme impact in lower Canyon and Bowman, high impact in mouth of Little Klickitat	buffers. Restore floodplain connectivity.
Reduced food web	Productivity	Little Klickitat to RM 1.24	Nutrient enrichment; agricultural practices and grazing.	F, I0-1, R1	Reduction in benthic community. Elevated temperatures and fine sediment delivery. Moderate impact	Actions in upper watershed to affect limiting factors in lower watershed: Restore floodplain connectivity and channel morphology. Disconnect roads from stream. Reduce sediment inputs. Improve road drainage characteristics and surfacing. No-till cropping. Promote riparian buffers. Increase riparian cover. Eradicate non-native invasive plant species from critical watershed areas. Investigate off-channel livestock watering.
Reduced key habitat quantity, loss of floodplain function and channel migration processes	Abundance, productivity	Canyon Creek	Hydroconfinement. Habitat fragmentation via subdivision, land-clearing, and development.	S, E	Channel simplification and reduced riparian function. Moderate impact. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Restore floodplain connectivity. Place LWD. Short-term introduction of spawning gravel. Protect existing habitat from future degradation.
Predation	Abundance, productivity	Little Klickitat R. to L. Klickitat Falls (RM 6.38); Canyon Creek; Bowman Creek to RM .15	Hatchery stocking practices; dewatering.	F, R0, I0-1, M1, M2+	Predation is hypothesized by EDT model. High density of hatchery-origin smolts due to stocking of catchable rainbow trout from Goldendale Hatchery in Little Klickitat R. and anadromous stocks in mainstem Klickitat R. Dewatering intensifies impact from avian and terrestrial predators. Moderate impact in all affected reaches	Change stocking practices with regards to numbers, location and timing of smolt outplanting. Research interaction with hatchery fish, native and non-native predators.
Altered hydrology	Abundance, productivity	Little Klickitat R. to L. Klickitat Falls (RM 6.38); Bowman Creek; Canyon Creek	Upstream diversions.	F, R0	Decrease in summertime base flows. Moderate impact on F, R0 in Little Klickitat from mouth to Mill Creek, Canyon and Bowman creeks	Manage diversions to maximize instream summer flows.
Reduced habitat diversity, floodplain function and channel migration processes	Abundance, productivity	Canyon Creek to RM 1.09; Little Klickitat R. to RM 1.24	Hydroconfinement. Habitat fragmentation via subdivision, land-clearing, and development.	S, F, R0, I0-1	Channel simplification and reduced riparian function. Moderate impact. Habitat protection through land acquisition/conservation easement by WDFW or land trust.	Restore floodplain and side-channel connectivity. Short-term introduction of spawning gravel. Place LWD. Protect existing habitat from future degradation.
Competition with hatchery fish	Abundance, productivity	Bowman Creek; Little Klickitat from Mill Creek to L. Klickitat Falls (RM 3.75 – RM 6.38)	Resident rainbow stocking from Goldendale Hatchery and mainstem Klickitat smolt planting (coho, steelhead).	R0, R1	Moderate impact	Change stocking practices with regards to numbers, location and timing of smolt outplanting. Research interaction with hatchery fish, native and non-native predators.

* Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0,1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage.

Table II-12. Potential Limiting Factors for Middle Columbia River Steelhead in the Trout Creek MiSA (provided by Yakama Nation Fisheries Staff).

Limiting Factor	VSP Parameters Impacted	Sites Affected	Threats	Life Stages Affected*	Significance (Scope/ Severity)	Actions
Altered sediment routing	Abundance, productivity	Trout Creek from top of falls to Bear Creek (RM 1.09 - RM2.62); Bear Creek to meadow at RM 3.10	Increased road densities and drainage extension; to a lesser degree, water withdrawal for watering roads (dust abatement).	E, I0-1	Delivery of fine sediment from upstream tributary sources. Point source delivery of fine sediment associated with road drainage. Extreme impact on E in Bear Creek from mouth to meadow at ~RM 3.1; high impact in Trout Creek from cascade to Bear Creek; moderate on I0-1 throughout	Improve road drainage characteristics and surfacing. Disconnect roads from stream. Riparian forest management and planning: plan to leave buffer strips in riparian forest zones.
Reduced food web	Abundance, productivity	Trout Creek from top of falls to Bear Creek (RM 1.09 – RM 2.62); Bear Creek to meadow at RM 3.10	Road densities, past riparian logging.	F, R0, I0-1, R1	Elevated temperatures and fine sediment levels. High impact on F in Trout Creek from cascade to Bear Creek and in Bear Creek to ~ RM 3.1; moderate impact on R0, I0-1, R1 in Bear Creek	Restore floodplain connectivity. Improve road drainage characteristics and surfacing. Disconnect roads from stream. Re-vegetate riparian zone and floodplain. Eradicate non-native invasive plant species from critical watershed areas. Riparian forest management and planning: plan to leave buffer strips in riparian forest zones.
Degraded water quality, particularly water temperatures	Abundance, productivity, spatial structure	Trout Creek from top of falls to Bear Creek (RM 1.09 – RM 2.62);	Floodplain roads; past riparian logging.	S, E, F, R0	Reduced riparian canopy; reduced perennial and hyporheic flows. High impact on E and moderate impact on S, F, R0 in Trout Creek from cascade to Bear Creek	Restore floodplain connectivity. Re-vegetate riparian zone and floodplain.
Reduced key habitat quantity, loss of channel structure and floodplain connectivity	Abundance, productivity	Trout Creek from top of falls to Bear Creek (RM 1.09 – RM 2.62); Bear Creek to meadow at RM 3.10	Hydroconfinement; road densities, floodplain roads, past riparian logging.	F, R0, M1, PH	Channel simplification and disconnected side-channels. Reduced LWD. Moderate impact on F, R0, M1, PH in Trout Creek from cascade to Bear Creek, and on F, PH in Bear Creek to ~RM 3.1	Place LWD. Disconnect roads. Excavate pools. Augment gravel. Restore floodplain connectivity.
Reduced habitat diversity, degraded channel structure, floodplain connectivity	Abundance, productivity	Trout Creek from top of falls to Bear Creek (RM 1.09 – RM 2.62); Bear Creek to meadow at RM 3.10	Hydroconfinement.	S, F, R0	Channel incision and disconnected side-channels. Reduced LWD. Moderate impact on affected life stages in Trout Creek from cascade to Bear Creek, and in Bear Creek to ~ RM 3.1	See above.
Altered hydrology	Abundance, productivity	Trout Creek from top of falls to Bear Creek (RM 1.09 – RM 2.62); Bear Creek to meadow at RM 3.10	Channel incision related to roads; increased peak flows. Reduced perennial and hyporheic flows associated with incision and extension of the drainage network by forest	E, F, I0-1,R0	Increased peak flows; reduced perennial and hyporheic flows. Moderate impact on F, R0 in Trout Creek from cascade to Bear Creek, and in Bear Creek to ~ RM 3.1	Restore floodplain connectivity. Disconnect road drainage from stream network to decrease runoff peaks and increase retention. Restore channel morphology and overbank flow frequency…reconnect floodplains.

