# BIOLOGICAL EVALUATION

## SKAGIT RIVER HYDROELECTRIC PROJECT LICENSE (FERC NO. 553) AMENDMENT:

## ADDITION OF A SECOND POWER TUNNEL AT THE GORGE DEVELOPMENT

***Final***

**June 2011**

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## List of Acronyms and Abbreviations

| | |
|---|---|
| 1-DMax | 1-day average of daily maximum temperature |
| 7-DADMax | 7-day average of daily maximum temperature |
| BA | Biological Assessment |
| BCMOE | British Columbia Ministry of Environment |
| BMI | benthic macroinvertebrates |
| BMP | best management practice |
| BRT | Biological Review Team |
| CFHMP | Comprehensive Flood Hazard Management Plan |
| CFRU | Cooperative Fisheries Research Unit |
| cfs | cubic feet per second |
| City | City of Seattle |
| CPOM | coarse particulate organic matter |
| CWT | coded wire tag |
| DOM | dissolved organic matter |
| DPS | Distinct Population Segment |
| EAP | Early Action Program |
| Ecology | Washington State Department of Ecology |
| EPA | Environmental Protection Agency |
| ESA | Endangered Species Act |
| ESU | Evolutionarily Significant Unit |
| FCC | Flow Coordinating Committee |
| FERC | Federal Energy Regulatory Commission |
| FPC | Federal Power Commission |
| FRAM | Fishery Regulation Assessment Model |
| GIS | geographic information system |
| HGMP | hatchery genetic management plan |
| HSRG | Hatchery Scientific Review Group |
| km | kilometers |
| LWD | large woody debris |
| mg/L | milligrams per liter |
| MSL | mean sea level |
| MSY | maximum sustainable yield |
| NCC | Non-Flow Coordinating Committee |
| NEPA | National Environmental Policy Act |
| NFS | National Forest System |
| NGO | non-governmental organization |
| NOAA | National Oceanic and Atmospheric Administration |
| NWFSC | Northwest Fisheries Science Center |
| NTU | nephelometric turbidity unit |

| | |
|---|---|
| PCB | polychlorinated biphenyl |
| POST | Pacific Ocean Shelf Tracking |
| PPM | parts-per-million |
| Project | Skagit Hydroelectric Project |
| PSE | Puget Sound Energy |
| PSIT | Puget Sound Indian Tribes |
| PSSRP | Puget Sound Salmon Recovery Plan |
| RIVPACS | River Invertebrate Prediction and Classification System |
| RM | river mile |
| RPM | reasonable and prudent measure |
| SCL | Seattle City Light |
| SEEC | Skagit Environmental Endowment Commission |
| SEPA | State Environmental Policy Act |
| SFEG | Skagit Fisheries Enhancement Group |
| SRFB | Washington Salmon Recovery Funding Board |
| SRSC | Skagit River System Cooperative |
| TBM | tunnel boring machine |
| TDG | total dissolved gas |
| TES | Threatened and Endangered species |
| TMDL | total maximum daily load |
| TNC | The Nature Conservancy |
| TRT | Technical Recovery Team |
| TSS | total suspended solids |
| Corps | U.S. Army Corps of Engineers |
| USFS | USDA Forest Service |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| UW | University of Washington |
| VSP | viable salmon population |
| WAU | Watershed Administrative Unit |
| WDF | Washington Department of Fisheries |
| WDFW | Washington Department of Fish and Wildlife |
| WDNR | Washington Department of Natural Resources |
| WDW | Washington Department of Wildlife |
| WECC | Western Electricity Coordinating Council |
| WRIA | Watershed Resource Inventory Area |
| WSA | Wildlife Settlement Agreement |
| WSPE | Wild Salmon Production Evaluation |

# 1 INTRODUCTION

The purpose of this Biological Evaluation (BE) is to assess whether the continued operation of Seattle City Light's (SCL) Skagit River Hydroelectric Project (No. 553) (Project), as proposed in SCL's application to the Federal Energy Regulatory Commission (FERC) for an amended Project license, might affect species listed as Threatened or Endangered under the Endangered Species Act. This BE has been prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act (ESA) (16 U.S.C. 1536 [c]) and follows the guidance provided by FERC (2001).

The Threatened and Endangered species considered in this BE are listed in Table 1-1. Of the eight currently listed species, only four were covered by the consultation process for the existing Project license, which was issued by the FERC in 1995 (letter from D.C. Fredrick, State Supervisor, U.S. Fish and Wildlife Service, Olympia, Washington to J. Clements, FERC, Washington D.C., 1994). None of the three fish species or the Canada lynx were federally listed in 1995, and were therefore not included in the consultation for the current Project license.

**Table 1-1. Threatened and Endangered species in the Skagit Project action area.**

| Species common name | Scientific name | Status | Listing Date |
|---|---|---|---|
| Bull trout | *Salvelinus confluentus* | Threatened | 1999 |
| Chinook salmon | *Oncorhynchus tshawytscha* | Threatened | 1999 |
| Steelhead | *Oncorhynchus mykiss* | Threatened | 2007 |
| Marbled murrelet | *Brachyramphus marmoratus* | Threatened | 1988 |
| Northern spotted owl | *Strix occidentalis* | Threatened | 1990 |
| Canada lynx | *Lynx canadensis* | Threatened | 2000 |
| Grizzly bear | *Ursus arctos* | Threatened | 1975 |
| Gray wolf | *Canus lupus* | Endangered | 1973 |

Source: U.S. Fish and Wildlife Service, Western Washington Office. 2007. Listed and Proposed Endangered and Threatened Species and Critical Habitat, Candidate Species, and Species of Concern in Whatcom County. http://www.fws.gov/wafwo/speciesmap/WHATCOM.html (accessed May 24, 2010).

The actions addressed in this BE are: 1) the proposed FERC non-capacity license amendment, which includes a new power tunnel, Project boundary adjustment, and formalization of currently voluntary downstream flow measures; and 2) ongoing operation of the Project under the license as amended. The proposed action includes ongoing operations because bull trout, Chinook salmon, steelhead, and Canada lynx were not listed as threatened or endangered when the Project was licensed in 1995. Because the proposed action includes continued operation of the Project, the BE describes the facilities and operations that are part of the existing FERC license (Section 2), as well as those included in the amendment (Section 3). Federal consultation related to the proposed action is summarized in Section 3.4.

To assess the impacts of the proposed action on listed fish this BE has established a consultation timeframe of 2012, which corresponds to the design and construction of the new power tunnel, through 2025, which is the end of the current 30-year Skagit Project License.

## 1.1. Project Location

The Project is located in Whatcom, Skagit, and Snohomish counties, Washington and consists of three power generating developments on the Skagit River – Ross, Diablo, and Gorge – and associated lands and facilities (Figure 1-1). The three developments are hydraulically coordinated to act as a single project and supply approximately 20 percent of SCL's power requirements, while providing instream flow conditions favorable to salmon and steelhead reproduction and rearing downstream of the Project.

The Project generating facilities are located in the Cascade Mountains of the upper Skagit River watershed, between river miles (RM) 94 and 127. These facilities are entirely within the Ross Lake National Recreation Area (NRA), which is administered by the National Park Service (NPS) as part of the North Cascades National Park Complex. The Project transmission lines cross a mixture of public and private lands and span over 100 miles from the Diablo switchyard to the Bothell Substation, just north of Seattle. The Project also includes over 9,000 acres of fish habitat restoration areas and wildlife habitat lands, which are located in the Skagit and Nooksack river basins.

## 1.2. Summary of Skagit River Project History

The Skagit River Project has existed, in one form or another, since 1919. A summary of the Project history is provided below.

### 1.2.1. Project Construction and Original License

The City of Seattle received permission from the federal government to start developing hydroelectric generating facilities on the Skagit River in 1918. The following year the City's electrical utility, SCL, began constructing the Gorge Timber Crib Dam, the Gorge Powerhouse, and an 11,000-foot long, 20.5-foot diameter, concrete lined power tunnel from the diversion to the generators. In 1927, the Federal Power Commission (FPC) issued the first license to the City of Seattle for its facilities on the Skagit, thereafter called Project 553. This initial license was only for Gorge and for the addition of the upstream Diablo Dam and Powerhouse. Over the next 50 years the FPC issued a series of license amendments that authorized Ross Dam and Powerhouse, plus several improvements to the Project.

### 1.2.2. Settlement Agreement and Current License

The original license for the Project expired in 1977, and the Project was operated under annual licenses from 1977 until 1995. When SCL applied for a new Skagit operating license in 1977, 12 parties filed motions with FERC to intervene in the relicensing procedures. The Interveners included the NPS, U.S. Fish and Wildlife Service (USFWS), Bureau of Indian Affairs, U.S. Forest Service (USFS), the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries), Upper Skagit Tribe, Sauk-Suiattle Tribe, Swinomish Indian Tribal Community (Tribes), Washington Department of Game, Washington Department of Fisheries, Washington Department of Ecology, and North Cascades Conservation Council.

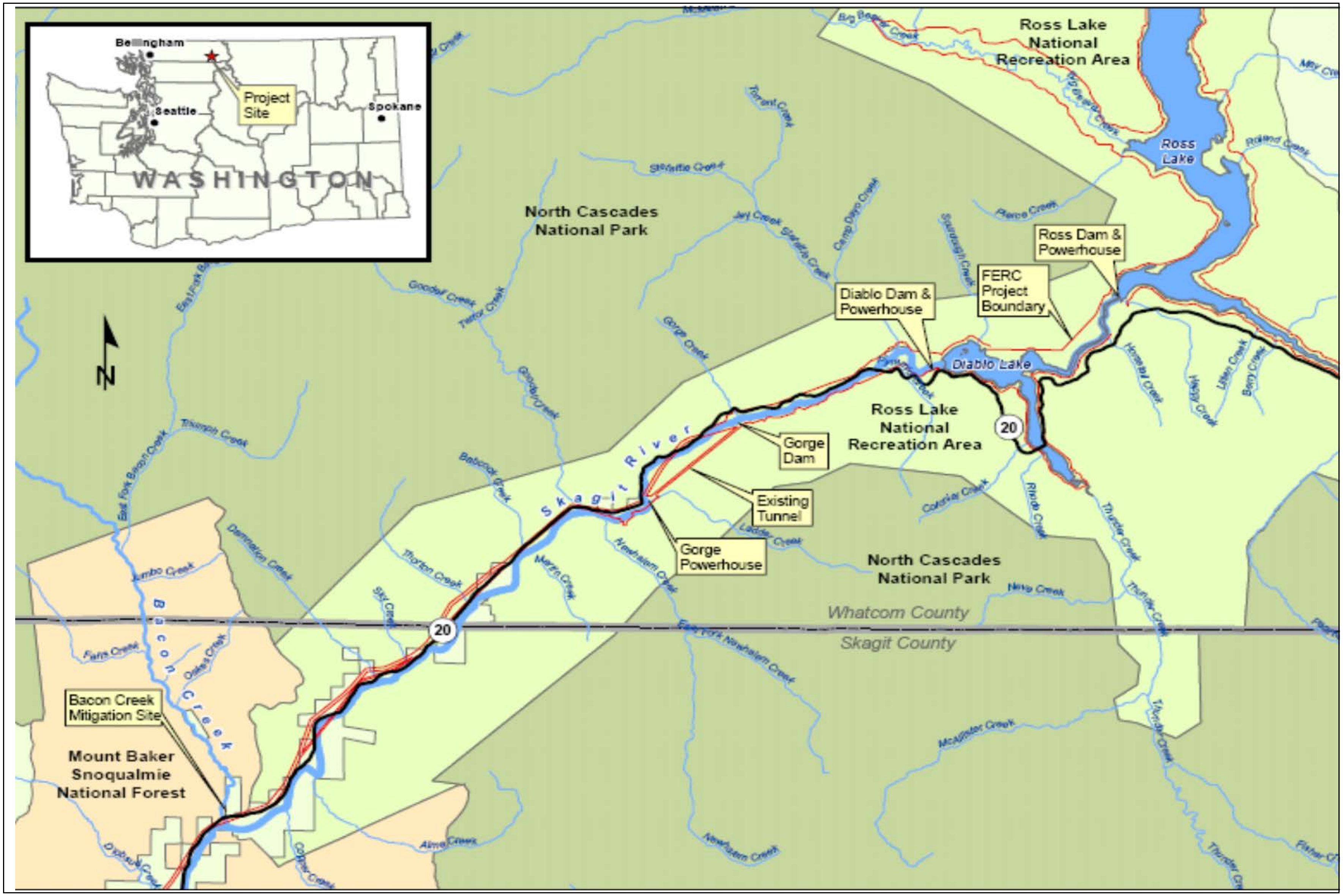



**Figure 1-1. Skagit Hydroelectric Project location and existing facilities.**

Between 1977 and 1989 Seattle worked collaboratively with the Interveners to carry out scientific research on the Project's impacts. During this time SCL negotiated several interim agreements with state and federal resource agencies and tribes that resulted in a number of major changes to project operations. Interim flow measures were effective from 1981 through 1990, and were designed to increase the level of fish protection while additional studies were conducted.

In 1991, following two years of negotiations, SCL and the Interveners reached settlement on all environmental issues. On April 22, 1991, the Seattle City Council adopted a resolution authorizing submittal to the FERC of Settlement Agreements in the areas of Fisheries, Wildlife, Recreation and Aesthetics, Erosion Control, Cultural Resources and Traditional Cultural Properties, together with an offer of settlement. These agreements were submitted, as a package, to the FERC and were intended to fully mitigate the Skagit Project's environmental impacts. On May 16, 1995, FERC issued a new 30-year operating license that incorporated most of the settlement agreements as license articles. An order on rehearing, issued on June 26, 1996, incorporated the remainder of the settlement agreements into the license. Major elements of the fisheries and wildlife settlement agreements are summarized below.

#### 1.2.2.1. Fisheries Settlement Agreement (FSA)

The Fisheries Settlement Agreement (FSA) defines SCL's obligations to Skagit River fishery resources and habitats, and establishes their intent to operate the Project in a manner that addresses the needs of fish, especially salmonids that spawn in mainstem reaches below the Project.

The FSA contains two major components: an anadromous fish flow plan (FSA Flow Plan); and an anadromous and resident fish non-flow plan (FSA Non-flow Plan).

- The ***FSA Flow Plan*** addresses flow conditions for the fishery resources in the mainstem Skagit River downstream of Gorge Powerhouse, and is intended to mitigate effects of Project operations on salmon and steelhead. Effects of Project operations during spawning and incubation of salmon are addressed by limiting maximum flows during spawning, shaping daily flows for uniformity through the spawning period, and maintaining minimum flows throughout the incubation period that are adequate to keep most redds covered until fry emerge from the streambed. For newly emerged fry, the effects of Project operations are mitigated by limiting daily downramp amplitude, maintaining minimum flows throughout the fry protection period, and restricting downramping to various rates and time periods to minimize or prevent stranding of fry. Where minimum flows required for incubation and fry protection for the various species of anadromous salmon and steelhead overlap in time, SCL provides the highest minimum flow indicated (FERC 1995). An important feature of the FSA Flow Plan is an adaptive approach to flow management below the dam. This involves regular meetings with the Flow Coordinating Committee (FCC) to evaluate system operations. This committee will modify project flow regimes to best suit the needs of salmonids that spawn below Gorge Dam based upon seasonal changes in hydrological conditions and fish spawning behavior (FERC 1995). Stakeholders represented on the FCC include the USFWS, NOAA Fisheries, NPS, USFS, WDFW, Upper Skagit Indian Tribe, Swinomish Tribal Community, and Sauk-Suiattle Indian Tribe.

The FSA Flow Plan also addresses flow insufficiencies that may result from abnormally low precipitation and runoff. During years or seasons of exceptionally low flows, SCL supplies reduced instream minimum flows to provide suitable habitat conditions for salmon and steelhead. Such flow insufficiencies may potentially result in failure to refill Ross Reservoir by July 31, or to empty Ross Reservoir if operations continue to draft the reservoir at the rate determined by minimum instream flow requirements (FERC 1995).

- The ***FSA Non-flow Plan*** is designed to mitigate residual impacts and habitat losses by providing funding for a variety of improvements, including salmonid production, research, habitat creation and improvement, and sediment reduction measures. While the FSA Flow Plan focuses on satisfying the instream flow requirements of anadromous salmon that spawn in mainstem reaches below Gorge Dam, the FSA Non-flow Plan is intended to address needs of resident fish species, including populations inhabiting the Project reservoirs and tributaries above Gorge Dam. Upstream passage for resident trout is maintained by annually removing transitory migration barriers in the drawdown zone of tributaries of Ross, Diablo, and Gorge reservoirs. Transitory barriers are comprised of debris stranded at tributaries outlets during drafting of the reservoirs (FERC 1995). In addition, rainbow trout populations in Gorge and Diablo reservoirs are annually supplemented with native broodstock. Research and habitat creation/restoration activities are determined collaboratively with stakeholders through the Non-flow Coordinating Committee (NCC).

#### 1.2.2.2. Wildlife Settlement Agreement (WSA)

The Wildlife Settlement Agreement (WSA) established the City's obligations relating to the wildlife resources affected by construction of the Skagit Project. Under the WSA, SCL agreed to make $17 million (1990 dollars) available for the purposes of securing and preserving valuable wildlife habitat in the upper Skagit and Nooksack river basins. Of the $17 million, $15,262,000–$16,554,000 were identified for the purpose of securing in land in fee; the remaining amount was allocated to habitat enhancement. In addition, the WSA requires that SCL provide funding and facilities for research in the North Cascades ecosystem. Decisions on land acquisition and research grants are made in collaboration with the stakeholders through the Wildlife Land Acquisition Group and the Wildlife Research Advisory Committee, respectively.

# 2 EXISTING PROJECT FACILITIES, OPERATIONS, AND MITIGATION AND CONSERVATION MEASURES

This section describes the existing Project facilities, reservoir operations, downstream flow operations, and the fish and wildlife mitigation measures included in the current FERC license that apply to ESA-listed species. It also describes the additional conservation actions that SCL is currently implementing on a voluntary basis to aid in the recovery of Chinook salmon, steelhead, and bull trout.

## 2.1. Existing Project Facilities

The Skagit River Hydroelectric Project includes the Ross, Diablo, and Gorge developments; the towns of Newhalem and Diablo, which provide Project administration, maintenance, and community support services; over 350 circuit miles of transmission lines; a number of fish habitat restoration sites; and approximately 9,364 acres wildlife habitat lands. These main components are described below.

### 2.1.1. Project Developments

In total, the Project has an installed generating capacity of 650.25 MW. Each of the three Project developments includes a dam, powerhouse, and reservoir (see Figure 1-1). There are no fish screens or passage facilities at any of the three Project developments because they are all located upstream of natural barriers to anadromous fish passage. Specifications for each development are summarized in Table 2-1 and described in detail below.

**Table 2-1. Summary information for the three Skagit River Project developments.**

| Specifications | Development | | |
|---|---|---|---|
| | **Ross** | **Diablo** | **Gorge** |
| **Dam type and size** | Concrete arch (540 ft high) | Concrete arch (389 ft high) | Concrete arch and gravity diversion (300 ft high) |
| **Reservoir area** | 11,860 ac | 770 ac | 240 ac |
| **Reservoir capacity** | 1,435,000 ac-ft[1] | 90,600 ac-ft | 8,500 ac-ft |
| **Useable storage** | 1,052,000 ac-ft | 8,820 ac-ft | 6,600 ac-ft |
| **Power tunnel** | 2 tunnels, each 26 ft diameter; 1,800 ft and 1,634 ft long | 1 tunnel - 2,000 ft-long | 1 tunnel - 20.5 ft diameter, 11,000 ft long |
| **Operating capacity** | 338.625 MW | 152.8 MW | 158.825 MW |
| **Generating units** | 4 | 4 | 4 |

[1] The U.S. Geological Survey uses 1,440,700 ac-ft as the capacity of Ross Lake.

#### 2.1.1.1. Ross

The Ross development is the most northern of the three Skagit Project developments; the dam is about 11 miles north of Newhalem (see Figure 1-1). Most of the water used for Skagit Project power generation originates in high mountain basins surrounding Ross Lake and upstream along the Skagit River in British Columbia. At 540 feet from bedrock to crest, Ross Dam is the highest of the three Project dams. Ross Powerhouse is located about 1,100 feet downstream of Ross Dam, on south side of Diablo Lake. Two 26-foot diameter power tunnels deliver water from the reservoir to the powerhouse.

#### 2.1.1.2. Diablo

The Diablo development is located between the Ross and Gorge developments; Diablo Dam is located about 4.5 miles downstream of Ross Dam (see Figure 1-1). The concrete arch dam is 389 feet from bedrock to crest. Diablo Powerhouse is located on the north bank of the Skagit River, about 4,000 feet downstream form Diablo Dam. A 2,000 foot-long tunnel and two inclined steel pipelines convey water from the reservoir to the powerhouse.

#### 2.1.1.3. Gorge

The Gorge Dam is located about 4 miles downstream from Diablo Dam near Gorge Creek (Figure 1-1). The dam is a combination concrete arch and gravity structure that rises 300 feet from bedrock to crest. Gorge Powerhouse is located 2.5 miles downstream from the dam on the south bank of the Skagit River near the town of Newhalem. A concrete-lined tunnel, 20.5 foot in diameter and 11,000 feet long, conveys water from the reservoir to the powerhouse.

The bypassed reach of the Skagit River between Gorge Dam and Powerhouse is about 2.7 miles long. Under the Skagit License and Settlement Agreement, SCL is not required to release any flow into the Gorge bypass reach. Other than accretion flow and tributary input, this reach is dewatered due to flow diversion unless water is being spilled at Gorge Dam. Most of this reach is upstream of several natural barriers to anadromous fish passage; the most downstream of these barriers is located 0.5 miles upstream of Gorge Powerhouse at RM 95 (Smith and Anderson 1921).

### 2.1.2. Diablo and Newhalem

The Skagit Project is in a remote location and includes two small towns that provide the facilities and services needed for Project operations and maintenance. Both towns were originally built to provide housing and services to the workers constructing the project. Newhalem is located between State Route 20 and the Skagit River, just downstream of Gorge Powerhouse (Figure 1-1). It includes administrative offices, maintenance facilities, housing, a meeting hall, and a commissary. Diablo is located about 8 miles north of Newhalem in the vicinity of Diablo Dam and Stetattle Creek (Figure 1-1). It consists mostly of houses, but also includes several other buildings used for administrative and maintenance purposes.

### 2.1.3. Project Transmission Lines

The Skagit River Project electrical transmission systems follows the Skagit River downstream to Marblemount and then cuts across the Sauk River valley to Darrington. After Darrington, the lines head west through the valley of the North Fork Stillaguamish River for about 15 miles; then head south into Snohomish County, ending at the Bothell Substation just north of Seattle. All circuits are 230 kV on Double-circuit steel towers. Approximately 100 miles long, the lines cross the Skagit, Sauk, North Fork Stillaguamish, and Snohomish rivers.

## 2.2. Existing Operations – Reservoirs

The three Skagit Project reservoirs are hydrologically coordinated but operated differently, as described below.

### 2.2.1. Ross Lake

Ross Lake covers 11,860-acres and is the largest reservoir in western Washington. The reservoir has a length of approximately 24 miles, and extends 1.5 miles into British Columbia at full operating pool. Ross Lake is a storage reservoir, and is drawn down in the winter for downstream flood control and to capture spring runoff, and refilled in the spring and summer. The large volumes of water used to meet the conditions required under the FSA Flow Plan are provided almost exclusively by Ross Lake. The normal maximum pool elevation is 1,602.5 feet; maximum drawdown under the License is 127 feet to elevation 1,475 feet (Figure 2-1).

Under License Article 301, which is based on an agreement with the Corps of Engineers (Corps), the upper 120,000 acre-feet of Ross Lake storage volume, and about 95,000 acre-feet of induced surcharge storage is reserved for flood control. Induced surcharge storage can occur during periods of extreme flooding and is accomplished by over-filling Ross Lake above the maximum operational elevation of 1,602.5 feet to approximately 1,610 feet. Draft from full pool must start no later than October 1, with the top 60,000 acre-feet evacuated by November 15, and the top 120,000 acre-feet of storage evacuated no later than December 1. After March 15, refill is permissible. Flood storage is used at the Corps discretion if flows at the United States Geological Survey (USGS) gage at Concrete are expected to exceed 90,000 cfs in an eight hour period. The Corps may not limit Ross Dam discharges to less than power requirements (FERC 1995).

In any given year, the winter drawdown of Ross Lake varies depending on water and snow pack. Under the agreement with the Corps, the reservoir must be at or below the flood control pool elevation of 1,592 feet between December 1 and March 15. On average, the typical winter low pool is to elevation 1,528 feet, a drawdown of 75 feet (Figure 2-1).

Depending on adequate runoff, anadromous fish protection flows, flood protection, and power generation needs, License Article 403 and Section 4.1 of the FSA require that SCL fill Ross Lake at soon as possible after April 15 each year, and to reach full pool by July 31. Ross Lake is held as close to full pool as possible through Labor Day weekend, with the intention of providing migratory fish that inhabit the reservoir in the summer to access to tributaries to spawn. Maintaining full pool during this period also addresses concerns associated with the recreational and aesthetics settlement agreements.

### 2.2.2. Diablo Lake

Diablo Lake has a surface area of 770 acres and is used primarily for daily and weekly reregulation of the discharge from Ross powerhouse. Under normal operations the water surface elevation of Diablo reservoir ranges from 1,205 to 1,201.5 feet. Drawdown of the reservoir normally does exceed 10 feet (elevation 1,195 feet) to maintain boat dock operations and avoid navigation hazards exposed at lower elevations.

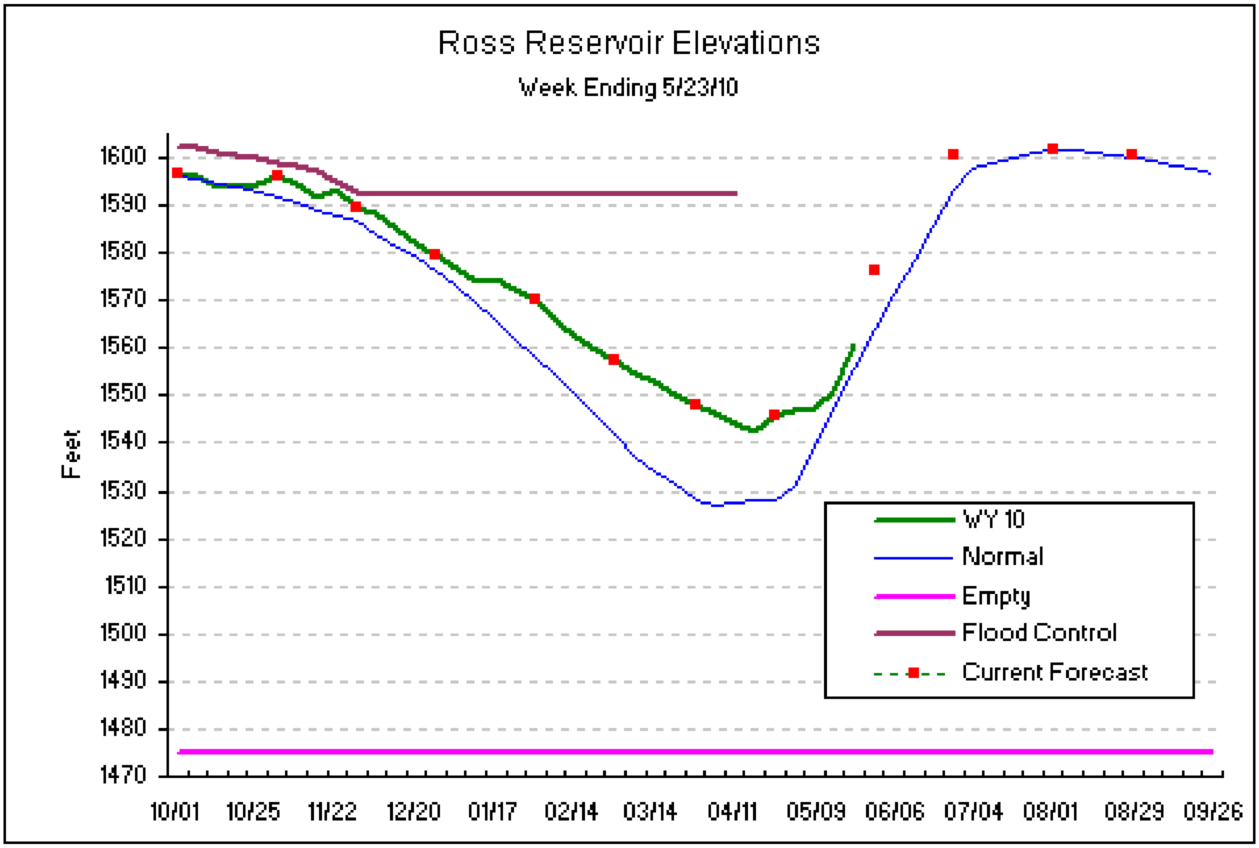



**Figure 2-1. Ross Lake elevations under normal operating conditions (2010 water year example).**

### 2.2.3. Gorge Lake

The 240-acre Gorge reservoir has a maximum and normal level of elevation 875 feet and is usually kept full or near full to provide maximum head for Gorge Powerhouse.

## 2.3. Existing Operations – Downstream Flows

The three Skagit developments are hydraulically coordinated to operate as a single project to supply power and provide instream flow conditions favorable to salmon and steelhead reproduction and rearing downstream of the Project. The FSA Flow Plan addresses flows for the fishery resources in the mainstem Skagit River downstream of Gorge Powerhouse. Its primary purpose is to minimize the effects of Project operations on salmon and steelhead. The measures included in the FSA Flow Plan were developed based on extensive research on the impacts of Project operations on fish and by extensive hydrological and operational modeling (Pflug and Mobrand 1989). Specific flow measures were developed for each species and life stage, as described in the following sections.

### 2.3.1. Salmon Spawning and Redd Protection

The primary means of protecting spawning salmon and subsequent redds downstream of the Project is to: (1) limit maximum flow levels during spawning to minimize redd building along the edges of the river in areas exposed by daily load following generation; and (2) maintain minimum flows throughout the incubation period to keep redds covered until the fry emerge.

The spawning periods for each species are based on historic habitat use data collected by resource agencies and tribes. The spawning periods for each species as identified in the FSA Flow Plan are as follows:

- Chinook salmon – August 20 to October 15 each year.
- Pink salmon September 12 and ends on October 31 in odd years
- Chum salmon – November 16 and ends on January 6 each year. To protect these fish several operational changes were required.

During the spawning period of each salmon species, daily flows cannot exceed 4,500 cfs for Chinook salmon, 4,000 cfs for pink salmon, and 4,600 cfs for chum salmon unless (a) the flow forecast made by SCL shows a sufficient volume of water will be available to sustain a higher incubation flow, thereby permitting a higher spawning flow or (b) uncontrollable flow conditions are present. Season Spawning Flow for each species is defined as the average of the highest ten Daily Spawning Flows at the Newhalem gage during the spawning period of that species.

Incubation periods start on the first day of the spawning period and end on April 30 for Chinook and pink salmon, and on May 31 for chum salmon. Instantaneous minimum flows are provided for each day of the incubation period of each species (see Appendix C of the FSA).

### 2.3.2. Salmon Fry Protection

The salmon fry protection period specified in the FSA Flow Plan is February 1 through May 31, which is when salmon fry are emerging from redds and are subject to stranding on gravel bars (Pflug and Mobrand 1989). Stranding refers to entrapment and death of juvenile salmonids on gravel bars that become exposed (dry) when the river drops rapidly in response to operational changes from a hydroelectric project. The vulnerability of salmonid fry to stranding depends on several biological, temporal, and physical factors, in addition to hydroelectric project operational factors. Stream flow properties include the river's height (stage) in relation to a specific habitat and the rate at which the stage changes in response to stream flow changes. Operational factors control changes in stream flow in response to changes in project operation, which reflect electrical power requirements.

These Project effects are addressed by limiting the daily downramp amplitude; maintaining minimum flows throughout the salmon fry protection period that are adequate to cover gravel bar areas commonly inhabited by salmon fry; and limiting downramping to nighttime hours except in periods of high flow as follows:

- ***Downramp Amplitude*** **–** The downramp amplitude is limited to no more than 4,000 cfs.
- ***Downramping Rate*** **–** During periods of daylight no downramping is allowed from the moment when the flow at Marblemount is predicted to be ≤ 4,700 cfs. Downramping may proceed at a rate of up to 1,500 cfs per hour as long as the flow at Marblemount is predicted to be > 4,700 cfs. During periods of darkness downramping is allowed at a rate up to 3,000 cfs per hour.

- ***Salmon Fry Protection Release*** **–** To maintain a predicted Marblemount flow of 3,000 cfs during the salmon fry protection period the Project must release up to 2,600 cfs.

### 2.3.3. Steelhead Spawning and Redd Protection

Measures to protect spawning steelhead and subsequent redds, downstream of the Project include limiting maximum flow levels during spawning; shaping daily flows for uniformity over the extended spawning period; and maintaining minimum flows through the incubation period adequate to keep redds covered until fry emerge from the gravel. To protect eggs and embryos from dewatering, the measures in the FSA Flow Plan substantially reduce the difference between spawning and incubation flows, thus decreasing the area of river channel subjected to dewatering.

The steelhead spawning period specified in the FSA Flow Plan is from March 15 through June 15 each year. This spawning period is divided into three sub-periods: March 15 – 31, April 1 – 30, and May 1 through June 15. Each sub-period is treated separately for the purpose of determining succeeding steelhead spawning and incubation flows. Planned flows are not to exceed 5,000 cfs for March steelhead, 5,000 cfs for April steelhead, and 4,000 for May through June 15 steelhead, unless the forecasted inflow and storage is great enough to provide incubation flows that are at least as high as the spawning flows. As stipulated in the FSA Flow Plan, any planned spawning flows greater than these flow ranges are not to be implemented prior to discussion with the Flow Coordinating Committee. The actual spawning flow for each sub-period is defined as the average of the highest ten Daily Spawning Flows at the Newhalem gage during that sub-period.

The incubation periods for each steelhead spawning group starts on the first day of the spawning sub-periods and ends on June 30 for March steelhead, and July 31 for both April steelhead and May through June 15 steelhead. An instantaneous minimum incubation flow for each day of the incubation period is provided as follows:

- Incubation flows during the first ten days of each spawning sub-period are based on the planned spawning flow.
- Thereafter, daily incubation flows are based on the average of the highest ten daily spawning flows that have occurred up to that day. Appropriate incubation flows for any given day are determined by the season spawning flows in Appendix G of the FSA.
- During the month of August, the instantaneous daily incubation flows at Newhalem gage is 2,000 cfs.

### 2.3.4. Steelhead Fry Protection

Newly emerged steelhead fry are protected from stranding by limiting daily downramp amplitudes and rates and maintaining minimum flows from June 1 through October 15 adequate to cover areas of gravel bar commonly inhabited by steelhead fry. Implementation details include:

- ***Downramp Amplitude*** **–** The maximum 24 hour downramp amplitude is limited to 3,000 cfs when flows at the Newhalem gage are > 4,000 cfs. When flows at Newhalem gage are ≤ 4,000 cfs, the downramp amplitude is limited to 2,000 cfs per day from June 1 through August and to 2,500 in September and October. During the month of August, downramp amplitude is further restricted to 500 cfs per day when flow insufficiency provisions are in effect (see FSA Section 6.4).

- ***Downramping Rate*** **–** When the Newhalem instantaneous flow is ≤ 4,000 cfs the allowed downramp rate is up to 500 cfs per hour. When the Newhalem instantaneous flow remains > 4,000 cfs a downramp rate of up to 1,000 cfs per hour is allowed.
- ***Steelhead Fry Protection Flow*** **–** Minimum flows at the Newhalem gage must be the higher of flows specified in Appendix I of FSA Flow Plan (Table 2-2) or by required steelhead incubation flows. During the portions of June and October excluded from the Steelhead Fry Protection Period minimum flows are determined by required salmon incubation flows.

**Table 2-2. Fry protection flows at Newhalem gage.**

| Month | Minimum Sufficient Instantaneous Flow (cfs)* |
|---|---|
| January | ** |
| February | 1800 |
| March | 1800 |
| April | 1800 |
| May | 1500 |
| June | 1500 |
| July | 1500 |
| August | 2000 |
| September | 1500 |
| October | 1500 |
| November | ** |
| December | ** |

Source: FSA Flow Plan Appendix I

* Minimum flow may be reduced to 1500 cfs when Natural Flow on the Inflow Day is less than 2300 cfs (Section 6.3.3.2 (3) of the FSA).