Limiting Factor	VSP Parameters Impacted	Sites Affected	Threats	Life Stages Affected*	Significance (Scope/ Severity)	Actions
			roads.			
Blocked or impaired passage	Abundance, spatial structure	Waterfall reach and upstream	Numerous (>10) naturally occurring cascades and waterfalls (6-8'); at least four road crossings that act as partial barriers (all four are upstream of the waterfall reach).	R0, R1, R2+, TR2+, PM	Though no one cascade is beyond the published ability of adult steelhead in terms of sheer size, there are several with very challenging hydraulics. Cumulatively, they likely restrict nearly all passage. Passage and spawning frequency of this watershed largely undocumented, assumed to be minimal above high gradient reach within lower 1.5 miles. May have been higher historically, but debris torrent associated with road failures in 1974 is believed to have radically altered channel morphology in lower five miles of Trout Creek. Passage conditions prior to torrent are unknown.	Provide passage where existing culverts block passage.

* Key to life history stage codes: S=Spawning; E=Egg incubation; F=Fry colonization; R0=0-age active rearing; I0-1=0,1-age inactive; M1=1-age migrant; R1=1-age active rearing; R2+=2+-age active rearing; M2+=2+-age active migrant; TR2+= 2+-age transient rearing; PM= pre-spawning migrant; PH= pre-spawning holding. **Bold** style denotes high to extreme impact on that life stage.

Appendix III. Current Efforts and Regulations

Numerous projects have been completed recently or have been initiated to address factors affecting salmonid production in the Klickitat subbasin. Additionally, there are numerous rules and regulations in place that will prevent or minimize future effects on salmonid production. These actions and regulations are described in the following sections.

Habitat Restoration Actions

Positive change is underway to address limiting factors and threats to improve steelhead habitat conditions. A number of actions are proposed, being planned, or are already being implemented in the subbasin to address these conditions and the affected populations.

Castile Falls Fishway

One major change is the renovation of the Castile Falls Fishway. Castile Falls, a natural barrier consisting of multiple cascades and barriers, was a historical obstruction to the upstream migration of anadromous fish into the upper Klickitat watershed. The fishway was first constructed in the early 1960s. Design flaws and improper maintenance contributed to the failure of the first attempt to provide passage over the falls. Recently, the Castile Falls Fishway was renovated to bring it into compliance with NMFS fish passage standards and facilitate anadromous fish passage to habitats in the upper subbasin. From 2003-2005, work was completed on the two fishway tunnels within the Castile Falls complex. Design improvements consisted of conversion from a pool-weir style fishway to a vertical slot fishway to allow passage over a wider range of river flow conditions and to reduce maintenance needs. Project engineers and biologists have measured improved flow, attraction flow and energy dissipation factor (EDF) within the weir—all of which are consistent with industry standards and which meet criteria for fish passage. Funds were appropriated after the major 1996 flood to perform major maintenance activities to this NOAA Fisheries/Mitchell Act-funded fishway. The first complete season that these facilities will be operational ends in 2006. At this time, a performance evaluation will be made (YN and Harbor Engineering Co. 2006).

The Castile Falls Enumeration Facility (CFEF) will provide the ability to enumerate escapement into the upper Klickitat subbasin, and assess recent improvements to the Castile Falls Fishway. A counting station will be placed in the upper CFEF. This structure will be installed at the fishway exit of the Castile Falls 10/11 Fishway tunnel and will include video monitoring and PIT-tag detection capabilities, as well as the ability to trap salmon and steelhead for biological and DNA assessment. The recounting structure will allow fisheries managers to: (1) determine escapement of Klickitat spring Chinook and summer steelhead into headwater habitats; (2) assess stock status and future trends as needed to calculate natural production and adult-to-adult return rates, and to refine EDT and run forecasting models used to guide supplementation and habitat restoration actions and set harvest objectives; (3) conduct video monitoring to gain critical biological data such as species, run timing, size, and sex ratio of returning adults; and (4) collect age and DNA information on returning adults.

Lyle Falls Fishway

Improvements are also planned at Lyle Falls Fishway to address limited adult fish passage through the fishway into the Klickitat subbasin. Engineering assessments (Harbor Consulting Engineers, Inc. 1996) identified the following factors currently restricting passage at the fishway:

1. Inadequate attraction water
2. Location of the fishway entrance
3. Configuration of the fishway entrance ports
4. Location of the fishway exit, with fish exiting into swift water
5. Trash rack debris accumulations
6. River shoaling at the fishway exit

A subsequent HEC-RAS hydraulic model report, using fisheries criteria in accordance with the accepted design criteria approved by fishery agencies (NOAA and WDFW), outlined repairs, modifications, and retrofits that would facilitate increased passage into the Klickitat subbasin for all fish at nearly all flow conditions.