** Minimum flows in these months are determined by incubation flow requirements.

### 2.3.5. Other Flow Management Measures

The FSA Flow Plan recognizes that full and complete protection of anadromous fish spawning, incubation, and rearing may not be possible, particularly when uncontrollable flow events occur. In addition to the downstream flow requirements described above, it was recognized that specific voluntary actions may be needed to provide better protection to salmon and steelhead spawning areas, redds, and fry as a result of new information on the effects of flows on spawning, incubation, and fry survival. These voluntary actions are cooperatively developed through the

Flow Coordinating Committee, which takes into account Project system flexibility, economic considerations, and potential impacts to all anadromous species and life stages at a given time. Critical data considered include tributary inflows between Newhalem and Marblemount, and field monitoring of redd locations. Implementation of voluntary actions typically involves development of a proposed action by SCL during or at the end of the spawning season for each species (or spawning group in the case of steelhead), and whenever uncontrollable flow events occur during the spawning, incubation, and rearing periods. The proposal is then presented to the Flow Coordinating Committee for review and discussion in an effort to reach consensus on a plan of action.

An example of the voluntary action implementation process occurred in the first few years of FSA Flow Plan implementation when SCL and the Flow Coordinating Committee determined that there were four flow measures that were either missing or inadequate. To meet the intent of the FSA Flow Plan, SCL worked with the Flow Coordinating Committee to develop/modify measures that further reduced the impacts of project operations on Chinook, chum, coho, and pink salmon, steelhead trout, and resident fish species in the upper Skagit River below the Project. Although these flow modifications are not current license requirements or subject to FERC compliance, SCL voluntarily agreed to incorporate them into its operational plans each year until they could be formalized through an amendment process. The details for these four FSA Flow Plan modifications are described in the proposed conservation measure section (Section 3.3.1) of this document.

## 2.4. Existing Mitigation Measures

The Settlement Agreement and FERC license for the Project includes a number of measures to mitigate for the loss of off-channel and side channel habitat from the Project for fish (FSA Non-flow Plan; License Article 404) and wildlife (Wildlife Settlement Agreement; License Article 410). Although the FSA Non-flow Plan was developed prior to the listing of Chinook salmon, bull trout, or steelhead, many of the mitigation measures in the plan benefit at least one of these species.

### 2.4.1. FSA Non-Flow Plan Measures

The FSA Non-flow Plan directs SCL to implement a range of mitigation measures including fish habitat acquisition, protection, and restoration, as well as research activities. These measures are described below.

#### 2.4.1.1. Fish Habitat Restoration

Wild salmon require a number of different channel habitat types for spawning and rearing. Off-channel habitats have only a downstream connection to the mainstem river, while side channels are connected to the mainstem at the up-and downstream ends. Prior to the construction and operation of the Project flooding events from unregulated flows created both off-channel and side-channels. Project operations impaired these channel-forming processes by reducing both the frequency and magnitude of downstream floods downstream. The FSA Non-Flow Plan includes a mitigation program that acknowledges this impact and seeks to off-set the reduction of this off-channel and side-channel habitats in the 27-mile reach of the Skagit River located downstream of the Project to the Sauk River. The program utilizes three approaches; protection of existing (functioning) off-channel habitat through acquisition, restoration of existing off-channel habitat, or construction of new off-channel habitat. Nearly three miles of off-channel habitats have been acquired, restored, or built since 1995. While focused primarily on improving habitat for chum salmon, the program has also benefited coho salmon, Chinook salmon, steelhead, and bull trout to a lesser degree (Table 2-3).

**Table 2-3. Completed FSA Non-Flow Plan salmon habitat restoration and acquisition projects that benefit Chinook salmon and steelhead.**

| Project | Type | Completion Year | Aquatic Habitat Area (sq ft) | Location (RM) |
|---|---|---|---|---|
| Newhalem Ponds | New channel construction | 1991 | 81,000 | 90.2 |
| County Line Ponds | New channel construction | 1991 | 22, 000 | 89 |
| County Line Ponds Expansion | Added a pond | 1996 | 730 | 89 |
| Taylor Channel | New off-channel construction | 1998 | 5,694 | 79.4 |
| Johnson Slough | Off-channel habitat acquisition and restoration | 2000 | 7,466 | 67.7 |
| Bacon Creek Rip-Rap Removal | Off-channel habitat restoration and floodplain re-connection | 2004 | 792,792 | 83 |
| O'Brian Creek Culvert Replacement | Bridge installed to replace undersized culvert | 2008 | 100,000 | 73 |
| Bacon Creek Road Replacement | Rip-rap removal and road replacement | 2005 | 24,000 | 82 |
| Ross Island Slough Acquisition | Acquisition and restoration of off-channel habitat | 2009 | 25,000 | 30 |

#### 2.4.1.2. Research on ESA-listed Fish

A substantial amount of research on ESA listed species, particularly Chinook salmon, has been conducted since the Project was licensed in 1995. Research on ESA-listed fish conducted or funded to date by SCL under the FSA Non-flow Plan is summarized below.

- ***Freshwater Habitat Rearing Preferences for Juvenile Chinook Salmon, Steelhead, and Bull Trout in the Skagit River Basin.*** This study is being conducted by the Upper Skagit Indian Tribe, Skagit River System Cooperative, and SCL to examine seasonal freshwater habitat preferences and spatial distribution of yearling Chinook salmon, juvenile bull trout, and yearling and older juvenile steelhead. The first phase began in 2007 and assembled a habitat database of the Skagit River basin in GIS, refined field methods for fish observation, collected pilot level fish observation data to be used in power analysis, and conducted power analysis on several field study designs. The second phase (2010 - 11) is a fully implemented field study. This study will provide a better understanding of the causes of decline in ESA listed species. For each of the three species, this study will determine the following: (1) seasonal habitat use; (2) seasonal location of fish within the basin; and (3) habitats types by location within the basin. The results of this research study will be used to guide habitat protection and restoration actions throughout the basin to improve the spatial distribution and life-history diversity of the yearling form of these listed species.

- ***Chinook Salmon Life History Study.*** This study fits into a larger applied research framework by providing specific juvenile life history data to a habitat-based salmon production model developed by the Skagit System Cooperative Research Program and the Northwest Fisheries Science Center (NWFSC) Watershed Program. The model framework consists of a relatively simple structure linking the various life history stages of ocean type Chinook salmon. This model is a scientific and data-based tool for evaluating the likely outcome of Chinook salmon habitat restoration efforts in the Skagit basin. The Skagit Chinook Salmon Life History Study has four main objectives.
  - Identify juvenile life history types of wild Skagit ocean type Chinook salmon.
  - Estimate the Skagit's distribution of juvenile life history types by brood year and understand the causes of annual variation (e.g., impacts by varying population size and environmental conditions).
  - Estimate marine survival by juvenile life history type (requires analysis of at least one brood year of adult Chinook salmon otoliths).
  - Estimate annual variation in marine survival by juvenile life history type and understand the causes of annual variation (requires longer term analysis of adult otoliths).

  Taken as a whole, this body of work provides extensive data on the life history characteristics of Chinook salmon populations during their freshwater rearing phases and population response to variation in stream discharge, restoration, and land use management. Fieldwork and analysis will not be completed until 2012. A final report/journal paper will be completed by WDFW/SRSC in 2011-2012.

- ***Skagit River Downstream Migrant Chinook Salmon Evaluation.*** Beginning in 1997 and annually through 2006, SCL provided funding to the WDFW's Wild Salmon Production Evaluation (WSPE) Unit to assess natural origin downstream migrant Chinook salmon production. Following each year's evaluation, the WSPE has produced an annual report describing findings from the year's activities, including age 0 Chinook salmon production estimates, size, timing, and egg-to-migrant survival (e.g., Kinsel et al. 2007). Chinook salmon outmigration total varied greatly from one to five million natural-origin sub-yearlings annually. Egg-to-migrant survival also varied greatly from 2-17 percent. Natural origin coho smolts, chum fry, pink fry, steelhead smolts, Dolly Varden trout/bull trout smolts catches were recorded. Egg-to-migrant survival was inversely related to flow level during vulnerable egg incubation periods each fall and winter. A final report/manuscript is being prepared by WDFW that describes the findings from the ten years of Chinook salmon production evaluations. The manuscript is to be completed in the 4th quarter of 2010.

- ***Inventory of Natural and Constructed Off-Channel Habitat in the Upper Skagit River Basin.*** In 2004, the SRSC completed an inventory of natural and constructed off-channel habitat in the upper Skagit River basin (including parts of Bacon Creek, Cascade, Suiattle, Sauk, and Whitechuck rivers) to assess the loss of off-channel habitat attributed to the hydroelectric project and to establish the need for additional off-channel habitat within the affected reach (Smith 2005). The SCL-funded study found that the density of natural off-channel habitat in the Upper Skagit Reach (normalized by effective floodplain area) is lower than the habitat density in unregulated river reaches (Smith 2005). The study also determined that when constructed habitat is factored into the analysis of off-channel habitat density, the upper Skagit Reach is comparable to other unregulated river reaches. In addition, the off-channel habitat inventory documented hydro-modified reaches that restrict available floodplain area, further limiting the formation of new off channel habitat.

### 2.4.2. Wildlife Mitigation Measures

The Skagit Wildlife Settlement Agreement includes programs for habitat acquisition, research grants, and research funding to mitigate for ongoing Project effects on wildlife. These three programs benefit federally listed wildlife species, as described below.

#### 2.4.2.1. Habitat Acquisition, Protection, and Management

The Wildlife Mitigation Lands Program provides for the acquisition, protection, and management of upland, riparian, and wetland habitats in the Skagit and South Fork Nooksack watersheds. Land acquisition began in 1992 and will continue until the $15,262,000 to $16,554,000 (1990 dollars) obligated by the WSA has been expended. All acquisitions and management actions on the Wildlife Mitigation Lands (WML) are made through consensus of the Wildlife Management Review Committee, which consists of representatives from the USFWS, WDFW, NPS, USFS, tribes, and the North Cascades Conservation Council. Management activities follow the Management Plan for Skagit Wildlife Mitigation Lands (SCL 2006) and are reviewed annually by the WMRC. As of July 1, 2010, the WML includes approximately 9,239 acres; all but the most recent acquisitions were incorporated into the FERC Project boundary in 2009 (Figure 2-2).

While the main purpose of these lands is as wildlife habitat, SCL management actions have reduced sediment input into the river and tributary streams and protected riparian zones to benefit listed fish species. The primary management on these lands has consisted of abandoning unneeded forest roads and stream culverts, controlling weeds, restoring wetland and riparian habitats, and controlling activities that resulting in resource damage (i.e., OVR use, trash dumping). The WML properties are within the ranges of the northern spotted owl and marbled murrelet. While most of the timber stands on the WML are not currently old enough to provide suitable nesting habitat for owls and marbled murrelets, many of the forested areas will develop into suitable habitat over time. A summary of WML properties is presented in Table 2-4.

#### 2.4.2.2. Wildlife Research Grants

The Wildlife Research Grant Program provides $50,000 (1990 dollars) annually for research on wildlife and wildlife habitat in the North Cascades ecosystem. Researchers from universities, state and federal agencies, and consulting companies are invited to submit proposals twice annually to SCL. Proposals are evaluated by the Wildlife Research Advisory Committee, which consists of representatives from the USFWS, WDFW, NPS, USFS, and a local university. To date, the program has awarded six grants focused on three threatened and endangered species—lynx, grizzly bear, and spotted owl (Table 2-5).

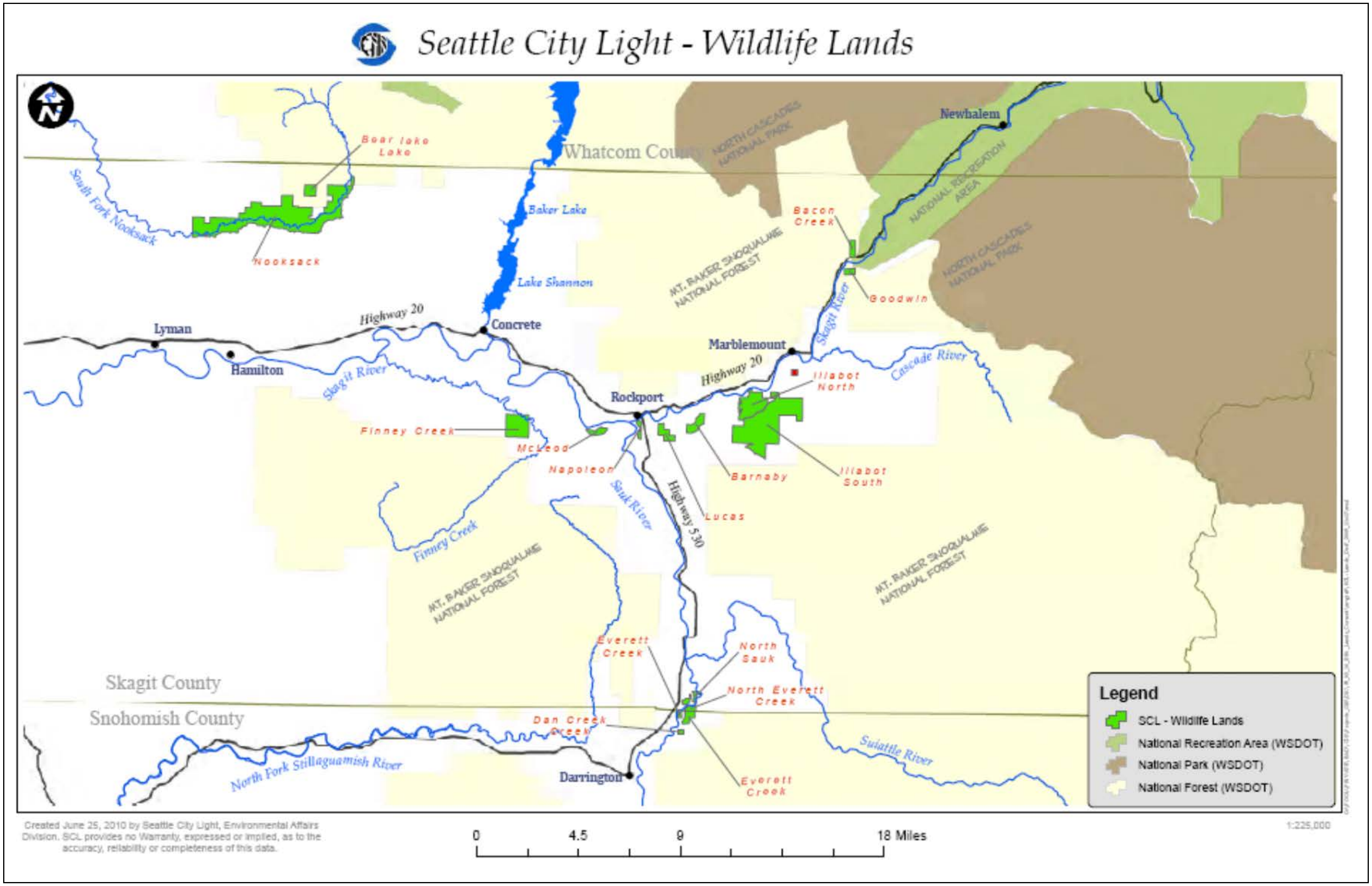



**Figure 2-2. Wildlife Mitigation Lands.**

**Table 2-4. Skagit Hydroelectric Project Wildlife Mitigation Lands.**

| Property | Year Acquired | Acres[1] | Habitats | Elevation (ft) | Management Actions Completed |
|---|---|---|---|---|---|
| **South Fork Nooksack River** | | | | | |
| S.F. Nooksack River | 1991-1993 | 3,805 | Conifer forest (including old-growth), riparian forest, wetland | 800-3,400 | Bridge removal, road abandonment, riparian zone conifer plantings |
| Bear Lake | 1993 | 155 | Old-growth conifer forest, lake, wetland | 3,200-3,900 | |
| Section 10 | 2003 | 40 | Conifer forest, riparian forest | 1,600-3,400 | Road abandonment |
| Olivine Ends | 2010 | 210 | Conifer forest, riparian forest | 1,300-2,500 | |
| ***Total S. Fork Nooksack*** | | ***4,210*** | | | |
| **Skagit River** | | | | | |
| Bacon Creek | 1997 | 119 | Conifer forest, tributary, riparian forest, rock quarry | 340-600 | Road relocation out of riparian zone, quarry reforestation (planned) |
| Illabot South | 1993-2003 | 2,522 | Conifer forest (including 67 acres of old-growth), tributary streams, riparian forest, transmission ROW | 300-4,000 | Road closures |
| Illabot North & O'Brian Slough | 1993-1998 | 743 | Conifer forest, tributary streams, riparian forest, oxbow lake and wetlands; transmission ROW | 260-300 | |
| Barnaby Slough | 1995 | 225 | Conifer forest, riparian forest, oxbow lake and wetlands | 250 | |
| Lucas Slough | 1995 | 204 | Conifer forest, oxbow lake and wetlands | 230 | Removal of abandoned road blocking sloughs |
| Napoleon Slough | 1995 | 62 | Floodplain wetland and riparian forest | 220 | |
| McLeod Slough | 1997 | 125 | Agricultural land, riparian forest, wetland | 210 | Life estate to harvest hay. |
| Finney Creek | 2010 | 641 | Conifer forest, tributary streams, riparian forest | 480-2,800 | Road abandonment (planned) |
| Goodwin | 2010 | 79 | Conifer forest, including some mature timber, tributary stream | 400-800 | |
| ***Total Skagit River*** | | ***4,720*** | | | |
| **Sauk River** | | | | | |
| Sauk Island | 1999 | 21 | Floodplain, riparian forest | 300-400 | |
| Everett & North Everett Creek | 1997 | 212 | Floodplain, riparian forest, deciduous and mixed conifer-deciduous forest | 300-400 | |
| Dan Creek | 1999 | 42 | Floodplain riparian forest, deciduous forest | 300-400 | |
| North Sauk | 2002 | 34 | Floodplain, riparian forest, deciduous and mixed conifer-deciduous forest | 300-400 | |
| ***Total Sauk River*** | | ***309*** | | | |

1. Based on GIS data from 2011 FERC boundary update.

**Table 2-5. Skagit wildlife research grants focused on threatened or endangered species.**

| Grant Title | Dates | Researchers | Results Summary |
|---|---|---|---|
| Grizzly Bear Presence and Population Estimate for the North Cascades | 1999-2000 | Washington State University | Density and population size estimates for the North Cascades are 0.15 bears/100 sq km and 6 bears, respectively. Natural recovery seems unlikely. The likelihood of extinction is high due to demographic and environmental stochastic effects associated with extremely small population numbers. |
| Habitat Selection by Lynx in the North Cascades | 2000-2003 | WDFW and USFS, Pacific NW Research Station | Lynx habitat use on the Okanogan Plateau was confined to older mid- and late successional stands where they sought out areas where small-diameter stems occurred in forest gaps. |
| Grizzly Bear Outreach Project Evaluation | 2003-2006 | Conservation Partnership and Insight Wildlife Management | Skagit and Whatcom County residents are ready for active steps toward grizzly bear recovery in the North Cascades. Additional education and confidence building that is needed to support recovery can be delivered effectively while other recovery actions are on-going. |
| Lynx Cycles and Barriers: Evaluating Dispersal Versus Climate Change in Flat-lining Populations | 2007-2010 | University of Alberta | In progress. |
| Factors Affecting Spotted Owl Persistence in Northwest Washington: A 20 year Retrospective | 2008-2009 | Hamer Environmental Consultants | Resurveys of an area with high spotted owl density in 1988 showed substantially decreased spotted owl abundance, increased barred owl abundance, and an expansion of habitat types and elevations used by barred owls. |
| Canada Lynx Conservation in the North Cascades: Habitat Use of GPS Marked Animals | 2009-2010 | WDFW | In progress. |

#### 2.4.2.3. Wildlife Research Funding

Under the Wildlife Settlement Agreement, SCL provides $20,000 (1990 dollars) of annual funding to the NPS for research on wildlife and plants. The NPS has used this funding for a variety of wildlife research and inventory projects within North Cascades National Park and Ross Lake National Recreation (combined these areas are known as the North Cascades National Park Service Complex or NOCA), including surveys for spotted owls and marbled murrelets.

## 2.5. Existing Conservation Measures for ESA-Listed Fish

None of the mitigation measures in the FSA-Non Flow Plan were specifically designed to address Project effects on Chinook salmon, steelhead, and bull trout because these species were not listed under the ESA as threatened at the time the Project was licensed in 1995. Following the listings of bull trout and Chinook salmon, in 2000 SCL implemented a program of voluntary conservation actions in Skagit River watershed. Known as the ESA Early Action Program (EAP), this program provides funding and a staff (one full time) to develop and complete research, conservation land acquisition, and habitat restoration projects in the Skagit River water for the recovery of listed fish species. The program was expanded in 2007 to add research, land acquisition, and recovery projects for steelhead.

The EAP has been very successful, resulting in the completion of major research, land conservation, and habitat restoration projects with ESA-listed species throughout the Skagit River watershed. Much of the success of this program can be attributed to the collaborative effort developed through long-term conservation partnerships with the Skagit Watershed Council, the three Skagit tribes, state and federal resource agencies, University of Washington, and non-governmental organizations, including the Skagit Fisheries Enhancement Group, The Nature Conservancy, and Skagit Land Trust. The EAP provides the services of SCL scientists to contribute to the development of local and regional recovery plans for Chinook salmon, bull trout, and steelhead in the Skagit River watershed. SCL fish biologists have served as members of the Skagit Chinook Recovery Planning Group and the FWS Puget Sound Bull Trout Recovery Implementation Team, and are currently serving on NOAA's Puget Sound Steelhead Technical Recovery Team.

The EAP has funded and completed much-needed research to guide recovery actions, acquire and restore critical freshwater and estuarine habitats, and build support for multi-species fish recovery in the Skagit River watershed. SCL's approach towards multi-species ESA fish recovery under the EAP program involves three key components:

- ***Protecting*** the highest quality habitats remaining that are vital to existing fish populations in the watershed; and
- ***Restoring*** habitat conditions in areas throughout the watershed that are limiting the survival and spatial distribution of listed fish species.
- Developing and implementing watershed-wide ***research*** programs that improve the scientific understanding of the life history and habitat requirements of listed species;

To date, the EAP has provided $3.9 million in direct funding (not including staff funding) for habitat protection and restoration projects in the Skagit watershed. The EAP also attracted an additional $4.5 million in grants and matching funds for habitat acquisition and restoration projects in the Skagit watershed during this period. In addition to funding salmon recovery projects, SCL supported the watershed planning process through staff participation and funding support of the Skagit Watershed Council.

### 2.5.1. EAP Habitat Acquisition Projects

To date, SCL has purchased and protected over 2,000 acres of high quality habitat in the Skagit watershed for ESA-listed fish species (Table 2-6). The largest of these conservation land acquisitions is the 1,108-acre Boulder Creek parcel, completed in partnership with The Nature Conservancy (TNC), the Washington Department of Natural Resources (DNR), and the USFWS in 2007. The project was funded through an FWS Endangered Species Program (Section 6) grant awarded to SCL and using matching funds provided by SCL. The upper Boulder Creek watershed contains over 200 acres of old-growth forest that provide habitat for marbled murrelets and northern spotted owls. The acquisition provides important migration, spawning, and rearing habitat for Chinook salmon, steelhead and bull trout. More importantly, the long-term conservation protection of the Boulder Creek watershed by SCL will improve water quality conditions and reduce sediment loads in the Cascade River, which is one of the most important areas for ESA-listed fish species in the Skagit River basin.

### 2.5.2. EAP Habitat Restoration Projects

Habitat restoration work completed under the EAP has focused on the middle Skagit River, an important Chinook salmon and steelhead spawning area and a key migration and foraging area for bull trout. A summary of habitat restoration projects that SCL has funded through the EAP Program is provided on Table 2-7. Completed projects include the following:

- Restoration of native riparian vegetation along a 2-mile section of the middle Skagit River, approximately 35 miles downstream of the Project (partnership with the Skagit Fisheries Enhancement Group);
- Native tree and shrub planting to reduce erosion and channel degradation in the Iron Mountain Ranch conservation area, a 240-acre parcel purchased by SCL in 2005 (matching funds from the State of Washington Salmon Recovery Funding Board; partnership with volunteers from the local community).

Currently SCL, in partnership with the Skagit River System Cooperative, FWS, WDFW, is initiating work on the Wiley Slough Estuary Restoration Project. This project will restore over 140 acres of lands behind dikes in Skagit River delta to naturally functioning estuary habitat. The project will significantly increase the amount of estuary area, which provides rapid-growth habitat important to the survival of juvenile Chinook salmon and sub-adult bull trout. SCL provided the initial $200,000 in funding for this project, which was then used to attract over $2 million in grant funding for this project from the FWS Coastal Grant Program, Salmon Recovery Funding Board, and the Natural Resource Conservation Service.

SCL is also key member of the technical advisory team for the Fisher Slough Restoration project sponsored by TNC, which is a major freshwater tidal land acquisition and restoration project located on the South Fork Skagit River that was awarded a $5.6 million stimulus grant from NOAA Fisheries in 2010. In addition, SCL is currently providing staff support for a major estuary restoration project located on Skagit Bay that is being sponsored by the WDFW.

### 2.5.3. EAP Research Projects

To date, SCL has provided $1,023,000 in voluntary funding for Chinook salmon, bull trout, and steelhead research studies in the watershed since the EAP was implemented in 2000. This

**Table 2-6. Habitat acquisition projects funded by the EAP.**

| Property | Year Acquired | Acres | Subbasin | Habitats Protected | Total Cost ($) |
|---|---|---|---|---|---|
| Suiattle Bend | 2000 | 132 | Suiattle River | Mainstem riparian and side channel | 190,000 |
| Nielsen Parcel | 2001 | 40 | Lower Sauk River | Side-channel and wetlands area | 68,925 |
| Darrington Parcel | 2002 | 114 | Middle Sauk River | Large side-channel and wetlands complex | 476,000 |
| Gilligan Creek | 2002 | 14 | Middle Skagit | Mainstem cottonwood forest and mouth of Gilligan Creek | 66,205 |
| Tenas Creek | 2003 | 70 | Suiattle River | Tributary riparian and alluvial fan | 115,978 |
| Iron Mountain Ranch | 2004 | 235 | Middle Skagit | Two-miles mainstem riparian habitat | 702,834 |
| Ross Island Ranch | 2005 | 125 | Middle Skagit | Largest side-channel complex in middle Skagit | 362,696 |
| Dangelmaier Parcel | 2006 | 8 | Middle Skagit | Mainstem riparian forest | 42,616 |
| Mill Creek Island | 2006 | 34 | Middle Skagit | Side channel complex to mainstem river | 19,493 |
| Cumberland Bend | 2006 | 43 | Middle Skagit | Mainstem riparian forest | 186,338 |
| Veleke Parcel | 2006 | 4 | Middle Skagit | Mainstem riparian forest | 35,533 |
| Boulder Creek Watershed | 2007 | 1,080 | Cascade River | Tributary riparian and uplands | 998,000 |
| Sjoboen Parcel | 2008 | 91 | Middle Skagit | Mainstem riparian forest | 753,518 |
| Lower Ross Island | 2009 | 36 | Middle Skagit | Largest side-channel complex in middle Skagit | 151,662 |
| Petrich Parcel | 2009 | 9 | Middle Skagit | Mainstem riparian forest | 53,867 |

investment attracted an additional $640,000 in grants and matching funds for Chinook salmon and bull trout research in the Skagit watershed. Major research programs include:

- ***Bull Trout Population Monitoring Program.*** This program is being conducted in partnership with the Washington Department of Fish and Wildlife (WDFW) and was originally implemented in 2001 to evaluate the population status of bull trout in the Skagit River. Since this time, WDFW has conducted yearly snorkel and spawning surveys to estimate the abundance of adult bull trout and redds within seven monitoring areas in the Skagit watershed. This monitoring project yielded valuable data on the population trends, age-class structure, distribution, and spawning timing of bull trout in this watershed. Results indicate that bull trout have substantially declined in abundance throughout the watershed in response to increasing variability in natural hydrological runoff patterns. The monitoring program provides an “early warning system” to resource

**Table 2-7. Skagit Watershed restoration project funded by the EAP.**

| Project | Year Funded | Restoration Objectives | Partners[1] | Total SCL Funding |
|---|---|---|---|---|
| Finney Creek Sediment Control | 2000 | Landslide stabilization to reduce sediment loads | USFS; SFEG | $200,000 |
| Skagit Estuary Restoration Study Phase II | 2000 | Identify and analyze restoration alternatives for Fir Island | SWC; SRSC; USFWS | $100,000 |
| Deepwater Slough Monitoring | 2001 | Implement multiple year monitoring program for large estuary project | SRSC; Corps; WDFW | $108,000 |
| Finney Creek Habitat Restoration | 2001 | Installation of log jams and riparian restoration | USFS; SFEG | $240,000 |
| Skagit Estuary Restoration Phase II | 2003 | Assessment of restoration alternatives for Skagit Delta | SWC | $145,950 |
| Ross Island Riparian | 2003 | Riparian planting and noxious weed removal along Ross Island Slough | SFEG | $46,000 |
| Wiley Slough Design Project | 2003 | Identify and analyze restoration alternatives for WDFW Wiley Slough property | SWC; SRSC; WDFW | $15,000 |
| Milltown Island Levee Removal | 2004 | Restoration of tidal freshwater wetland area in Skagit delta | SRSC; WDFW | $135,944 |
| Iron Mountain Ranch Riparian | 2005 | Riparian planting and fencing along two-mile section of middle Skagit River | SFEG | $29,500 |
| Rawlins Road Estuary Restoration Study | 2005 | Complete 3-D hydrodynamic model of Skagit Bay and drainage model of Fir Island | SWC; SRSC; PNNL | $30,000 |
| Wiley Slough Construction | 2006 | Dike removal and setback project to restore estuary habitat in Skagit delta and bay | SRSC; SWC; WDFW | $150,000 |
| Cottonwood Island Feasibility Study | 2007 | Expand 3-D hydrodynamic model to Skagit forks confluence for restoration project analysis | SWC; PNNL | $30,000 |
| Anderson Creek Restoration | 2008 | Engineering assessment and riparian planting of Anderson Creek alluvial fan | SFEG | $63,256 |
| Ross Island Invasive Species Control | 2009 | Remove invasive plant species and native riparian plantings | SFEG | $25,000 |

Corps=Corp of Engineers; PNNL=Pacific Northwest National Laboratory; SFEG=Skagit Fisheries Enhancement Group; SRSC=Skagit River System Cooperative; SWC=Skagit Watershed Council; USFS=U.S. Forest Service; USFWS=U.S. Fish and Wildlife Service; WDFW=Washington Department of Fish and Wildlife.

managers regarding the status of this species in the watershed, and resulted in the implementation of harvest restrictions in 2007 to improve the recruitment of reproductive bull trout in the Skagit River.

- ***Upper Skagit River Bull Trout Monitoring Program.*** This program was initiated by SCL in 2002 in partnership with the British Columbia Ministry of Environment

(BCMOE), Skagit Environmental Endowment Commission (SEEC) and North Cascades National Park with the purpose of providing the data needed to guide recovery actions for trans-boundary bull trout populations within the upper Skagit River in the U.S. and Canada. Bull trout were implanted with radio telemetry tags in 2002 and 2003, and tracked using fixed receiver stations positioned at the outlet of major tributaries to Ross Lake including the upper Skagit River in British Columbia.

This study found that bull trout are present as three different life history forms in the upper Skagit watershed: resident (stream dwelling adults), fluvial (river dwelling adults), and adfluvial (lake dwelling adults). The majority of bull trout were found to be adfluvial forms, with these fish residing in Ross Lake most of the year. The majority of bull trout in Ross Lake (> 70%) were found to migrate into the upper Skagit River in British Columbia to spawn. The highest number of spawners was observed in the mainstem Skagit River between Hozomeen and 26-Mile Bridge. In addition to the upper Skagit River in B.C., major spawning areas for Ross Lake bull trout were Lightning Creek, and the Ruby Creek drainage including Canyon Creek. Based upon mark-recapture numbers of adult fish, the spawning population of bull trout in the upper Skagit River including Ross Lake was estimated as 1,200 fish. Study results are described in several reports by Nelson et al. (2004), Murray and Gaboury (2005), and R2 Resource Consultants (2009).

- ***Diet and Bioenergetic Study***. Conducted by the University of Washington (UW), the purpose of the bioenergetic study was to evaluate the food habits and trophic relationships of bull trout, juvenile Chinook salmon and steelhead in 25-mile reach downstream of the Project. One of the main objectives of this study was to determine if bull trout predation potentially limited the production of juvenile steelhead and Chinook salmon in the mainstem Skagit River and major tributaries between Rockport and Newhalem. This study included a diet and bioenergetic analysis among the different age-classes of bull trout on a seasonal basis. This study found that salmon carcasses and eggs contributed approximately 50 percent of the annual energy budget for large bull trout in mainstem habitats. The remaining 50 percent of the annual energy budget was acquired from juvenile salmon, resident fishes, and immature aquatic insects. Predation on juvenile Chinook salmon and steelhead/rainbow trout was highest during winter and spring (January-June). Predation on juvenile salmon differed between 2007 and 2008, and was likely due to the dominant odd-year spawning cycle for pink salmon. The population impact of bull trout predation on ocean- and stream-type Chinook salmon was estimated to be negligible, while the impact on steelhead/rainbow trout was potentially very high. The study concluded that complex trophic interactions between bull trout, steelhead, and Chinook salmon are present in the upper Skagit River drainage, creating both challenges and opportunities for creative adaptive management strategies for these listed species.

- ***Puget Sound Fish Migration Research Program***. SCL partnered with the U.S. Army Corps of Engineers, NOAA Fisheries, and WDFW to study the migratory behavior and life history of bull trout and steelhead in the Puget Sound, with the Skagit River one of the major focus areas of this research effort. Bull trout and steelhead were surgically implanted with acoustic transmitters and tracked through network of acoustic receivers deployed throughout the Puget Sound, with 40 of these receivers located in the Skagit watershed, Skagit Bay, and Swinomish channel. This bull trout migration study found that Skagit bull trout have complicated migratory pattern that results in highly diverse life history forms. Major life history forms of bull trout in the Skagit include anadromous, fluvial, adfluvial, and resident forms. Many subadult and adult bull trout migrate from upper river to the estuary and nearshore areas of the Skagit River and Puget Sound. Individual bull trout can remain in estuary and marine nearshore habitats for over a year prior to migrating back to Skagit headwater areas to spawn. The steelhead migration study found that juvenile steelhead from the Skagit outmigrate rapidly from the river and through the Puget Sound in the spring, spending an average of one week in the river, migrating through the Puget Sound to the Pacific Ocean in an average of two weeks. Most outmigrating juvenile steelhead spend less than a day migrating through the Skagit delta and estuary, and the majority Skagit steelhead smolts migrate northward through Skagit delta and bay. Most steelhead smolts from the Skagit migrate west through Deception Pass and into the Pacific Ocean via the Strait of Juan de Fuca.

- ***Genetic Analysis of Bull Trout Populations***. The purpose of this study is to identify and investigate genetic differences among local bull trout populations in tributaries of the upper Skagit River below the Project and in Ross reservoir. The research project has provided information on spatial patterns of genetic divergence among bull trout populations in the Skagit watershed, including the upper Skagit, Cascade River, Suiattle River, and upper Sauk River subbasins. The findings of this study to date have substantially improved our understanding of the spatial structure and diversity of bull trout populations in the vicinity of the Project, which in turn will help identify and guide management actions that can help protect these populations. The study determined that bull trout populations in the upper Skagit River drainage above the gorge section of the river (i.e., above Gorge Dam) are genetically distinct from downstream populations. The study also found that bull trout originating from major tributaries of the Skagit, including Goodell, Bacon, and Illabot creeks, and the Cascade River, upper Sauk River, and Suiattle River are genetically distinct, and should be considered independent populations. This project was initiated by the University of Washington 2009, and is scheduled to be completed during the third quarter of 2010.
- ***Skagit Steelhead Hatchery Impacts Research Project.*** This project is being conducted to assess whether hatchery steelhead have deleterious ecological and/or genetic impacts on wild steelhead populations in the Skagit watershed. Conducted in cooperation with the WDFW and the Skagit tribes, it examines (1) predation by larger hatchery juveniles on wild steelhead juveniles; (2) competition between wild and hatchery juveniles for similar diet items; (3) habitat competition between wild and hatchery juveniles; (4) genetic introgression by hatchery steelhead on wild steelhead populations in major Skagit River subbasins, and (5) statistical evidence from long-term spawner abundance data that hatchery plants may have contributed to declines in wild steelhead stocks. Methods include genetic analysis, hydro-acoustic tracking of juvenile and adult wild and hatchery steelhead, stomach contents analysis, outmigration trapping, and analysis of escapement and run size data from northwest Washington and Georgia Strait rivers. The study was initiated in March, 2009 and will be completed by March 2012. To date, this study has found that genetic introgression of native steelhead appears to be increasing over time, with 11 to 20 percent of wild steelhead exhibiting hatchery (Chamber Creek origin) genetic markers. Rainbow trout appear to be genetically highly diverse throughout the

Skagit River basin, and rainbow trout sample above the Skagit Hydroelectric Project dams appear to be genetically unique compared to rainbow trout and steelhead populations below the dams.