The completion of on-going engineering and design work for Lyle Falls will establish a facility that allows a high proportion of returning fish to be physically examined at a location in the lower watershed. A video monitoring and PIT-tag detection system would enable escapement monitoring, provide run-timing information, and improve enumeration of natural- and hatchery-origin recruits returning to the subbasin. It could also determine the presence/absence of a fluvial bull trout population. The collection facility would support data collection that bears on the scientific justification for particular supplementation activities proposed for the subbasin. See ISRP 2005-16. The facility would support monitoring and evaluation strategies in the proposed Klickitat Anadromous Fishery Master Plan (KMP) that can be undertaken prior to implementation of supplementation activities, including the following:

- *Strategy SC3d. Use radio telemetry, mark-recapture, and/or run reconstruction to determine passage and entrainment rates at Lyle and Castile Falls and to track natural spawners to their spawning grounds.*

- *Strategy SC5a. Collect DNA samples and morphometric data from fish passing through the Lyle Falls and Castile Falls traps. Use findings from Yakima and other Columbia Basin studies in conjunction with information from these samples to target genetic studies in the Klickitat subbasin. Convene meetings of tribal and state geneticists as necessary to further develop sampling rates, protocols, and evaluation measures.*

- *Strategy SC6b. Update and maintain all Klickitat-related databases with historical and current harvest data.*
- *Strategy SC6c. Use run reconstruction methods developed for Yakima Basin spring Chinook to reconstruct Klickitat run and harvest to the Columbia River mouth.*

Fish passage barriers

Current culvert replacement projects throughout the subbasin are ensuring that passage structures will allow movement of all life stages of salmonids by maintaining a natural stream bottom and stream width, and allowing for natural floodplain function. These bottomless arch culverts and bridges allow for the natural movement of sediments, bedload material, and large woody debris needed for the formation of pool and complex rearing habitats.

Washington State Parks recently replaced a railroad trestle that was impeding steelhead migration in Logging Camp Creek. Klickitat County, Yakama Nation Fisheries, WDFW, two private landowners, Mid-Columbia Regional Fisheries Group and community volunteers recently completed a fish passage and habitat restoration project that enables steelhead to access habitat in Snyder Creek.

Habitat enhancement projects

Habitat enhancement projects are also being implemented by a variety of different entities in many parts of the watershed to improve spawning and rearing conditions. The Underwood Conservation District, which includes some western portions of the Klickitat watershed, repaired a headcut in 2004 in upper Snyder Creek, the result of previous incision and downcutting in the headwaters, which they continue to monitor.

The Mid-Columbia Fisheries Enhancement Group is involved in a number of habitat restoration projects in the Klickitat River subbasin in conjunction with YKFP, Federal and state agencies, local partners and private landowners. In the spring of 2006, Mid-Columbia Fisheries began a riparian restoration project along 2,000 linear feet of river bank on the lower mainstem Klickitat. Mid-Columbia Fisheries was a partner in a project on the Little Klickitat River sponsored by the Central Klickitat Conservation District. This project restored a 350 ft. section of the Little Klickitat River within the Goldendale City limits. The goal of the project is to improve water quality, stabilize eroding stream banks, reduce sediment, increase riparian cover, and reduce water temperature. As part of the project, old abutments made from dilapidated barrels and other debris was removed from the river banks. Banks were re-shaped, large woody debris was installed and the area is being re-planted.

A number of habitat projects are underway to address the temperature TMDL (Anderson 2004) for the Little Klickitat. The City of Goldendale rehabilitated Bloodgood Springs which feeds Bloodgood Creek, a source of cold water for the Little Klickitat River. Bloodgood Springs has been abandoned as a city water source, and the water rights were transferred to a well in the Simcoe Mountains.. The pumping infrastructure neat the Bloodgood stream has been removed. (David McClure, personal communication).

In 2003, the City of Goldendale abandoned its use of Bloodgood Springs at the head of Bloodgood Creek and moved its water right for these springs to a well in the Simcoe Mountains. Additionally, this well in the Simcoe Mountains has been added to the authorized points of withdrawal for the City of Goldendale's "Mountain Springs" water right. This water right change has enabled the City of Goldendale to decrease its use of the springs which are in the headwaters if the Little Klickitat River. In recent years, the City brought the "Basse Well Field" on line and reduced the City's dependence on the springs in the Little Klickitat River's headwaters. The City of Goldendale historically land applied wastewater, now the City's new wastewater treatment plan puts treated effluent directly into the Little Klickitat River, improving stream flow in the river. The City is following-up on work started under the WRIA 30/Klickitat River watershed planning effort by obtaining grant funding and implementing more intensive investigations of aquifer storage and recovery opportunities for addressing climate change/variability concerns as they relate to the City's water needs and Little Klickitat River stream flows. In support of implementing the *Klickitat River Management Watershed Plan*, the City has obtained grant funding and initiated a project to improve its water conveyance system and achieve significant water conservation objectives, which are anticipated benefit Little Klickitat River stream flows.

The Central Klickitat Conservation District also has a number of projects in progress to address water quality and/or bank stability in the Little Klickitat watershed in conjunction with the Washington Conservation Corps, the Northwest Service Academy, Klickitat County and others through EQIP (Environmental Quality Incentives Program), CREP (Conservation Reserve Enhancement Program and CCRP (Continuous Conservation Reserve Program). Additionally, TMDL implementation work (e.g., stream flow and temperature monitoring, riparian planting) by the conservation district is support by a chapter 319 grant and related conservation programs or grants.

The USDA Forest Service is working on restoring an approximately 25-acre parcel near the mouth of the Klickitat River on the west bank. The goal of the project is to re-establishing the native riparian and wetland plant communities.

The Klickitat Public Utility District (KPUD) participates in the WRIA 30/Klickitat watershed planning process which addresses water quantity, water quality, and fish habitat within the Klickitat Basin. A recent project with potential benefits to water quality involved replacing the town of Klickitat's wastewater collection system piping with interceptor tanks and new pipe to reduce the affects of storm water and flooding. KPUD replaced the wastewater treatment plant. The plant employs an ultraviolet light treatment system to provide pathogen reduction (to kill fecal coliform) and to eliminate the daily use of chlorine as the main means of germicide. This treatment method will eliminate the discharge of chlorine into the Klickitat River from the plant. These two projects received approval by members and Elders of the Yakama Nation in 2004.

Construction was completed in May of 2007 (Tim Furlong, Klickitat PUD, personal communication, 2009).

Habitat restoration activities are a key component of the Yakima/Klickitat Fisheries Project (YKFP), an effort co-managed by the Yakama Nation Fisheries Program (lead agency) and Washington Department of Fish and Wildlife aimed at recovery of native anadromous salmonid populations in the Yakima and Klickitat River basins. The principal focus of the YKFP is to increase natural production of and opportunity to harvest salmon and steelhead in the Yakima and Klickitat subbasins using supplementation, harvest augmentation and habitat improvements. The YKFP is sponsored in large part by the Bonneville Power Administration with oversight and guidance from the Northwest Power and Conservation Council (NPCC) (Yakama Nation Fisheries 2006).