# 3 PROPOSED ACTION

SCL proposes to amend the FERC License for Project 553 to include the following non-capacity improvements and provisions:

- ***Construct a second power tunnel between Gorge Dam and Powerhouse (the Gorge 2nd Tunnel)***. Amendment No. 5 to the Skagit License, issued in 1949, authorized SCL to expand Gorge Powerhouse, install a fourth generator, and build High Gorge Dam. These improvements increased Gorge's output as intended, but they also increased the water velocity in the power tunnel. With the increased velocity came a corresponding increase in frictional head loss, resulting in an efficiency reduction for the powerhouse. The addition of a second power tunnel will reduce the hydraulic head loss, increasing Gorge plant efficiency, resulting in an additional 56,000 megawatt hours per year.
- ***Adjust FERC boundary along the route of the Gorge 2nd Tunnel.*** The proposed 2nd tunnel alignment will lie within the narrow FERC boundary surrounding the existing Gorge tunnel except at the upstream and downstream ends, where the new tunnel would extend (underground) slightly outside the existing Skagit Project boundary. Therefore, SCL proposes to expand the Skagit Project boundary at each end of the new tunnel to accommodate the best tunnel design.
- ***Add the currently voluntary flow measures to the Skagit River to the License.*** Since 1995, SCL has voluntarily implemented four flow measures that are more restrictive than those required under the current license. These voluntary flow modifications provide enhanced protection for salmon downstream of the Project. SCL proposes to add the voluntary flow measures to the Project license through this amendment to ensure that they continue to be incorporated into daily operational plans.

The proposed action also includes existing facilities and ongoing operations (described in Section 2) because bull trout, Chinook salmon, steelhead, and Canada lynx were not listed as threatened or endangered when the Project was licensed in 1995.

## 3.1. Proposed New Facilities

SCL proposes construction of a second power tunnel—the Gorge 2nd Tunnel—to convey the flow of water between the Gorge reservoir and the Gorge Powerhouse (Figure 3-1). Currently, water flows through a single 12,000-foot-long, 20.5-foot-diameter, concrete-lined tunnel. A companion tunnel would be constructed parallel to the existing tunnel, branching off from the existing tunnel approximately 100 feet downstream of the existing water intake at the dam and converging back into it at a point just upstream of the powerhouse. The companion tunnel would not involve any new water withdrawals from or discharges into the Skagit River, and would not increase the amount of water sent through the turbines at Gorge Powerhouse. The companion tunnel would be approximately 11,000 feet long, 22 feet in diameter, and horizontally and vertically offset from the existing power tunnel by approximately 50 feet. It would be excavated through hard rock using a tunnel boring machine (TBM), and unlined for most of its length. The new tunnel would be constructed underground except for development of the new tunnel access (portal) near Gorge Powerhouse, which would be at surface level.

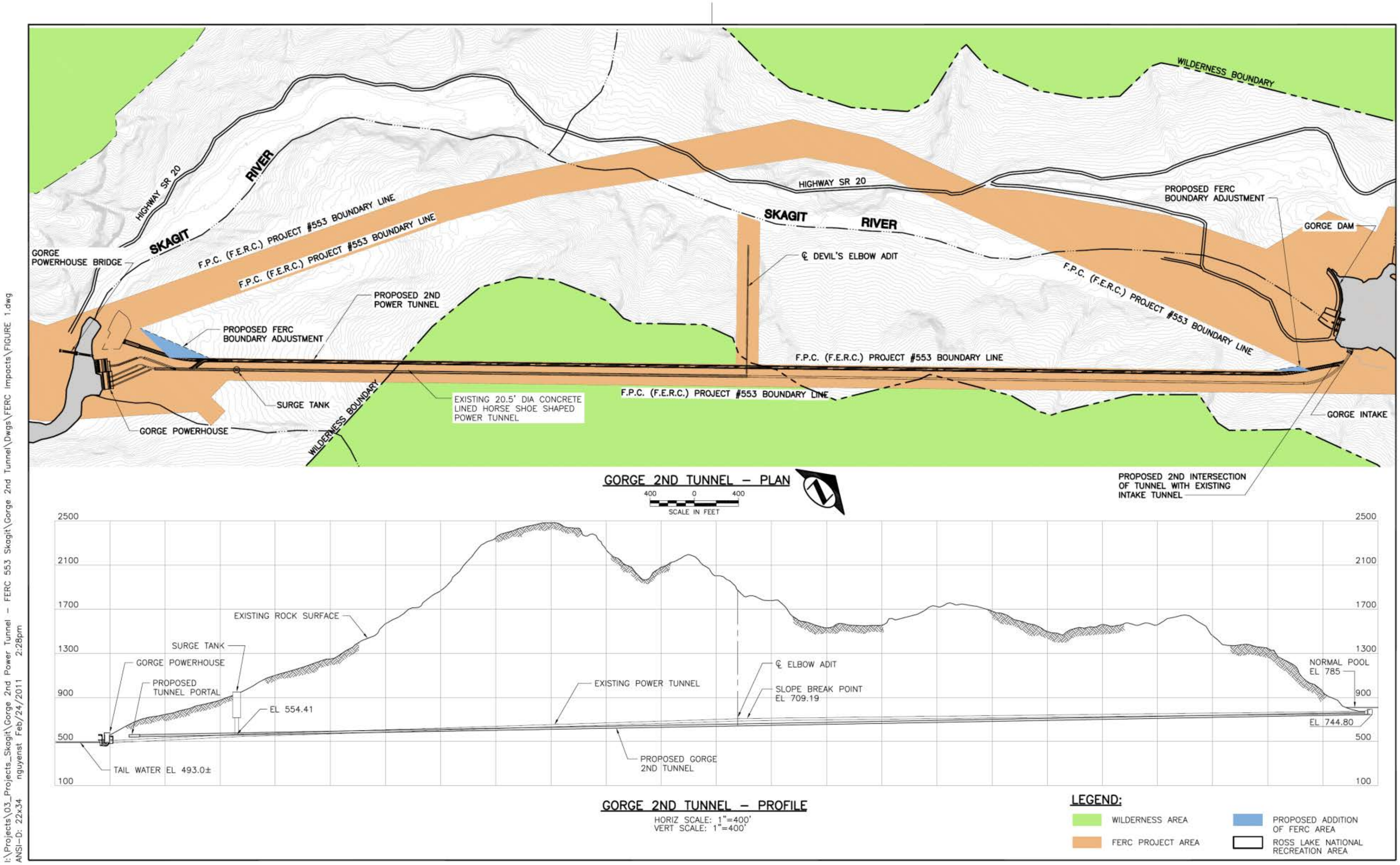



**Figure 3-1. Schematic of Gorge 2nd Tunnel.**

Drill-and-blast methods would be used to construct a short starter tunnel, needed to launch the tunnel boring machine at the portal. Drill-and-blast methods would also be used to develop two underground connector tunnels that would join the new tunnel with the existing tunnel. A cast-in-place concrete lining would be constructed in the connector tunnels. Development of the tunnel connections would require a complete plant shutdown and draining of the existing power tunnel. During this approximately 2 ½ month period (June 1 to August 15), fish protection flows would be conveyed through the Gorge bypass reach.

The alignment of the new tunnel lies within the existing Skagit Project boundary, except at the upstream and downstream ends where the new tunnel would extend (underground) slightly outside the existing Skagit Project boundary. The Skagit Project boundary would need to be expanded by approximately 1.21 acres to accommodate the new tunnel alignment and to allow for rock stabilizing and scaling activities needed to create safe working conditions at the portal (Figure 3-1). This boundary change would include a 1.06-acre parcel near the downstream terminus of the new tunnel and a 0.15-acre parcel at the upstream end near the intake.

The new portal would be located in the base of the mountainside to the north of the existing power tunnel portal, which is immediately north of the Gorge Powerhouse (Figure 3-1). The TBM would be launched from an adjacent 65,400 square-foot (approximately 1.5-acre) proposed construction staging area that currently consists of an asphalt parking lot and a large grass and gravel area enclosed by a chain link fence. This area contains a greenhouse, gardener's office, and two associated cold frames; a septic drain field (which would be abandoned before the start of construction); and several concrete block structures used for storage. The staging area/portal site would be accessed using the existing steel Gorge Powerhouse Bridge crossing the Skagit River.

The staging area is bordered to the north and east by steep, near vertical rock slopes, on the west by the Skagit River bypass reach, and on the south by Gorge Powerhouse and associated parking lots. Most vegetation on the site consists of lawn grass and ornamental shrubs and trees. The steep slope between the site and the Skagit River bypass reach supports a dense ground cover of English ivy. The proposed portal hill slope site includes a few large native trees and is characterized by numerous rock outcrops and varying amounts of talus (loose boulders). The outcrops are cut by joints (fractures), and some outcrops have been undercut at the base to form overhanging blocks. Both adverse jointing (fracture planes dipping out of slope) and overhanging outcrops create potentially unstable blocks that could be dislodged during construction. The size and apparent stability of these blocks varies across the portal hill slope area.

Preparation of the staging/portal area for tunneling would require targeted rock scaling (a form of rock removal), vegetation removal, and demolition of all currently existing structures in the staging area. New facilities would be developed to support temporary construction activities; one of these new buildings would be retained after construction as a permanent storage facility for Gorge Powerhouse.

Surface construction facilities would likely consist of the following:

- Office trailers for owner/designer, contractor, and CM inspectors, and change rooms (dry houses) for workers
- Vehicle parking and turn-arounds
- Maintenance shop, tool containers
- Crane, loader, generator, and other surface support equipment
- Material stockpile area (including tunnel support and tunnel lining materials)
- Water treatment facilities at the staging area, along the west side of State Route (SR) 20
- Temporary excavated material stockpile area
- Muck car dump/rollover area (muck car option only)
- Rock transfer area for loading haul trucks.

Excavation of the tunnel would result in a large volume of loose (bulked) rock spoils. The two standard methods of removing the excavated material from TBM tunnels employ either rail-mounted "muck" cars or a continuous horizontal conveyor belt.

Rock spoils from the TBM excavation are anticipated to consist of flat gravel-sized pieces of rock, commonly referred to as "chips," and sand. Material generated during drill-and-blast excavation is anticipated to be coarser than TBM-generated material, containing cobble-sized and possibly boulder-sized pieces. Ideally, maximum rock size would be limited to 3 feet. However, the size of blasted material is a function of blast-hole spacing and powder factor, in addition to rock type and quality (joint spacing and condition).

A 22-foot-diameter tunnel would result in a bulked volume of approximately 278,800 cubic yards (154,900 cubic yards in-place volume) of excavated rock spoils (Jacobs Associates 2009). The excavated material may be transported from the tunnel portal for deposition in the Bacon Creek Quarry site via one of two methods:

- **Option 1.** Develop a temporary spoils stockpile site within the portal staging area (east side of the Skagit River) and use 12-cubic-yard capacity trucks to haul the spoils from the stockpile area directly to the Bacon Creek Quarry site.
- **Option 2.** Develop a temporary spoils stockpile area on the west side of the Skagit River, either across from Gorge Powerhouse near the switchyard, or on the north side of Highway 20 near the tourist parking area. Either of the locations under Option 2 would require attaching an enclosed conveyor belt to the existing Gorge Powerhouse Bridge to transport the spoils across the Skagit River to the stockpile area. Larger capacity trucks with trailers would be used to haul the material from the stockpile to the Bacon Creek Quarry site.

Under Option 1, the contractor would stockpile, load, and transport tunnel spoils directly from the portal staging area. If a rail-mounted muck car system is used to remove the excavated rock from the tunnel, loading from the portal staging area could be accomplished using a lift-off box with a crane to dump the rock spoils into a three-sided eco-block stockpile enclosure for truck loading with a front end loader. Alternatively, a car dumper could be installed below or adjacent to the rail track to feed a stacked conveyor that would dump into an eco-block stockpile enclosure for truck loading. Loading spoils from a stockpile area within the portal staging area would require the use of smaller capacity haul trucks without trailers, due to the limited turning radius at the east end of the Gorge Powerhouse Bridge and within the portal staging area. Empty haul trucks would drive across the existing single lane bridge onto the portal site to be loaded, then drive back across the bridge, and merge onto westbound SR 20. Empty trucks waiting to cross the bridge would queue up in the wide shoulder along the southern side of eastbound SR 20. If 12 cubic yard tandem axle trucks are used, the contractor would haul an average of 9 cubic yards per trip. Based on this capacity, approximate 197 one-way truck trips per day across the bridge and along SR 20 to the Bacon Creek quarry site would be required for the excavation of a 22-foot diameter tunnel.

Under Option 2, the temporary spoils stockpile area would be located on the west side of the Skagit River, either in an area that currently contains a gravel parking lot and a set of interpretive signs for visitors, or in a clearing on the north side of SR 20 in Newhalem that currently contains grass lawn and a few trees. An enclosed conveyor belt would be attached to the Gorge Powerhouse Bridge to transport spoils across the river from the portal to the stockpile area. Temporary piers would be constructed upland of the ordinary high water mark to provide additional support on the west side of the river for the conveyor. Assuming a 22-foot-diameter tunnel and 20-cubic-yard-capacity trucks hauling an average of 14 cubic yards per trip, the expected average number of one-way truck trips would be 127 per day during approximately 12 months of tunneling activity. If the stockpile was located in the area near the switchyard, empty trucks waiting to enter the loading area would queue up along Ladder Creek Lane near the Ladder Creek Suspension Bridge. If the stockpile was located in the clearing on the north side of SR 20, empty trucks would queue up in the existing gravel access road and tourist parking lots along the north side of SR 20.

SCL anticipates that haulage would typically occur only during daytime working hours, and the temporary stockpile area would be sized accordingly. Up to 2-days' volume of rock—approximately 3,550 cubic yards—may be stored at the temporary stockpile area at any given time, depending upon mining and rock removal schedules. Containment facilities and procedures would be developed and implemented to manage storm water and dust associated with the stockpile and loading operations.

There would be limited areas to temporarily stockpile naturally contaminated spoils for evaluation at the portal staging area. Naturally contaminated spoils, if encountered, potentially would need to be transported and stockpiled off site for evaluation prior to disposal at an appropriate facility (not deposited in the Bacon Creek Quarry site).

The excavated material would be transported by truck westbound along SR 20 to the abandoned 6-acre Bacon Creek Quarry located on SCL-owned wildlife habitat land. The site is located approximately 10 miles southwest of the tunnel portal. The excavated material would be used to restore natural contours within the quarry and to develop improved drainage for the site. Topsoil would be brought in as needed and native vegetation planted to create upland habitat for wildlife.

The project would also include a temporary pipeline to convey tunnel water from the tunnel to a water infiltration area and overflow pond during construction. The system likely would include at least two pipes, one approximately 8 to 10 inches in diameter for normal flows of up to 300 gallons per minute (gpm) out of the tunnel, and another, larger pipe of approximately 14 to 16 inches in diameter for high flow conditions of up to 1600 gpm. After crossing the Skagit River on the Gorge Powerhouse Bridge, the tunnel water conveyance pipe would be placed in a trench and buried for approximately 200 feet alongside SR 20, then turn to the northwest and be routed under the highway by means of trenchless technology.

On the other side of the highway, two options are available for placement of the pipe. With the above ground option, the pipe would likely surface to daylight and extend above ground for approximately 3,600 feet to the treatment and infiltration areas. No soils would be disturbed along this portion of the pipeline because the pipeline would be supported and anchored at or above grade on blocks and sandbags where needed. The Contractor would also have the option to place the conveyance pipes in a trench to protect them from freezing. It is also possible that an intermediate pump station would need to be installed halfway between the portal and the infiltration area.

The tunnel water filtration treatment facilities would be placed on the surface (at grade) in a graveled or otherwise previously disturbed area near the gravel access road located along the north side of SR 20 in Newhalem. In the infiltration area, pumps and perforated pipes would be used to broadcast the treated water across a large natural depression, where the water would percolate into the ground. The Contractor may determine the need to bury some or all of the perforated pipes used to distribute the water below the frost line, to allow infiltration to continue under freezing conditions.

A tunnel water overflow holding pond would be constructed near the infiltration area on land that is currently covered with grasses and herbacious plants. A watertight liner would be installed between built-up sides, forming a basin to contain overflow while awaiting treatment and filtration. The overflow pond could temporarily cover up to one acre (43,560 square feet) of land.

Construction activities for the Gorge 2nd Tunnel project are expected to last 26 to 27 months, from site preparation and initial assembly of the TBM through construction close out and restoration of the construction staging area and supporting temporary facilities areas. Monitoring of the restored construction staging/support areas would extend, as needed to ensure successful restoration of those areas. Monitoring and maintenance of the Bacon Creek Quarry wildlife habitat site would be ongoing. When complete, the only visible evidence of the Gorge 2nd Tunnel would be the new portal near Gorge Powerhouse, a new nearby storage building, and additional areas of native vegetation along the river adjacent to the staging area and at the Bacon Creek Quarry site.

Mitigation measures will be implemented to reduce the risk of adverse effects of the projects to wildlife, aquatic species, construction workers, and the public. Mitigation measures to protect water quality and aquatic species include:

- Enclose or otherwise contain the spoils stockpile area to prevent fugitive dust from escaping to adjacent areas, including high voltage electrical equipment in Gorge switchyard.

- Develop and implement a plan for managing and treating stormwater in and around the stockpile area.
- Develop and implement a plan for managing and treating tunnel water.
- Develop and implement a plan for monitoring for the presence of acidic water or heavy metals from sulfide minerals and develop procedures to prevent leaching of these materials into the Skagit River, Bacon Creek, or groundwater.
- Cover haul truck loads, before crossing the railroad bridge, to reduce dust and contain loads.
- Drive trucks exiting the portal staging area through wheel washes to remove soil and rock before crossing the bridge.
- Install temporary covering for the railroad bridge deck grating to prevent back fall of material into the river.
- Provide a spill release into the Gorge bypass reach during the 2½ month plant shutdown required to construct the tunnel connections to ensure that fish flow requirements downstream of the Project are met.
- Schedule the tunnel connection work for June 1-August 15 to avoid salmon and bull trout spawning periods and minimize fish entry into the Gorge bypass reach.
- Develop and implement a spill flow reduction plan to minimize the risk of fish stranding as flow is returned to the tunnels. Conduct pre- and post-spill surveys and implement stranded fish recovery and removal measures as needed.

Additional mitigation measures are presented in Section 3.1.4, Proposed Environmental Measures, in the Applicant Prepared Environmental Assessment developed for the Gorge 2nd Tunnel Project (SCL, 2011). Specific mitigation measures, monitoring, and standard operating procedures will be fully developed as part of the final design and permitting process.