The Klickitat Watershed Enhancement Project (KWEP) conducts protection and restoration projects in the Klickitat River and tributaries to subbasin supporting native anadromous fish production. The goal of the KWEP, in keeping with the objectives of the Klickitat Subbasin Plan, the Klickitat Lead Entity Strategic Plan and the 1994 NPCC Fish and Wildlife Program, is to restore watershed health to aid recovery of salmonid stocks in the Klickitat subbasin. Restoration activities are aimed at restoring stream processes by removing or mitigating watershed perturbances and improving habitat conditions and water quality. Protection activities complement restoration efforts within the subbasin by securing refugia and preventing degradation of habitat. Actions under these projects include instream large woody debris placement, culvert replacements and other passage improvements, forest road rehabilitation, floodplain reconnection, and habitat acquisition; all of these habitat actions are consistent with objectives described in the subbasin plan (NPCC 2004, pp. 333-352). Assessment, monitoring and data management are also crucial components of the KWEP Program. Cooperation with state, Federal, tribal, and private entities ensures maximum effectiveness in 90 percent of the off-reservation project area in private ownership (Conley 2006).

The *Klickitat Watershed Management Plan* was completed and approved under chapter 90.82 RCW. This watershed plan (available at http://klickitatcounty.org/NaturalR/default.asp?fD=3) will guide management of water resources in those areas of the Klickitat Basin that are outside of the Yakama Reservation and tribal trust lands. The purpose of the watershed plan is to incorporate broad-sense interests (e.g., aesthetic and recreational values, consideration of species not listed under the ESA) that eclipse the purposes of the ESA. As provided in state statute, a detailed implementation plan, *Detailed Implementation Plan Klickitat River Basin (WRIA30)* (Aspect 2008) (available at http://klickitatcounty.org/NaturalR/Content.asp?fC=23&fD=3), was developed during the first year following watershed plan approval. Primary responsibility for implementing the watershed plan is assigned to the "Implementing Governments," which are Klickitat County, state agencies (represented by the Department of Ecology), Klickitat PUD, City of Goldendale, and Central Klickitat Conservation District. Action-specific responsibilities and terms of commitment (e.g., rules, ordinances, or agreements), funding sources, and schedules with milestones for project completion are specified in the detailed implementation plan. Grant funding for the first five years of watershed plan implementation is provided for in chapter 90.82 RCW. Actions completed pursuant to the watershed planning process have included various assessments pertaining to water quality, water quantity, and fish habitat in the Klickitat Basin, and installation and maintenance four continuous flow monitors on the Little Klickitat River and three continuous flow monitors on Swale Creek, and, installation and maintenance of a SNOTEL precipitation monitoring station in the Simcoe Mountains. Priority goals in the watershed plan include those pertaining to the following key concerns:

- Current and future water demand (which consider stream flow needs of fish);
- Summer stream flow in the Little Klickitat River;
- Little Klickitat River temperature;
- Swale Creek temperature;
- Fish habitat restoration and protection; and
- Potential effects of population growth on fish habitat.

Klickitat County is actively engaged in projects and programs benefiting ESA-listed fish species within the county. The County is the lead agency for watershed planning and *Klickitat Watershed Management Plan* implementation, as well as the lead entity for the "SRFB process" through which PCSRF and state finding is obtained for salmon and steelhead habitat projects within the Klickitat and White Salmon River basins. Over the last five years the County has sponsored approximately a dozen salmon and steelhead habitat restoration projects, conducted in cooperation with a range of partners including the EKCD, Mid-Columbia Regional Fisheries Enhancement Group, Yakama Nation Fisheries, and WDFW. The County has also contributed matching funds for such projects as the Klickitat Wastewater Treatment Plan upgrade and "in-kind match" for such projects as the conservation district's implementation of the Little Klickitat River Temperature TMDL.

Regulatory Protection

Various state, tribal and county regulatory mechanisms are in place to protect riparian areas from current and future threats posed to listed species through habitat loss and degradation caused by human land uses and development. Numerous voluntary programs are also available to address habitat conservation. In addition, some areas receive special protection through designation, such as Wild and Scenic River reaches, primitive areas, and wildlife refuges.

NOAA Fisheries and/or U.S. Fish and Wildlife Section 7 Consultations

Section 7 of the Endangered Species Act directs all Federal action agencies to consult with NOAA Fisheries and the U.S. Fish and Wildlife Service to ensure that their actions will not jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat. Actions include not only direct Federal actions, but also actions funded with Federal dollars. A Biological Assessment or Biological Evaluation is usually developed and submitted to NMFS for review prior to implementation of the project. The reader can find additional information regarding the consultation process at: www.cit.noaa.gov/nosign/default.asp?action=ConsultationGuide.

Clean Water Act

The Federal Clean Water Act addresses the development and implementation of water quality standards, the development of total maximum daily loads (TMDL), filling of wetlands, point source permitting, the regulation of stormwater, and other provisions related to protection of U.S. waters. The Clean Water Act is administered in the State of Washington by the Department of Ecology (Ecology) with oversight by the EPA. State water quality standards are set to protect beneficial uses, which include several categories of salmonid use. Ecology has a water quality certification program under which it reviews projects that will discharge dredged or fill materials into waters of the U.S. and issues certifications that the proposed action meets State water quality standards and other aquatic protection regulations, if appropriate. Ecology also issues National Pollution Discharge Elimination System (NPDES) permits, and develops water quality cleanup plans (TMDL) to address water quality limited streams.

National Environmental Policy Act (NEPA) Review

NEPA requires Federal agencies to consider the probable impacts of their proposed activities, programs, and projects (including funding of state, local, and private actions) on the quality of the human environment. NEPA reviews help agencies decide whether to undertake a proposed action. In most cases, the NEPA review requires the development of an Environmental Assessment (EA) or Environmental Impact Statement (EIS) that addresses the probable effects of a project and its alternatives on various elements of the environment, including soils, geology, landscapes, atmospheric conditions, vegetation, fish and wildlife, and cultural resources. Many Federal funding programs are covered under a general NEPA review completed when the funding program was developed.

Watershed Planning Act

In 1998 chapter 90.82 RCW was amended with the passage of ESHB 2514. This law is also known as the Watershed Planning Act. The Watershed Planning Act was established to address the diminishing water availability and quality, and the loss of habitat for fish in the State of Washington. The Watershed Planning Act provides a framework for local citizens, tribes, and state and local agencies to work together to develop and implement Watershed Management Plans for entire watersheds.