## 3.2. Proposed Project Operations as Amended

The Gorge 2nd Tunnel will not involve any new withdrawals or discharges into the Skagit River. Nor will it increase the amount of water going into the Gorge Powerhouse. Dividing the existing flow between two tunnels for two miles (the approximate length of the companion tunnel) will significantly decrease the amount of energy lost to friction. This means that more energy can be transformed into electricity by the four generators in the Gorge Power using the same amount of water. The energy captured this way meets Washington I-937 standards (criteria) for new green energy. The Gorge 2nd Tunnel Project is expected to capture approximately 56,000 megawatt-hours of energy a year – enough energy to power 4,500 homes. The renewable energy captured by the project translates to a reduction in greenhouse gas emissions equivalent to keeping 7,800 cars off the road.

Operation of the Project will not change with the addition of Gorge 2nd Tunnel. The operation of the three Project reservoirs and flows downstream of the Project will remain the same. The only proposed change is to incorporate the four flow measures that are currently voluntary (see Section 2.3) into the amended license. There will be no *de facto* changes in operations or Skagit River flows downstream of the Project resulting from the amendment.

## 3.3. Proposed Conservation Measures

Because the ongoing operation of the Skagit River Hydroelectric Project has the potential to affect three federally-listed salmonid species, SCL has consulted with the NOAA Fisheries and USFWS (Services) pursuant to the ESA and has developed a set of conservation measures that would minimize the impact of the Project on the affected species. These proposed measures would be implemented as part of the Incidental Take Permit issued for the Skagit Hydroelectric Project by the Services.

### 3.3.1. Additional Flow Measures

As described in Section 2.3.5, SCL has been implementing four flow measures since 1995 that were developed under the voluntary action process in the FSA Flow Plan. These voluntary flow measures further reduced the impacts of Project operations on fish, including listed species, in the upper Skagit River below the Project. As part of the consultation process for this BE SCL met regularly with the Flow Coordinating Committee to refine the language needed to incorporate the four flow measures into the amended Skagit Project License. As a result of this consultation, SCL proposes to implement the four flow measures detailed below as conservation measures to be incorporated into the license amendment, making them mandatory for the remaining term of the license.

- ***Steelhead and Chinook salmon Yearling Protection Period Downramp Rate –*** The intent of the FSA parties was to have a downramp rate restriction for each month of the year to protect juvenile salmon and steelhead from stranding. The FSA Flow Plan established downramping rates for all but October 16 through January 31, inadvertently omitting this period. To protect steelhead and Chinook salmon yearling SCL, in agreement with the Flow Coordinating Committee, will limit downramp rates to < 3,000 cfs/hr from October 16 to January 31 each year.
- ***Salmon Fry Protection Period Start Date –*** The start date of the salmon fry protection period is defined by the FSA Flow Plan as February 1 each year. Research completed subsequent to the FSA Flow Plan has shown that significant numbers of Chinook salmon fry begin to occupy floodplain habitats in the upper Skagit River as early January 1 (Kinsel et al. 2008). To further minimize Chinook salmon fry stranding SCL will implement all salmon fry protection period measures on January 1 each year.
- ***Chum Salmon Spawning Period Start Date –*** The start date of the chum salmon spawning period is defined by the FSA as November 16 each year. Research completed subsequent to the FSA has shown that 10 percent of the upper Skagit chum typically spawn between November 1-15 each year (WDFW-ChumSpawningsummary.xls 2007). To protect all spawning chum salmon SCL will recognize the spawning start date as November 1st.
- ***Chum Salmon Incubation Flows For November and December –*** During the first two years of FSA Flow Plan implementation, field monitoring of chum redd protection levels during the months of November and December revealed that the required minimum incubation flows required for redd protection could not provide the expected level of redd protection. SCL will provide minimum incubation flow releases that exceed those required by Table C-3 of the FSA Flow Plan of at least 1,800 cfs to provide the expected level of protection (Table 3-1).

### 3.3.2. Listed Fish Species Recovery Measures

Over the past 10 years, SCL's voluntary EAP (see Section 2.5) has resulted in a substantial number of conservation land acquisition and habitat restoration projects throughout the Skagit Watershed that have protected and restored habitats important to the long-term population viability of all three ESA-listed fish species in the Project Area. The land acquisition and restoration programs are consistent with the major recovery goals of the Skagit Chinook Recovery Plan and the Puget Sound Bull Trout Recovery Unit Plan, and build-upon the success

**Table 3-1. Chum salmon incubation flows (revised Table C-3 from the FSA Flow Plan).**

| Chum Season Spawning Flow (cfs)[2] | Minimum Instantaneous Incubation Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nov[3,4] | Dec[3,4] | Jan[4] | Feb[4] | Mar | Apr | May |
| 3000 | 2100 | 1800 | 1000 | 1800 | 1800 | 2100 | 1500 |
| 3100 | 2100 | 1800 | 1500 | 1800 | 1800 | 2100 | 1500 |
| 3200 | 2200 | 1800 | 1500 | 1800 | 1800 | 2100 | 1500 |
| 3300 | 2200 | 1800 | 1500 | 1800 | 1800 | 2100 | 1500 |
| 3400 | 2200 | 1800 | 1800 | 1800 | 2100 | 2100 | 1500 |
| 3500 | 2200 | 1800 | 2200 | 1800 | 2100 | 2100 | 1500 |
| 3600 | 2200 | 1800 | 2200 | 1800 | 2100 | 2100 | 1500 |
| 3700 | 2200 | 1800 | 2200 | 1800 | 2200 | 2100 | 1500 |
| 3800 | 2200 | 1800 | 2200 | 1800 | 2200 | 2100 | 1500 |
| 3900 | 2200 | 1800 | 2200 | 1800 | 2200 | 2100 | 1500 |
| 4000 | 2200 | 1800 | 2200 | 1800 | 2200 | 2100 | 1500 |
| 4100 | 2200 | 1800 | 2200 | 1900 | 2300 | 2200 | 1500 |
| 4200 | 2200 | 1800 | 2300 | 1900 | 2300 | 2200 | 1500 |
| 4300 | 2200 | 1900 | 2400 | 1900 | 2300 | 2200 | 1500 |
| 4400 | 2200 | 1900 | 2400 | 1900 | 2300 | 2200 | 1500 |
| 4500 | 2200 | 2100 | 2400 | 2000 | 2300 | 2300 | 1600 |
| 4600 | 2200 | 2100 | 2600 | 2300 | 2600 | 2500 | 1600 |
| 4700 | 2200 | 2100 | 2800 | 2500 | 2800 | 2600 | 1700 |
| 4800 | 2200 | 2100 | 2900 | 2600 | 2800 | 2600 | 1800 |
| 4900 | 2400 | 2200 | 3000 | 2600 | 2900 | 2800 | 1900 |
| 5000 | 2600 | 2200 | 3000 | 2600 | 2900 | 2800 | 1900 |
| 5100 | 2600 | 2500 | 3000 | 2600 | 3000 | 2800 | 1900 |
| 5200 | 2600 | 2500 | 3000 | 2600 | 3000 | 2900 | 1900 |
| 5300 | 2600 | 2500 | 3000 | 2600 | 3100 | 3000 | 2100 |
| 5400 | 2800 | 2500 | 3200 | 2800 | 3300 | 3100 | 2100 |
| 5500 | 2900 | 2500 | 3200 | 2800 | 3300 | 3100 | 2200 |
| 5600 | 3000 | 2500 | 3200 | 2800 | 3300 | 3100 | 2200 |
| 5700 | 3000 | 2600 | 3200 | 3000 | 3500 | 3300 | 2300 |
| 5800 | 3000 | 2700 | 3400 | 3000 | 3500 | 3300 | 2400 |
| 5900 | 3300 | 2800 | 3400 | 3000 | 3500 | 3300 | 2500 |

**Table 3-1. Chum salmon incubation flows (revised Table C-3 from the FSA Flow Plan).**

| Chum Season Spawning Flow (cfs)[2] | Minimum Instantaneous Incubation Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nov[3,4] | Dec[3,4] | Jan[4] | Feb[4] | Mar | Apr | May |
| 6000 | 3400 | 3100 | 3400 | 3000 | 3500 | 3300 | 2700 |
| 6100 | 3500 | 3200 | 3500 | 3000 | 3700 | 3600 | 2900 |
| 6200 | 3500 | 3200 | 3500 | 3300 | 3900 | 3700 | 2900 |
| 6300 | 3800 | 3200 | 4100 | 3700 | 4000 | 4000 | 3000 |
| 6400 | 4000 | 3300 | 4100 | 3700 | 4000 | 4000 | 3300 |
| 6500 | 4200 | 3300 | 4100 | 3700 | 4100 | 4100 | 3500 |
| 6600 | 4200 | 3800 | 4100 | 3800 | 4400 | 4300 | 3600 |
| 6700 | 4300 | 3800 | 4200 | 3800 | 4400 | 4300 | 3600 |
| 6800 | 4600 | 3900 | 4200 | 4100 | 4700 | 4500 | 3700 |
| 6900 | 4600 | 4000 | 4700 | 4200 | 4800 | 4500 | 3700 |
| 7000 | 4600 | 4000 | 4700 | 4200 | 4800 | 4500 | 3800 |

[1] Table revised April, 2010. The FCC will monitor the effectiveness of these modifications over the first 5-years implementation. If needed, the FCC can make additional adjustments with the approval of SCL.

[2] Most likely spawning flows in bold.

[3] Months during which spawning occurs are based on 50 percent tributary inflow exceedance probabilities (EP) for both spawning and incubation. Succeeding incubation flows are based on 50 percent EP during spawning and 90 percent EP during incubation.

[4] Months during which incubation flow is based on the below gravel model.

of recovery projects being conducted throughout the Skagit Watershed by resource agencies, tribes, and conservation organizations. The EAP fish research program has resulted in major improvements in the knowledge of habitat requirements, life history diversity, genetic diversity, migratory behavior, and population trends of Chinook salmon, steelhead, and bull trout in the Skagit Watershed.

As conservation measures for an Incidental Take Statement, SCL proposes to continue the EAP through 2025, which is the end of the current 30-year license for the Project. SCL will commit to specific levels of funding for the conservation land acquisition, habitat restoration, and research projects through 2025. The habitat acquisition and restoration actions will build upon past and current EAP programs for the recovery of Chinook salmon, steelhead, and bull trout. The research program will focus on further identifying potential impacts of the Project operations on these three species, which can then lead to the development and implementation of management actions that will further reduce Project-related take on the three listed fish species.

SCL proposes to implement and fund the following programs for ESA fish species recovery:

- ***Conservation Land Acquisition and Management Program.*** SCL will provide a minimum of $1.5 million for habitat acquisition, management, and restoration in the Skagit watershed, for an approximate annual average of $100,000 per year, between 2011 and 2025. The program will fund and manage land acquisition projects that provide permanent protections to the habitat important for the long-term population viability of Chinook salmon, steelhead, and bull trout. The habitat acquisitions will be identified using the Skagit Watershed Council's (SWC) strategic approach for ESA species recovery, through continuing involvement as a member of the SWC land acquisition committee, and in coordination with the Services. SCL will continue to fund a FTE staff position to manage this program. A key component of position will be to develop grant proposals for the purpose of leveraging SCL's funding with matching funding for ESA species recovery and ecosystem restoration. The staff person will coordinate grant proposals with watershed restoration and salmon recovery partners for funding available through the Salmon Recovery Funding Board, Puget Sound Partnership, NOAA Fisheries, USFWS, WDFW, and other organizations.

- ***Habitat Restoration Program.*** As needed, SCL will use some of the funds in the Conservation Land Acquisition and Management Program for habitat restoration in those areas of the Skagit watershed where habitat is currently limiting the production and diversity of Chinook salmon, steelhead, and bull trout. These areas include the Skagit estuary and tidal delta, the middle Skagit River, the lower and middle Sauk River, and important tributaries to these species including Bacon Creek, Illabot Creek, Diobsud Creek, the Cascade River, Finney Creek, and Day Creek.
- ***ESA Fish Research Program.*** SCL will provide funding for research on the population status, life history and genetic diversity, habitat requirements, migratory behavior, and the impact of Project operations on Chinook salmon, steelhead, and bull trout. This funding is not to exceed $1.5 million between 2011 and 2025 (average of $100,000 per year), as research needs are identified in coordination with the Services representatives on the Non-flow Coordinating Committee. The geographic scope of research projects includes the three reservoirs, the upper Skagit River downstream of the project, as well as major tributaries important to the long-term viability of populations in the watershed. These projects will be developed and managed by a FTE staff member. Potential projects at this time include:
    - Bull trout habitat use investigation in Ross, Diablo, and Gorge reservoirs.
    - Bull trout population monitoring project for Ross Lake.
    - Water temperature analysis and limnological monitoring of Ross, Diablo, and Gorge reservoirs.
    - Trophic assessment of Ross Lake.
    - Analysis of non-native fish species impacts (including brook trout and redside shiners) on bull trout in project reservoirs.
    - Modeling of climate change impacts on temperature regimes in Skagit Project reservoirs and upper Skagit River.
    - Analysis of flow releases on steelhead spawning and rearing habitat use in the upper Skagit.
    - Assessment of impacts of upper Skagit flow fluctuations on invertebrate productivity and diversity (re: forage base for juvenile steelhead, Chinook salmon, and bull trout).
    - Expansion of genetic baseline work for steelhead (including rainbow trout) and bull trout in the upper Skagit River.

SCL's funding commitment for the EAP from 2011 through 2025 is contingent upon the use of the funds for Chinook salmon, steelhead, and bull trout recovery in the Skagit River watershed.

These funds are specifically intended for projects that will improve the abundance and diversity of listed fish populations in the Skagit through habitat protection and restoration actions, and through improved knowledge of the life history, population status, and ecology of these species. As such, the funding for the EAP through 2025 should be regarded as a long-term commitment to the recovery of ESA-listed species by SCL, and is not intended to diminish or replace SCL's fish mitigation requirements for the Skagit Hydroelectric Project as defined in the FSA.

The benefits of the EAP to endangered species recovery have been substantially elevated by SCL's ability to leverage these funds with federal and state grants and matching funds. SCL has been able to acquire grants and matching funds for fish recovery projects because these EAP funds are not tied to SCL's mitigation obligations. Since the implementation of the EAP in 2000, SCL has been able to obtain almost $3.2 million in grants and matching funds for conservation land acquisitions, $1.3 million for habitat restoration projects, and $640,000 for research (Table 3-2). Almost 51 percent of the funding for projects sponsored by EAP comes from grants and federal matching funds. Sources of grant funding have included the Washington Salmon Recovery Funding Board, National Fish and Wildlife Foundation, and USFWS ESA program. The EAP funds have been further used by SCL's conservation partners, including Skagit Watershed Council, SRSC, WDFW, The Nature Conservancy, and Skagit Land Trust to obtain grants for projects benefiting listed fish species in the Skagit.

**Table 3-2. Funding sources for EAP projects in the Skagit Watershed, 2000-2010.**

| Program Element | SCL EAP Funding | Matching Grant and Federal Funds | Total |
|---|---|---|---|
| Conservation Land Acquisitions | $2,601,730 | $3,199,968 | $5,801,698 |
| Habitat Restoration Projects | $1,313,650 | $2,287,149 | $2,600,799 |
| Endangered Species Fish Research | $1,023,340 | $639,800 | $1,663,140 |
| **TOTAL** | **$4,938,720** | **$5,126,917** | **$10,065,637** |

## 3.4. Federal Action History Related to the Proposed Action

Section 7(a)(2) of the ESA requires federal agencies to ensure their actions do not jeopardize listed species. Formal consultation with USFWS and NOAA Fisheries is required for the license amendment. Since the 1995 relicensing of the Project three fish and one wildlife species occurring in the Skagit River basin have been listed under the ESA: steelhead, bull trout, Chinook salmon, and Canada lynx. Thus, the consultation process needs to address effects of the ongoing operation of the Project under the amended license for these species, as well as the impacts of the Gorge 2nd Tunnel Project for the species that were listed in 1995 (northern spotted owl, marbled murrelet, gray wolf, and grizzly bear).

SCL submitted its request to FERC for designation as the non-federal representative on August 18, 2009. On December 29, 2009 FERC designated SCL as its non-federal representative for informal consultation with the FWS and NOAA Fisheries. Informal consultation on listed species with federal agencies regarding the proposed FERC non-capacity license amendment and the ongoing operation of the Project under the license as amended are summarized in Table 3-3 (see SCL 2011 for full consultation record on the proposed action).

**Table 3-3. Record of consultation meetings with federal agencies on listed species.**

| External Stakeholder/Agency | Issue | Date | Location |
|---|---|---|---|
| Flow Coordinating Committee (FCC)<br><br>[Committee members represent the following federal, state and tribal organizations; USFWS, NOAA Fisheries, NPS, USFS, WDFW, Upper Skagit Indian Tribe, Swinomish Tribal Community, Sauk-Suiattle Indian Tribe] | Project introduction, ESA, flow agreement | 12/10/2008 | Mount Vernon |
| | Project update | 2/5/2009 | Mount Vernon |
| | USFWS/NOAA Fisheries meeting review, Gorge 2nd Tunnel Sub-Committee formation | 3/24/2009 | Mount Vernon |
| | Upper Skagit Tribe meeting review, Project update | 5/5/2009 | Mount Vernon |
| | Project update, FERC meeting review | 7/8/2009 | Mount Vernon |
| | BE consultant announced, flow measures discussion | 1/6/2010 | Mount Vernon |
| | BE outline review, G2T sub-committee meeting report | 3/10/2010 | Mount Vernon |
| | BE status, G2T sub-committee meeting, White Paper review, organizational review-approval process discussed | 4/29/2010 | Mount Vernon |
| | Project update, review of license amendment application process | 6/10/2010 | Mount Vernon |
| | Project update, review of license amendment application process and FSA modification | 10/26/2010 | Mount Vernon |
| | Project update, review of license amendment application process and FSA modification | 12/6/2010 | Mount Vernon |
| | Project update, review of license amendment application process and FSA modification | 2/17/2011 | Mount Vernon |
| NOAA Fisheries | Initiate ESA informal consultation | 3/9/2009 | Olympia |
| | Discuss contents and format of BE, action area | 8/31/09 | Olympia |
| National Park Service (NPS) | Geotech investigations | 04/2009- | Seattle |
| | Geotech investigations | 07/2009 | Newhalem |
| | Project introduction | 1/13/2009 | Sedro Woolley |
| | NPS concerns and mitigation | 3/3/2010 | Seattle |
| | Issues of concern and possible mitigation actions | 3/10/2010 | Seattle |
| | NPS concerns - water management | 4/7/2010 | Ft. Collins-Seattle conf call |
| | Joint Agency Meeting | 9/24/2010 | Newhalem |
| | Goodell Creek dike issues | 10/28/2010 | Newhalem |
| | Bacon Creek quarry site restoration | 1/24/2011 | Sedro Woolley |
| U.S. Fish and Wildlife Service (USFWS) | Initiate ESA informal consultation | 3/9/2009 | Olympia |
| | Discuss contents and format of BE, action area | 8/31/09 | Olympia |
| U.S. Forest Service (USFS) | Bacon Creek quarry site restoration | 1/24/2011 | Sedro Woolley |

# 4 ACTION AREA

The action area for this BE encompasses all areas to be affected directly or indirectly by the Proposed Action and not merely the immediate area influenced by Skagit Project as amended. For the purposes of this BE different aquatic and terrestrial action areas are defined.