As part of the planning process, a watershed assessment is completed for each Water Resource Inventory Area (WRIA) to evaluate water supply and use. Once the watershed assessment is complete, a management plan, followed by a detailed implementation plan, is developed to address water quantity, water quality, and fish habitat issues identified in the assessment. A watershed assessment has been completed for the Klickitat subbasin (WRIA 30) (WPN and Aspect 2005a) and the *Klickitat River Watershed Management Plan* (WPN and Aspect 2005a) and *Detailed Implementation Plan Klickitat River Basin (WRIA30)* (Aspect 2008) have been approved.

State Environmental Policy Act (SEPA)

SEPA regulations require an environmental review of actions taken by the state and local agencies, including funding and permitting. Some actions, such as the construction of single-family dwellings, minor road repair, and issuance of business licenses, are exempt. A SEPA review evaluates the probable environmental effects of a proposed project. This information is used to determine if the action should be taken as proposed, if mitigation is necessary, or if the proposal should be rejected.

Forest & Fish Regulations (Washington State)

The Washington Forests & Fish Law (ESHB 2091) was signed into law in 1999 as part of The Washington State Forest Practices Act (Title 76.09 RCW), passed in 1974. The Forests & Fish Law, based on the Forests & Fish Report, resulted in changes to forest practices rules to protect riparian and aquatic resources on more than eight million acres of private forestland. It is intended to meet the provisions of the Federal Clean Water Act concerning non-point source silvicultural practices. Changes to the law included:

- Updates of the stream typing system in the state to improve mapping of fish-bearing waters,
- Increases in buffer widths along fish bearing and non-fish bearing streams,
- Changes in forest practices to protect against landslides
- Mandatory requirements to update the forest road system to hydrologically disconnect roads from streams and minimize sediment delivered to streams,
- New regulations on pesticide applications to prevent or avoid drift of chemicals into streams,
- Increased protection of wetlands
- Changes in enforcement,
- Establishment of a scientifically based adaptive management and monitoring process for evaluating the impact of forest practices on aquatic resources,
- Establishment of a process for amending the forest practices rules to incorporate new information as it becomes available, and
- Establishment of a small landowner office to assist non-industrial landowners.

Additional information regarding the Forest Practices rules can be found at: http://www.dnr.wa.gov/forestpractices.

- The Washington Department of Natural Resources, on behalf of the State of Washington, submitted applications to NMFS and the U.S. Fish and Wildlife Service for incidental take permits under section 10 of the Endangered Species Act. Issuance of these permits would provide assurances that all forest practices activities in compliance with the state forest practices rules and administrative program will satisfy ESA requirements for aquatic species. The two services released the final HCP, the final environmental impact statement (FEIS), and implementing agreement in a ***Federal Register*** *Notice* on Jan. 27, 2006. This notice provides an opportunity for the public to review the final documents and the responses to public comments on the draft documents.

Klickitat County Shorelines Master Plan

In 1971 the Washington State Legislature passed the Washington Shoreline Management Act (SMA), adopted by public referendum in 1972. The purpose of the Act is "to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines" by requiring every county and many cities to develop a Shoreline Master Plan to govern development in shoreline areas http://www.ecy.wa.gov/programs/sea/sma/st_guide/intro.html). Klickitat County's Shorelines Master Plan (SMP) was first adopted in 1975 and has been updated periodically since then. The SMP and brochure on the shorelines permit program can be accessed from the Klickitat County Planning Department's web site: http://klickitatcounty.org/Planning/default.asp?fCategoryIDSelected=301427788.

The Klickitat County's (SMP) regulates "development" within the "shorelines" of the Klickitat River and other water bodies in Klickitat County's jurisdiction. "Development" is broadly defined as: construction or exterior alteration of existing structures; dredging; drilling; dumping; filling; removal of any sand, gravel or minerals; bulkheading; driving of piling; placing of obstructions; or any project of a permanent or temporary nature which interferes with the normal public use of the surface of the waters overlying lands subject to the SMP regulations at any state of water level. "Shorelines" are those lands extending landward for 200 feet in all directions as measured from the ordinary high water mark, floodways and contiguous floodplain areas landward 200 feet from such floodways;, and all wetlands and river deltas associated with the streams and lakes. The SMP applies to the shorelines of the main stem of the Klickitat River as well as the shorelines of all tributaries with a mean annual flow of 20 cfs or more.

The SMP designates various shorelines of the Klickitat River and its tributaries as "environments", which determine the level of protection that is warranted. Much of the Klickitat River is designated either "Natural Environment" which prohibits most development within its shorelines or "Conservancy Environment", which allows a limited scope of development, subject to conditions (i.e. shoreline conditional use permit).

Each development proposal is subject to review pursuant to the shoreline environment within which it is to be located. One or more shoreline permits must be secured prior to implementation: Substantial Development Permits (SDP) are required for any development for which the total cost or fair market value exceeds $5,000, or any development which materially interferes with the normal public use of the water or shorelines; Shoreline Conditional Use Permits (CUP) are required for development types that warrant conditions to ensure consistency with the SMP; and Variances (VAR) are issued to grant relief from specific bulk, dimensional, or performance standards of the SMP in order to avoid unnecessary hardship, provided that extraordinary circumstances are shown to exist and the public interest shall suffer no substantial detrimental effect. Some types of development, such as a single-family residence, normal maintenance and repair, or construction of a normal protective bulkhead for a single family residence, are exempt from the requirement of a substantial development permit, but are still subject to all other provisions of the SMP.

Existing structures and developments that were established prior to adoption of the SMP are considered legally established "non-conforming" uses. Since adoption of the SMP, all developments within shorelines, including modifications to non-conforming uses, have been reviewed by the County and Washington Department of Ecology (Ecology) to ensure compliance with the goals and requirements of the SMP.

The Department of Ecology reviews the County's permit decisions and has final authority to approve or deny conditional use permits and variances. Persons may appeal the final decision to the Shorelines Hearings Board.