## 4.1. Aquatic Action Area

The aquatic action area includes all areas to be affected directly or indirectly by the Gorge 2nd Tunnel Project, the four additional instream flow measures for fish protection, and the ongoing operations of the Skagit Hydroelectric. The action area for aquatic species extends from the upper end of Ross Lake at the US – Canada border (RM 125) to the mouth of the Skagit River where it enters Skagit Bay (RM 0). It includes: (1) all three reservoirs (Ross, Diablo, and Gorge); (2) the remaining reach of the mainstem Skagit River between Diablo Dam and Gorge Reservoir; (3) the entire length of the mainstem Skagit River downstream from Gorge Powerhouse in Newhalem; and (4) the fish habitat restoration sites that were acquired and/or restored as part of the FSA Non Flow Plan (Section 2.4.1).

## 4.2. Terrestrial Action Area

The action area for terrestrial species includes (1) lands within the channel migration zone of the Skagit River between Gorge Powerhouse and the confluence of Bacon Creek; (2) lands within 0.5 mile of the infrastructure of the project, towns of Newhalem and Diablo, powerhouses, and dams; (3) lands within 200 horizontal feet of the Ross, Diablo, and Gorge reservoirs (normal full pool level) to the US–Canada border; (4) areas in which construction noise will be above ambient levels around the Gorge 2nd Tunnel portal, water treatment, and Bacon Creek spoil disposal sites, as described in the following paragraph; and (5) all wildlife habitat mitigation lands (WHL) that are part of the FERC Project area in the Skagit, Sauk, and South Fork Nooksack river basins.

The terrestrial action area for construction of the proposed Gorge 2nd Tunnel was defined as the zone within which noise levels will potentially exceed existing ambient levels. The attenuation distances were calculated by estimating the noise level that will be generated by construction equipment and activities for the following project elements: (1) blasting operations at the portal entrance; (2) heavy equipment, compressor, and generator use at the portal/staging area; (3) rock loading at the stockpile area; (4) truck traffic during rock hauling; and (5) Bacon Creek restoration activities (Table 4-1).

## 4.3. Known Ongoing and Previous Federal Actions within the Action Area

In addition to its critical role in maintaining Puget Sound fisheries, the Skagit River Basin includes agricultural lands, several towns, transportation corridors, and other hydroelectric power generation facilities. Known ongoing and previous federal actions regarding these other activities are discussed below.

**Table 4-1. Projected noise levels and attenuation distances to determine the terrestrial action area for construction of the Gorge 2nd Tunnel.**

| Location – Construction Activity | Estimated Total Maximum Noise Level ($L_{max}$ [dBA]) at 50 ft | Attenuation Distance to Ambient Noise Level (ft)[1] |
|---|---|---|
| Portal – blasting | 94 | 12,559 |
| Staging Area/Portal – typical construction | 85 | 4,456 |
| Bacon Creek Quarry – restoration | 84 | 3,972 |
| Rock Stockpile Area – rock loading | 82 | 3,155 |
| SR20 Construction Traffic | 63 | 2,339 |

1. dBA-Decibels Adjusted.
2. The existing ambient level of 46 dBA was measured behind the Gorge Powerhouse by the NPS Natural Sounds Program (NPS 2009).

### 4.3.1. Skagit Basin Comprehensive Flood Hazard Management Plan (FEMA Authority)

In November of 2007 Skagit County initiated the preparation of a Comprehensive Flood Hazard Management Plan (CFHMP) for the Skagit Basin. The purpose of the CFHMP is to establish the need for flood control maintenance work, define structural alternatives, identify and consider potential impacts of in-stream flood control work on in-stream resources, and identify the river's floodway. The CFHMP was developed under the direction of the Federal Emergency Management Authority.

The presence of fish resources, primarily salmon and steelhead, is a key consideration in performing any flood hazard management activities in and around the waters of the State of Washington. The potential loss of fish habitat resulting from construction in and next to rivers has been a major concern. The CFHMP focuses on the importance of ecosystem restoration. This document also identifies watershed and flooding characteristics, flood hazard areas, flood storage and conveyance areas, flood hazard management options, and recommended actions. Completion of the CFHMP is expected in 2010.

### 4.3.2. Corp of Engineers Flood Control

Flood control within the Skagit basin in administered by Army Corp of Engineers (Corp). Flood control is largely achieved by reserving storage space in reservoirs operated by SCL and Puget Sound Energy (PSE), and maintenance of a substantial dike system located in the lower portion of the watershed. The flood control obligations stemming from the Skagit and Baker hydroelectric projects are described briefly as follows.

- ***Skagit Hydroelectric Project Flood Control.*** SCL reserves a maximum of 120,000 acre-feet of storage space in Ross reservoir for flood control during the period from October 1 through March 15. SCL typically begins to draw Ross reservoir down by October 1st. By November 15th 60,000 acre-feet of flood space has been created and by December 1st the full 120,000 acre-feet of storage has been reserved for flood control purposes.

- ***Baker River Hydroelectric Project Flood Control.*** The Baker River Project dedicates 74,000 acre-feet of winter flood storage under contract with the Corps. Large winter freshets are moderated by storage in the hydro project reservoirs, and the water captured is gradually released afterward.

### 4.3.3. Baker River Hydroelectric Project Relicensing

The Baker River Hydroelectric Project (Baker Project; FERC Project No. 2150) is owned and operated by PSE and generates 170 MW of energy plus an additional 30 MW of energy from an auxiliary powerhouse addition. The project also provides important flood protection to the lower Skagit River valley and urban floodplain communities. PSE received a new, 50-year federal operating license for the Baker Project in October of 2008. The project, located on a tributary of the Skagit River, provides major inflow to the mainstem Skagit River.

The new license for the Baker Project contains several fish protection provisions such as constructing improved fish-passage systems for moving salmon; replacing the Lower Baker Dam adult-fish trap with a new, state-of-the-art facility; constructing a sockeye fish hatchery; and improving existing sockeye spawning habitat. Improved flow releases at Lower Baker Dam will accommodate the needs of fish and fish habitat more effectively. New powerhouse generators will enable PSE to moderate the lower dam's outflows and thereby reduce water-level fluctuations in the Baker and Skagit rivers. The license also contains provisions to increase the project's flood-storage capacity during winter months by up to 29,000 acre-feet at Lower Baker reservoir above the 74,000 acre-feet already provided at Upper Baker reservoir. A Biological Opinion on the effects of the Baker Project on Chinook salmon was prepared by NOAA Fisheries in 2004; a second Biological Opinion addressing effects on Chinook salmon and steelhead was released in 2008. USFWS issued a Biological Opinion on the effects of the project on bull trout, spotted owls, bald eagles, gray wolves, and grizzly bears in 2007.

# 5 LISTED SPECIES, RANGEWIDE STATUS, AND CRITICAL HABITAT

## 5.1. Species Description and Status

The following subsections provide descriptions of the biology, distribution, historical and current pressures, factors limiting recovery, and current population and trend information for each ESA-listed species. General life history and biology information for each listed species is not provided. Instead, the discussions are focused on the unique or site-specific information important to understanding the effects of the proposed action on the listed species. References to general life history information will be provided in each species' subsection.

### 5.1.1. Puget Sound Chinook Salmon

The aquatic action area falls within the Puget Sound Chinook Evolutionarily Significant Unit (ESU) that was listed as threatened on March 24, 1999 (64 FR 14308). The listing was reaffirmed on June 28, 2005 (70 FR 37160) following a status review by NOAA Fisheries. The ESU includes all naturally spawned populations of Chinook salmon from streams and rivers flowing into Puget Sound, the Straits of Juan Fuca from the Elwha River eastward, and 26 hatchery programs. The Puget Sound Salmon Recovery Plan (Shared Strategy for Puget Sound 2007) included the Skagit River as one of 14 regional/watershed recovery units. The Puget Sound Technical Recovery Team (TRT) identified 22 independent Chinook salmon populations within five biogeographic regions (Nooksack, Hood Canal, South/Central, Whidbey, and Strait of Juan de Fuca) in the Puget Sound ESU (Ruckelshaus et al. 2006). The following recovery criteria were established (PSTRT 2005):

- The viability status of all populations in the ESU is improved from current conditions.
- At least two to four populations in each of five biogeographic regions are viable.
- At least one population from each major genetic and life history group historically present within each of the five biogeographic regions is viable[1].
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario.
- Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with an ESU recovery.
- Populations that do not meet the criteria for all four viable salmon population (VSP) parameters are sustained to provide ecological functions and preserve options for ESU recovery.

The four VSP parameters are: abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). Abundance is the size of the population. Productivity refers to the intrinsic growth rate of a population growth, which can be expressed as the average annual

[1] This criterion implies that at least one of the spring Chinook salmon populations in the Skagit River basin must be viable for recovery because all of the spring-run populations in the Whidbey basin biogeographical region are in the Skagit River basin.

percent increase or decrease the size of a population over a period of time (e.g., 20 years). Diversity addresses the variability in genetic, physiological, morphological, and life history and behavioral attributes. Spatial structure is the geographic distribution of fish at all life stages.

The Skagit River includes 6 of the 22 independent Chinook salmon populations in the Puget Sound ESU, and consequently will play an important role in its recovery. The six Skagit River populations (also referred to as stocks) are (Figure 5-1):

- Lower Skagit Fall Chinook Salmon
- Upper Skagit Summer Chinook Salmon
- Lower Sauk Summer Chinook Salmon
- Upper Sauk Spring Chinook Salmon
- Suiattle Spring Chinook Salmon
- Upper Cascade Spring Chinook Salmon

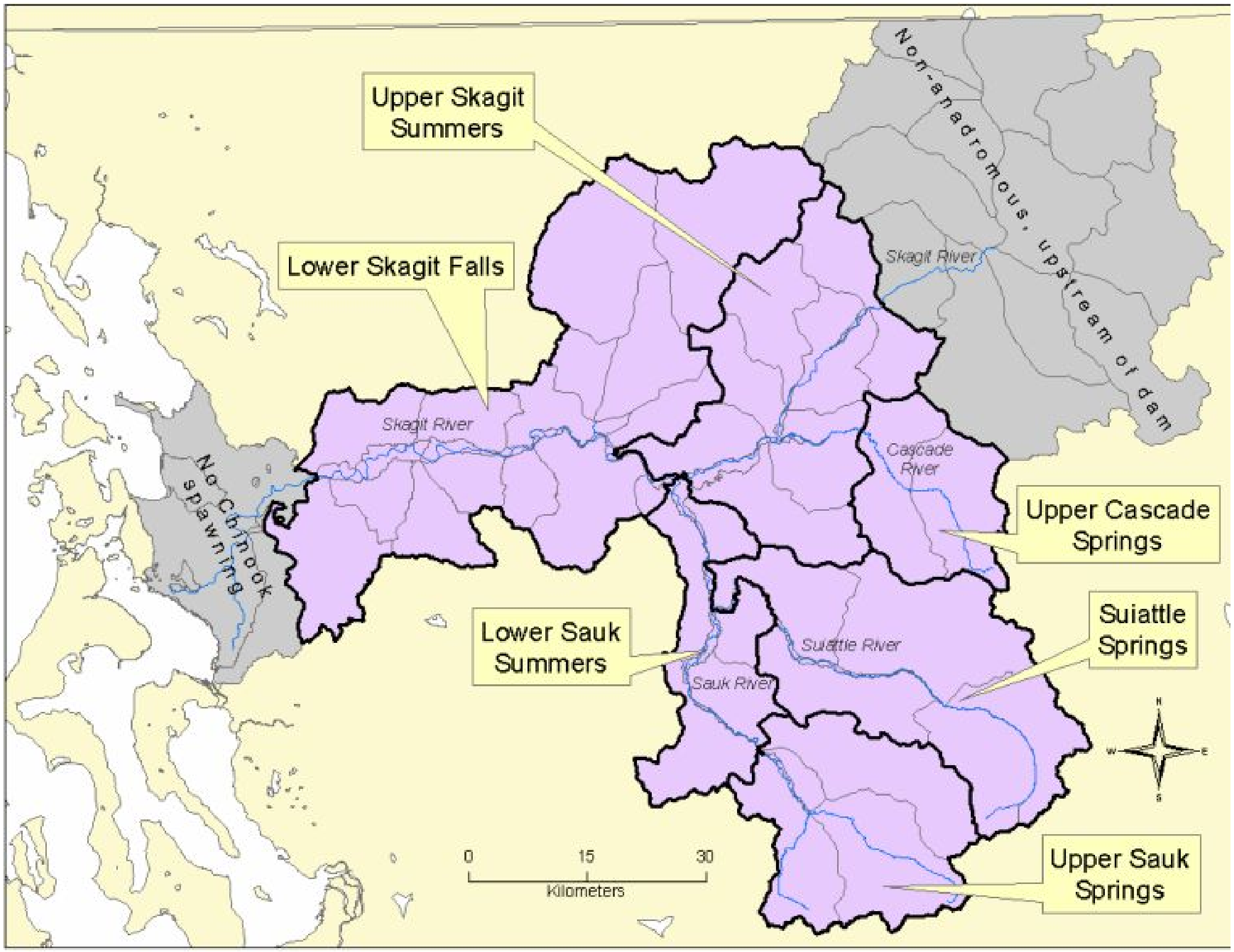
Each of these populations are considered “demographically independent populations” that were identified using a number of criteria including distinct trends in population abundance and variability, genetic separation, differences in life history characteristics and age structure, spatial and/or temporal separation of spawners, unique habitat and hydrological characteristics of a watershed, and catastrophic risk (e.g., drainage located near volcano) (PSTRT 2005). However, many of their freshwater, estuarine, nearshore, or marine rearing life stages may overlap in both time and space. The focus of this BE will be on the spawning and freshwater rearing life stages of Skagit River Chinook salmon because these life stages are more proximate to, and thus more likely to be affected by, the Proposed Action. Estuarine, nearshore, and marine rearing life stages will also be discussed, but each in relatively less detail and primarily to place into context the importance of the spawning and freshwater life stages to overall life cycle abundance and productivity. General information on Chinook salmon life history, behavior, and distribution can be found in Wydoski and Whitney (2003), Healey (1991), Scott and Crossman (1973), Groot and Margolis (1991), Quinn (2005), and the NMFS status review prepared by Myers et al. (1998).

The following sections provide information on the status of the Skagit River basin Chinook salmon populations. Topics for discussion include:

- Distribution and periodicity;
- Juvenile life history patterns;
- Spawner age structure;
- Abundance, productivity, and diversity;
- Threats to population persistence; and
- Limiting factors.

#### 5.1.1.1. Distribution

The six Skagit River Chinook salmon stocks occupy distinct geographic areas in the basin in regards to spawning (Figure 5-1). Several mainstem reaches of the Skagit basin are used for




Source: SRSC and WDFW (2005).

**Figure 5-1. Skagit River Chinook salmon populations.**

rearing and migratory habitat in by multiple Chinook salmon populations, including the upper Skagit River (used by upper Skagit summers and upper Cascade springs), the lower Sauk River (used lower Sauk River summers, upper Sauk River springs, and Suiattle River spring, and the lower and middle Skagit River (used by all six populations). The outmigration timing and spatial habitat use patterns of juvenile Chinook salmon outmigrating from the six spawning population areas is not well known. With the exception of the Baker River sub-basin, Chinook salmon occupy nearly all of the historically accessible and utilized spawning areas in the Skagit River basin.

- ***Lower Skagit Fall Chinook salmon*** spawn downstream of the Sauk River in the mainstem river and tributaries. Most Lower Skagit Fall Chinook salmon spawning occurs in the mainstem between the town of Sedro-Woolley (RM 23.0) and the mouth of the Sauk River (RM 67.2) (Figure 5-17). River entry for Skagit River Fall Chinook salmon begins in late July and spawning begins in late September, but most spawning occurs in October (Orrell 1976; WDF and WWTIT 1994; SRSC and WDFW 2005).

- ***Upper Skagit Summer Chinook salmon*** spawn in the Skagit River mainstem and its tributaries upstream of the confluence with the Sauk River (SRSC and WDFW 2005; WDFW 2002a). Important tributaries include the lower Cascade River, and Illabot, Diobsud, Bacon, and Goodell creeks (Figure 5-18). Spawning begins in late August, but primarily occurs in September to early October, which is somewhat earlier than the Lower Skagit Fall Chinook salmon population. The upper extent of spawning is near the Gorge Powerhouse. Historically, the series of chutes and falls located in the bypass reach between Gorge Powerhouse and Gorge Dam were a natural barrier to anadromous fish (Smith and Anderson 1921).
- ***Lower Sauk Summer Chinook salmon*** spawn in the Sauk River mainstem and its tributaries from the mouth to the Darrington bridge (RM 21.1) (SRSC and WDFW 2005; WDFW 2002a). The only important tributary used by this population is Dan Creek (Figure 5-19). Most of the spawning is between the Suiattle River and the Darrington bridge. Spawning begins in late August, but primarily occurs in September to early October, which is somewhat earlier than the Lower Skagit Fall Chinook salmon population and similar to the Upper Skagit Summer Chinook salmon population.
- ***Upper Sauk Spring Chinook salmon*** spawn in the Sauk River mainstem and its tributaries upstream of the Darrington bridge (RM 21.1) (SRSC and WDFW 2005; WDFW 2002a). The only important tributary used by this population is the White Chuck River (RM 31.8) and spawning also occurs in the North Fork to the falls at RM 41.2 and the South Fork to RM 3.5 (PSIT and WDFW 2009) (Figure 5-19). Most of the spawning is between the confluence with the White Chuck River and the confluence of the North and South Forks of the Sauk River (RM 40). River entry begins in April and spawning occurs in late July through early September.
- ***Suiattle Spring Chinook salmon*** spawn in the Suiattle River mainstem and its tributaries upstream of approximately Big Creek (RM 7.7) (SRSC and WDFW 2005; WDFW 2002a). Because of high sediment loads from glaciers, observation of spawning in the mainstem Suiattle River is difficult; some spawning does occur in the mainstem (WDFW 2002a), but there is some uncertainty regarding the magnitude of mainstem spawning. Suiattle Spring Chinook salmon extensively use clear-running tributaries including Big, Tenas, Straight, Circle, Buck, Lime, Downey, Sulphur, and Milk creeks for spawning (WDFW 2002a; HSRG 2003) (Figure 5-19). Most of the spawning in these tributaries occurs in the lower sections because of upstream barriers. River entry begins in April and spawning occurs in begins in mid-July through mid-September.
- ***Upper Cascade Spring Chinook salmon*** spawn in the Cascade River mainstem and larger tributaries upstream of RM 7.8 and the end of the canyon near Lookout Creek (SRSC and WDFW 2005; WDFW 2002a). Tributaries to this part of the Cascade River are typically steep. Spring Chinook salmon may use the lower valley floor reaches of some of the larger tributaries such as Marble, Sibley, Found, Kindy, Sonny Boy creeks, and North Fork and South Fork Cascade River for spawning (WDF 1975; WDFW 2002a) (Figure 5-20). River entry begins in April and spawning occurs in mid-July through mid-September.