Klickitat County Critical Areas Ordinance

Klickitat County adopted a Critical Areas Ordinance (CAO) in 2001 and, with the concurrence of Washington Departments of Fish and Wildlife, Community Trade and Economic Development, and Ecology, amended it in 2004. The CAO extends beyond the geographical scope of the County's SMP to protect wetlands, critical fish/wildlife habitat, geologically hazardous areas, aquifer recharge areas, and frequently flooded areas. The CAO is, in effect, an overlay on existing land use regulations. The CAO provides for standard setbacks of 300' from Category I wetlands; 200' from Category II; and 75' from Category III and IV. The CAO provides for standard buffers of 200' from Type 1 & 2 waters; 150' from Type 3 waters; 50' from Type 4 waters; and 25' from Type 5 waters. A wildlife habitat management plan is required for new development that will likely impair habitat functions and values. As with the SMP, developments and uses that existed prior to the adoption of the CAO are considered legally established "non-conforming" uses. The CAO and brochures land use permit programs can be accessed from the Klickitat County Planning Department's web site: http://klickitatcounty.org/Planning/default.asp?fCategoryIDSelected=301427788.

Klickitat County Floodplain Management Ordinance

The Klickitat County Floodplain Management Ordinance (FPO) regulates all development and activities that may increase flood hazards. A permit is required for development within areas of special flood hazard (with at least one percent chance of flooding). The applicant for a non-residential structure must include a certification and flood analysis conducted by a professional engineer. In general, development that will does not meet the specific criteria in the ordinance for development in these areas, to protect public health and safety, will be denied. The FPO and brochures land use permit programs can be accessed from the Klickitat County Planning Department's web site: http://klickitatcounty.org/Planning/default.asp?fCategoryIDSelected=301427788.

Klickitat County Zoning Ordinance

The Klickitat County Zoning Ordinance (CZO) was adopted in 1979 and has been amended over time. Much of the Klickitat River watershed is zoned by the CZO as "extensive agriculture" which requires a 20-acre minimum lot size for the purpose of dividing properties, and new development/uses are restricted to resource management uses/activities and other compatible uses. One permanent residential dwelling is allowed per lot. Some areas of the watershed are zoned for residential development. The allowable minimum lot size for new lots is either 1 or 2 acres; and one residential dwelling is allowed per lot. Other than residential development, most new development/uses in these zones is either prohibited or allowed per a zoning conditional use permit. The CZO and brochures land use permit programs can be accessed from the Klickitat County Planning Department's web site:
http://klickitatcounty.org/Planning/default.asp?fCategoryIDSelected=301427788.

Klickitat County Environmental Ordinance (CEO)

The Klickitat County Environmental Ordinance (CEO) was adopted pursuant to the State Environmental Policy Act (SEPA). The CEO and SEPA require an analysis of probable significant adverse environmental impacts that may result from a proposed development. The CEO and SEPA require a threshold determination for each proposed development that is not exempt. The threshold determination is a determination that a project will or will not have probable significant adverse environmental impacts. If a project has probable significant adverse impacts, and environmental impact statement (EIS) is prepared. Any proposed development/use that is not specifically exempt in SEPA, chapter 43.21C RCW, or the SEPA rules adopted by the Department of Ecology, chapter 197-11 WAC, is required to comply with SEPA. Klickitat County provides applicable state agencies and tribes, as well as the public, the opportunity to review threshold determinations and EISs.

Washington State Water Pollution Control Act (Chapter 90.48 RCW)

This act gives Ecology the authority to protect water quality in the state and to promulgate regulations as needed to achieve this goal. The Act makes discharges of pollutants into waters of the state unlawful and has provisions for enforcement of violations, including the authority and process for issuing compliance orders and civil penalties, and for seeking criminal penalties. The Act also provides for permitting processes, cooperation with other entities, water quality monitoring, grants, and numerous other subjects regarding management of water quality issues in the state.

Washington's statewide monitoring program

In 2001, Substitute Senate Bill (SSB) 5637 was signed into law. This act related to monitoring of watershed health and salmon recovery. The Monitoring Oversight Committee developed a comprehensive statewide strategy that addresses the actions identified in SSB 5637 (WPN and Aspect Consulting 2005). Among other things, the Plan is intended to provide information regarding trends in fish, water, and habitat conditions and assess effectiveness of actions taken to improve watershed health and provide for salmon recovery. The strategy includes documentation of fish population trends in some areas of the state; however, the Klickitat River watershed is not one of the areas included to date in that monitoring effort. The strategy is also monitoring the effectiveness of habitat restoration efforts funded by the state. The monitoring of project effectiveness follows the Monitoring and Evaluation Strategy (Washington Salmon Recovery Funding Board 2003) that was developed in support of the Comprehensive Statewide Strategy. The Monitoring and Evaluation Strategy specified methods to assess a wide range of restoration and protection projects.

On-Site Sewage Systems

Chapter 246-272 of the Washington Administrative Code (WAC) regulates the on site disposal of sewage in the state. The law is applicable to septic systems as well as larger on-site systems. The rule addresses location of systems, site evaluations, design, installation, inspection, operation and maintenance, repair, abandonment, and other areas of concern. The rule helps to prevent the discharge of sewage into fish-bearing streams.

Hydraulic Code

Chapter 75.20 RCW governs construction projects within the waters of the state. The law requires hydraulic project approvals from the Department of Fish and Wildlife for wharves, bulkheads, bridges, culverts, fish habitat restoration projects, and other construction activities within the ordinary high water mark. This regulation helps to protect fish and fish habitat during construction.

Regulation of Dairy Farms

Chapter 90.64 RCW, the Dairy Nutrient Management Act, includes a number of requirements designed to protect water quality from dairy operations. These are in addition to NPDES requirements in the Federal and state Clear Water Acts for concentrated animal feeding operations. The Act requires inspection of all dairy farms, implementation of dairy nutrient management plans, technical assistance and enforcement (including civil penalties) against significant polluters. The intent of the regulation is to protect water quality and, subsequently, fish habitat. Ecology is the primary regulatory authority under this Act.

Other Rules and Regulations

There are over 100 additional rules and regulations applicable to the protection of water quality and fish habitat in the State of Washington. These rules cover a broad range of subjects such as groundwater quality standards, application of pesticides, well construction, motor oil disposal, utilities, solid waste disposal and recycling, water supply facilities, mining, energy facilities, dikes and levees, aquiculture, etcetera. Lists of applicable laws and rules and links to the specific requirements of those laws and rules can be found at: www.ecy.wa.gov/laws-rules.

Yakama Reservation Forest Management Plan

The Yakama Nation has a variety of protective land use regulations in effect on reservation lands. One of these is the Forest Management Plan (FMP). Under the 1993-2002 FMP, the Yakama Administrative Forest was divided into 11 Land Use Management Areas (LUMA). Each LUMA was managed for multiple uses with emphasis on dominant resource features and objectives. The draft FMP soon to be ratified changes the designation of LUMAs to Management Emphasis Areas (MEA), which will be managed within the forest habitat types (USDI Bureau of Indian Affairs and Yakama Indian Nation 2004). The forestry program is using historical species composition and stand densities as references for the desired future stand conditions. Just as with the health of aquatic systems, forest health describes the ability of a forest ecosystem to remain productive, to maintain a diversity of plants and animals, aesthetic appeal, and resource sustainability, and to withstand disturbances over time. In addition, a healthy forest is resilient to periodic disturbances such as drought, insects, diseases, fires, climatic change, and management practices.

The Forest Management Plan prescribes the number of miles and density of roads allowed to be built for the purpose of harvesting timber from the Administrative Forest, and forest treatments such as thinning and prescribed burns are being put into place to move the forest vegetation more toward the historical condition of seral stands rather than dense, late successional forest cover. Streams are classified according to their flow, use for domestic purposes and use by fish for spawning, rearing and migration, and buffers and harvest restrictions are set accordingly. The objectives are the preservation of stream bank and riparian cover, water quality and flow maintenance and soil stabilization (USDI Bureau of Indian Affairs and Yakama Indian Nation 1993).

The draft Yakama Nation Forest Management Plan (FMP) designates Management Emphasis Areas that provide for special management emphasis within the closed area (closed to non-tribal members) of the reservation. Table III-1 lists the Management Emphasis Areas within the Klickitat subbasin, as well as the acreage and goal of each.

Table III-1. Trust Forest and Non-Forest Areas by Management Emphasis (BIA and YN 2004).

Management Emphasis Area	Forest (Acres)	Non-Forest (Acres)	Total (Acres)
General Forest	228,623	11,697	240,320
Wildlife Winter Habitat	99,684	52,131	151,815
Safety Corridor	7,086	523	7,609
Old-Growth	14,485	0	14,485
Canyon	50,500	11,749	62,249
Alpine	41,035	7,062	48,097
Riparian	10,403	628	11,031
Primitive	30,990	5,197	36,187
Tract D Recreation	10,072	6,794	16,866
Traditional Use	1,934	407	2,341
Total Acres	**494,812**	**96,188**	**591,000**

Court-mandated buffers on salmon-supporting waters

In January 2004, the U.S. District Court for the Western District of Washington at Seattle ordered protections to prevent the potential adverse effects of any of 54 pesticides on threatened and endangered salmonids. Under the order, buffer zones are required for the application of any of the 54 pesticides that received a "likely to adversely affect" determination as a result of EPA review. The order prohibits ground applications of these pesticides within 20 yards (60 feet) of streams and other water bodies accessible to salmon. The order also requires a buffer zone of 100 yards (300 feet) for aerial applications. The buffer zones remain in effect until the conclusion of the EPA consultations with NMFS. The U.S. Court of Appeals for the Ninth Circuit upheld the January 2004 order in June 2005. The no-spray buffers will remain in effect until EPA and NMFS complete the pesticide consultation process (WSDA 2006). Streams in the Klickitat subbasin that are subject to these buffers are: Blockhouse Creek, Butler Creek, East Prong and West Prong Little Klickitat River, mainstem Klickitat River, Little Klickitat River, Snyder Creek, Swale Creek, and White Creek (WSDA 2006).

Conservation Reserve Enhancement Program (CREP)

The Conservation Reserve Enhancement Program (CREP) is a joint partnership between the State of Washington and USDA, and is administered by the Washington State Conservation Commission and the Farm Services Agency (FSA). The agreement was signed in 1998 and provides incentives to restore and improve salmon and steelhead habitat on private land.

The land enrolled in CREP by voluntary landowners is removed from production and grazing under 10 or 15-year contracts. In return, landowners plant trees and shrubs to stabilize the stream bank and to provide a number of additional ecological functions. Landowners receive annual rent, incentive and maintenance payments and cost share for practice installations. These payments made by FSA and the Conservation Commission, can result in no cost to the landowner for participation (http://crep.scc.wa.gov/).

Special Land Use Areas

Yakama Reservation Primitive Area

The Primitive Area, established by Tribal Council Resolution, consists of the upper reaches of the Klickitat River, roughly half of which drains into the West Fork of the Klickitat, with the other half draining directly into the Klickitat. The 1993–2002 FMP stated that the Primitive Area was to be maintained in its natural state and that natural ecological events should be allowed to occur as freely as possible, provided adjacent lands are not unreasonably affected. The Primitive Area runs from just north of Potato Hill through the Two Lakes, Howard Lake, and Fish Lake areas, then north of Jennie's Butte, through McCormick Meadows, and ending just east of Diamond Butte. The Cascade crest forms the western edge of the Primitive Area, including Cispus Pass. Much of the Forest Service land north and west of the Primitive Area is also managed as reserve, notably the Goat Rocks Wilderness.

Columbia River Gorge National Scenic Area

"The National Scenic Area was created to protect and enhance the scenic, natural, cultural and recreational resources of the Columbia River Gorge while encouraging economic development" (www.fs.fed.us/r6/columbia/). Part of the NSA has been designated along the southernmost portion of the Klickitat subbasin, adjacent to the Columbia River. All new development and land uses must be reviewed in the National Scenic Area to determine if they are consistent with the Act and the implementing land-use ordinances. The development guidelines of the management plan are implemented through land-use ordinances which must be consistent with the management plan.

Klickitat Wildlife Area

The Klickitat Wildlife Area is owned and managed by WDFW. The area covers approximately 14,000 acres in the western portion of Klickitat County. It lies on the east slope of the Cascade Mountains about halfway between the Columbia River Gorge to the south and Mt. Adams to the north. The Klickitat River forms a deep, twisting canyon on its way south to the Columbia River. This twisting characteristic has created juxtaposing areas of forage on south slopes and thermal cover on north slopes. General vegetation types include the forest riparian zone along the Klickitat River, south-facing hillsides of open grasslands, north-facing hillsides forested with conifers, and the flatter plateau covered by mixed forests of oak and pine interspersed with small grassland (http://www.wdfw.wa.gov/lands/r5klick.htm).

Conboy Lake National Wildlife Refuge

The Conboy Lake National Wildlife Refuge (NWR) is managed by USFWS. The refuge is located approximately 10 miles east of Trout Lake and 7 miles southwest of Glenwood, in the Glenwood Valley/Camas Prairie area. The NWR contains 5,184 acres of marsh, meadows, grasslands, and forest. The former mountain lake is now present only in winter and early spring. The area provides a spring migration area for Canada geese and ducks, (mainly mallards and pintails) and wintering use for tundra swans, Canada geese, ducks, and bald eagles. Additionally, one of three known nesting areas for sandhill cranes in Washington is located on the NWR, as is one of two known populations of Oregon spotted frogs (www.r1.fws.gov/visitor/washington.html).

Wild and Scenic Rivers

The Wild and Scenic Rivers Act was created by Congress to preserve in a free-flowing condition selected rivers of the nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historical, cultural, or other similar values. On November 17, 1986, the lower 11.1 miles of the Klickitat River (from its confluence with Wheeler Creek, near the town of Pitt, to its confluence with the Columbia River) were designated as a National Recreation River under this legislation. The "recreational" designation is for those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past. The segment is administered by the Secretary of Agriculture (Wild and Scenic Rivers Act. http://www.nps.gov/rivers/wsract.html). The Act restricts the construction of any dam or other water resource project on or directly affecting a designated river, or that which would have a direct and adverse effect on the values for which such a river was established, such as its free-flowing nature. The Act directed the Forest Service to develop management plans for these portions. In addition, the Act calls for completion of Wild and Scenic River Suitability Studies on other segments of the Klickitat. The Wild and Scenic Rivers Act on the Klickitat River does not supersede local Shoreline Management Plans.

Appendix IV. Estimates of Abundance Provided by Yakama Nation Fisheries

The following information is provided by Yakama Nation Fisheries. The information contained in this appendix represents the best available information prior to the installation of the adult fishway trap near Lyle. Monitoring of adult passage through the Lyle Fishway trap is provided better estimates of population size in 2005 and 2006 (Gray 2007) and will continue to provide better estimates of population size in the future.

Prior to the run year of 2005-06, total abundance and escapement estimates of wild Klickitat steelhead are highly uncertain. Run reconstruction and escapement has relied upon estimated number of spawners expanded from redd surveys. In some years, High flow and turbidity have precluded survey ability and effectiveness resulting in low and/or conservative spawner escapement estimates. Beginning in 2005-06, a Mark-recapture procedure used for population estimates has been implemented for estimating abundance at the mouth of the Klickitat for both wild and hatchery steelhead.

In the most recent ten years between 1997-98 and 2006-07, tribal harvest of wild steelhead in the Klickitat has ranged from 0 to 363 with an average of 107 fish annually (Table 1). Estimated harvest rates derived for years prior to 2005-06 are likely biased high as result of underestimated spawner escapement and total run size to the mouth of the Klickitat. For the return years of 2005-06 and 2006-07, estimated harvest rates on wild steelhead were 5.8 percent and 3.5 percent respectively (Table 1). Expansion of the spawner escapement estimates for harvest prior to these two years would suggest a much higher rate upward around 15 percent for the period of record of 1986-2007. Considering the recent two year average of 4.7 percent expanded from the mark recapture abundance estimates, actual harvest over the recent ten year period of record has probably ranged from 3.5 percent – 10 percent of the wild run to the mouth of the Klickitat.

Table IV-1. Estimated Klickitat River Steelhead Returns, Harvest and Escapement (Source Yakama Nation Fisheries).

Klickitat River Steelhead

		Sport			Tribal						
Year	Run[1]	Hatchery	Wild	Total	Hatchery[2]	Wild[2]	Total	Escapement[3]	Redds[4]	Wild run to mouth[7]	Wild Harvest rate[8]
1986-87	9,834	1,426	54	1,480	5,107	901	6,008	2,346			
1987-88	3,751	1,480	34	1,514	1,141	201	1,342	895			
1988-89	4,208	1,718	0	1,718	1,263	223	1,486	1,004			
1989-90	1,702	833	0	833	536	95	631	238	95		
1990-91	2,957	1,055	0	1,055	1,464	258	1,722	180	72		
1991-92	3,595	823	8	831	1,620	286	1,906	858			
1992-93	3,251	1,260	0	1,260	1,033	182	1,215	776			
1993-94	3,402	1,211	25	1,236	1,151	203	1,354	812			
1994-95	1,915	857	34	891	482	85	567	457			
1995-96	1,805	864	9	873	433	76	509	423	169		
1996-97	1,082	608	14	622	241	43	284	176	71		
1997-98	2,185	1,062	18	1,080	455	80	535	570	228		
1998-99	1,521	650	12	662	224	39	263	596	239		
1999-00	1,725	575	28	603	214	0	214	908	363		
2000-01	2,851	1,433	59	1,492	495	67	562	797	319		
2001-02	5,264	3,708	16	3,724	724	55	779	761	304		
2002-03	6,022	3,552	97	3,649	1285	363	1,648	725	290		
2003-04[5]	2,766	1,673	0	1,673	369	151	520	573	229		
2004-05	2,957	1,658	0	1,658	747	153	900	399	160		
2005-06[6]		1,115	0	1,115	368	98	466	520	12	1675	5.8%
2006-07[6]						61			74	1730	3.5%
Avg:	3,305	1,378	20	1,398	968	178	1,146	701	188	1,702	4.7%

Note: Data for this table are from YN and WDFW databases and US v. Oregon TAC reports
[1]Sum of harvest and escapement
[2]Hatchery and wild proportions of tribal harvest are estimated as follows: For 1999-00 through 2005-06 percentages estimated from sampling of ceremonial and subsistence harvest were applied to total tribal harvest. For 1986-87 through 1998-99 the average percentages from the 1999-2005 sampling were applied to total tribal harvest.
[3]Assumes 2.5 fish per redd. For years when redd counts were unavailable or unreliable, assumes average escapement-to-total-harvest ratio from years when reasonably accurate redd counts were available
[4]Actual redd counts expanded for mileage surveyed
[5]Sport Harvest numbers include data from May 1 - April 30 except for 2003-04, which does not include April data
[6]High flows and turbidity limited survey ability and effectiveness, probably biasing the redd count low.
[7]Wild run to mouth includes Lyle Falls Mark-recapture expansions and tribal fisheries below Falls
[8] Estimated terminal harvest rate for wild steelhead