Analysis of genetic material is commonly used as one of the key factors used to discern population structure and assignment of particular individuals to a population. However, criteria for grouping versus separating populations based upon genetic similarities or differences can be somewhat subjective and also dependent upon the scale of the analysis. The PSTRT (Ruckelshaus et al. 2006) used a variety of metrics to examine genetic similarity among Puget Sound Chinook salmon populations that was used, along with life history traits and geographic separation, in their determination of population independence. Genetic metrics included allele frequency analysis, estimates of divergence time in generations, and Cavalli-Sforza cord distance. Each of the metrics provided evidence regarding the relatedness of the populations which the PSTRT integrated into their decision-making process. The PSTRT's premise was that population segments were independent unless the available information suggested they should be grouped. For the Skagit River Chinook salmon populations, they concluded the six populations did qualify as demographically independent populations. However, the evidence presented in Ruckelshaus et al. (2006) suggests that from a genetics perspective, the Upper Sauk Spring Chinook salmon population and the Upper Skagit Summer Chinook salmon populations are relatively similar, and the Upper Cascade Spring Chinook salmon and Suiattle Spring Chinook salmon populations are relatively similar. The Lower Skagit Fall Chinook salmon and Lower Sauk Summer Chinook salmon populations appear to have the highest amount of genetic divergence relative to other Skagit River Chinook salmon populations.

#### 5.1.1.2. Juvenile Chinook Salmon Life History Patterns

Chinook salmon juvenile life history patterns are typically grouped into "ocean-type" and "stream-type" (Healey 1991). Ocean-type juveniles outmigrate to marine waters as sub-yearlings, while stream-type juveniles rear in freshwater for at least a year. In the Skagit River ocean-type Chinook salmon juvenile life history forms have been further refined such that there are four life history strategies: fry migrants, delta rearing migrants, parr migrants, and yearlings (SRSC and WDFW 2005). Fry migrants are juveniles that outmigrate shortly after emergence and spend relatively little time in the Skagit mainstem river and delta, but some may spend a significant amount of time in a limited number of pocket estuaries situated along Skagit Bay. Delta rearing migrants emerge at the same time as fry migrants, move rapidly to the delta region, but then spend several weeks to several months rearing in the Skagit River delta before moving into Skagit Bay at an average size of 74 mm (range 49-126 mm). Parr migrants (also referred to as "fingerling" or "riverine" life history forms) rear in freshwater for several months, then move through the delta relatively quickly and enter Skagit Bay at about the same size as delta rearing migrants. Yearlings rear in freshwater for over a year and outmigrate from late March through May at an average size of 120 mm (range 92 to 154 mm) (SRSC and WDFW 2005).

Analysis of scales from spawned-out adults suggest the yearling life history strategy accounts for 2.6 to 51.2 percent of spawning populations with the yearling component being relatively minor for the Upper Skagit Summer Chinook salmon (2.6%), Lower Sauk Summer Chinook salmon (9.1%), and Lower Skagit Fall Chinook salmon (17.8%). Yearling outmigrants are relatively common for the spring Chinook salmon populations, accounting for 44.5 percent, 50.3 percent, and 51.2 percent of the Upper Sauk, Upper Cascade, and Suiattle Spring Chinook salmon populations, respectively (SRSC and WDFW 2005). The larger proportion of yearling outmigrants for the more upstream spring Chinook salmon populations is consistent with the life history characteristics of Chinook salmon observed in other Pacific Northwest rivers as discussed in Healey (1991) and Quinn (2005).

Wild Chinook salmon fry enter Skagit Bay in February and March at an average size of 39 mm (range 30 to 46 mm) (Beamer et al. 2005a). Farther upstream, trapping at RM 17 during 2007 (at the Burlington Northern Railroad crossing in Mount Vernon) indicated some fry may begin outmigrating in mid-January and peak fry migration is usually in mid-March (Kinsel et al. 2008). Median migration dates between 1997 to 2006, when 50 percent of the fry have passed the trap averaged March 27 and have ranged from March 10 (1999) to May 2 (1998) (Kinsel et al. 2008).

Early fry outmigrants captured in the traps at Mt. Vernon are about 38 mm in size. As the season progresses the average size as well as the range of sizes for subyearling outmigrants increase as parr migrants account for a larger proportion of the population passing the trap location. After April 15, sub-yearling outmigrants are considered parr migrants. During the last week of sampling in late July 2007, the combined scoop trap and screw trap sub-yearling Chinook salmon mean length was 75.9 mm with a range of 60 mm to 84 mm (20 of 304 fish measured) and consisted entirely of parr migrants (Kinsel et al. 2008).

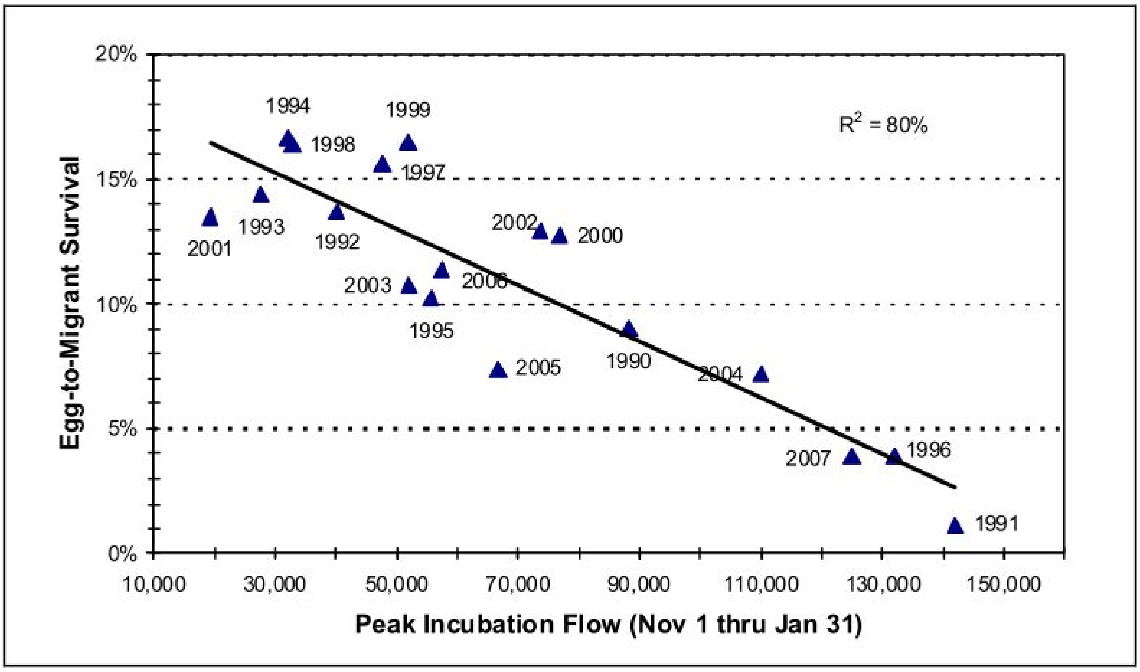
### 5.1.1.3. Freshwater and Marine Survival

#### 5.1.1.3.1. Freshwater Survival

There is evidence that freshwater survival in Skagit River Chinook salmon populations, particularly egg-to-outmigrant survival, is affected primarily by peak flows throughout the basin and high sediment loads in specific watersheds (SRSC and WDFW 2005). Peak flows can adversely affect egg to fry survival by causing scour to incubating eggs and alevins in redds, and result in high mortality rates to fry. High sediment loads can adversely affect the quality of spawning gravels through delivery of fine sediments and by altering channel morphology, which can contribute to scour.

DeVries (1997) conducted a literature survey that suggested the depth of Chinook salmon egg pockets may range from about 15 cm (top of pocket) to 50 cm (bottom of pocket). Scour that occurs deeper than the top of an egg pocket can mobilize and crush eggs. Flows that overtop a natural channel’s banks generally have approximately a 1.5 recurrence interval (Leopold et al. 1964). Flows sufficiently large to significantly alter a stream channel’s morphology are larger than about a 2-year recurrence interval for low gradient alluvial channels to 5-year recurrence interval for high gradient streams (Washington Forest Practices Board 1997). Evaluation of peak flows during egg incubation have demonstrated that Chinook salmon egg to fry survival in the Skagit River is negatively related to flood recurrence interval for flows greater than a 2-year event (Figure 5-2) (Kinsel et al. 2008). At flows less than a 2-year recurrence interval under the current flow regime, egg survival ranges from about 10 percent to 17 percent and appears unrelated to flow.

Poor egg-to-outmigrant survival as a result of peak flow events is considered a major factor limiting Chinook salmon production in the Skagit River (SRSC and WDFW 2005). The flood control and fish management flows of the Skagit Hydroelectric Project substantially reduce the magnitude of peak flow events in the Skagit River, particularly in the 25-mile section of the river between Gorge Powerhouse and the Sauk River confluence. Peak flows are reduced by the large volume of flood storage provided by Ross Lake, and SCL attempts to keep flows from exceeding 18,000 cfs during the egg incubation period of Chinook salmon, pink salmon, chum salmon, and




Source: Kinsel et al. (2008).

**Figure 5-2. Egg to migrant fry survival at different peak flow levels of the Skagit River as measured at the USGS gage in Sedro Woolley, Washington.**

steelhead to minimize redd scour. Flows higher than this guideline occur as a result of natural tributary inflows downstream of the project, and during flood fight efforts when the project is under the control of the Army Corps of Engineers to protect property and human lives.

As a result of lower precipitation levels in the upper basin and SCL's flow management measures, peak flows in the upper Skagit River are considerably smaller in magnitude than peak flows in the Sauk River and lower Skagit River for the same flood events (Figure 5-3). Precipitation levels are substantially lower in the upper basin compared to the Sauk River Basin because of rain shadow effects (Pacific International Engineering 2008). Peak flows in the upper Skagit River at Marblemount have exceeded 40,000 cfs four times during the past 25 years, have exceed 60,000 cfs only twice during this period (1996 and 2003 flood events). The average annual peak flow of the upper Skagit River at Marblemount since 1985 has been 29,400 cfs (drainage area = 1,381 sq-mi). In comparison, peak flows of the unregulated Sauk River have exceeded 40,000 cfs 10 times during the past 25 years, have exceeded 80,000 cfs three times during this period, and exceeded 100,000 cfs during the 2003 flood. The average annual peak flow of Sauk River since 1985 has been 43,200 cfs (drainage area =714 sq-mi, roughly half that of the upper Skagit). Finally, peak flows in the lower Skagit River at Concrete have exceeded 40,000 cfs 18 times since 1985, and have exceeded 100,000 cfs six times during this period. The average annual peak flow of the lower Skagit River at Concrete since 1985 has been 84,200 cfs (drainage area = 2,737 sq-mi).

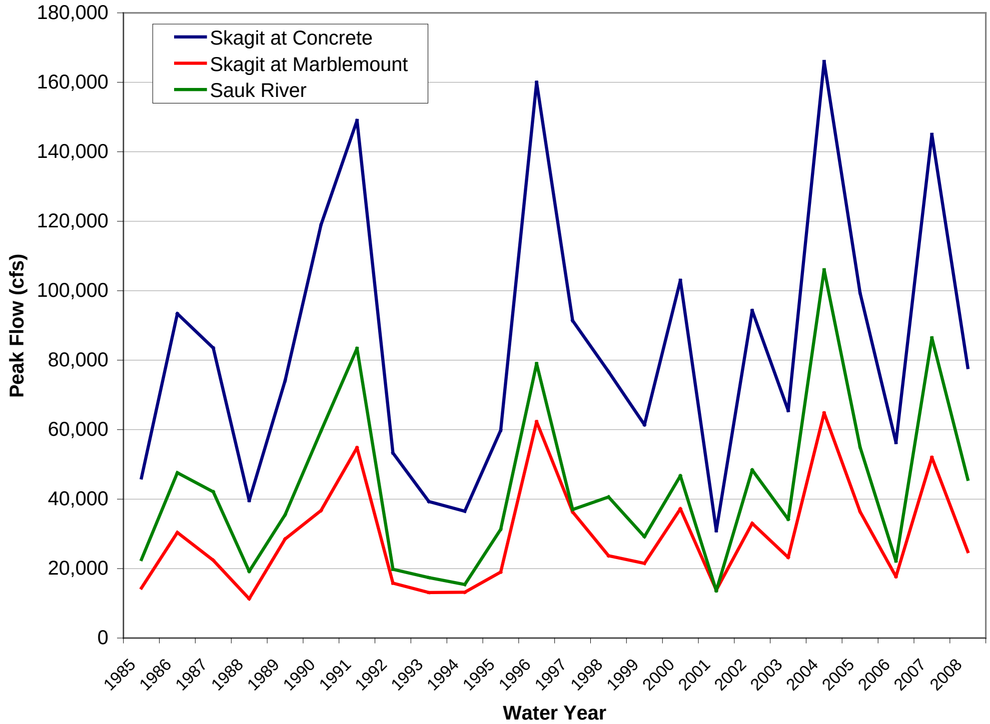



**Figure 5-3. Annual peak flows (instantaneous) of the Skagit River at Marblemount and Concrete, and the lower Sauk River.**

The effects of SCL's flow management measures on peak flows can be shown more directly by comparing peak flows occurring under existing conditions (i.e., with project flows) with natural peak flows (i.e., without project flows) that have been calculated for the same time period. For the last 25 years, the Skagit Hydroelectric Project has reduced peak flows in the upper Skagit River by an average of 38 percent, with peak daily flows of 21,500 cfs occurring with the project, and peak daily flows of 34,600 cfs calculated for natural (without project) conditions (Figure 5-4). The reductions in peak flows by the project have been greatest during major flood events, which occurred during the 1991, 1996, 2004, and 2007 water years. During these major flood years, peak daily flows averaged 44,500 cfs under flood and fish protection measures implemented by SCL, but would have averaged 70,000 cfs under natural (without project) conditions.

The negative relationship between peak flows and egg-to-outmigrant Chinook survival has been well documented in the Skagit River (SRSC and WDFW 2005; Kinsel et al. 2008). This relationship has been evaluated in the upper Skagit River using the updated data from the WDFW smolt trap located in the lower Skagit River (Zimmerman et al. *In Prep*). The negative relationship between peak flows in the upper Skagit River and egg-to-outmigrant survival measured at the smolt trap is highly significant (Figure 5-5), showing that peak flows in the upper Skagit have a major influence on the total number of Chinook smolts migrating out of the Skagit basin.

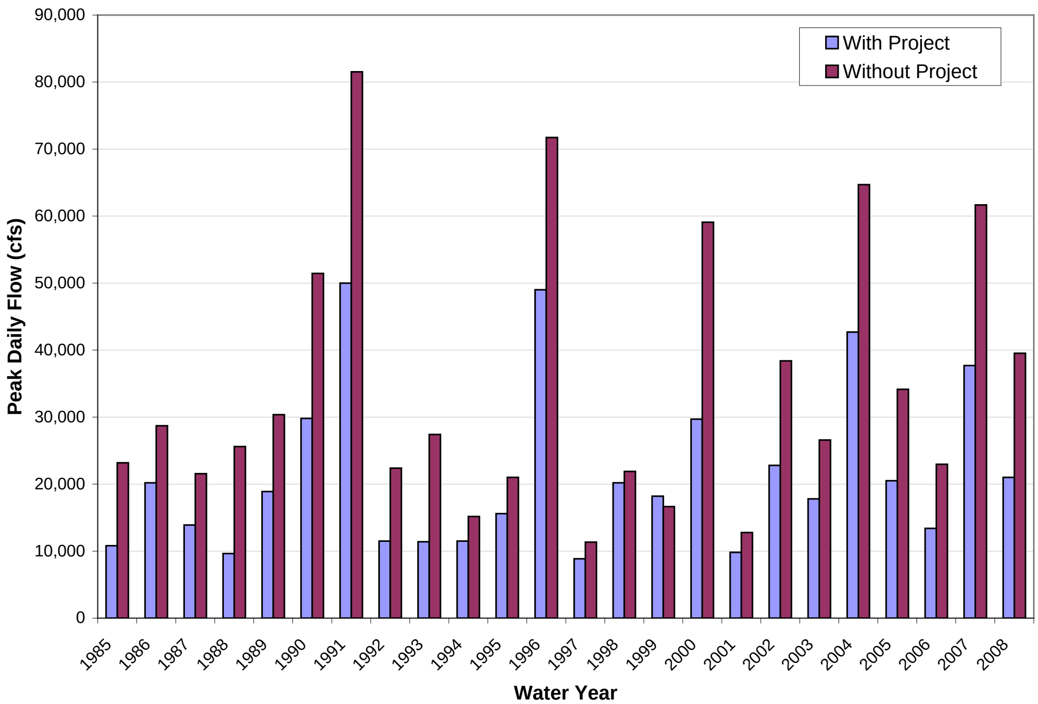



**Figure 5-4. Annual peak flows of the upper Skagit River at Marblemount under existing (with project) and synthesized natural (without project) flow regimes.**

Using this relationship, the effects of peak flow reduction measures by the Skagit Hydroelectric Project on Chinook salmon egg-to-outmigrant survival for the entire Skagit basin can be calculated. The peak flow reduction measures by the Skagit Hydroelectric Project provide a major benefit to the eggs, alevins, and fry of Chinook salmon, increasing average survival rates from 7.3 percent under natural (without project) conditions to 10.8 percent (Figure 5-6). The peak flow reductions result in a 48 percent increase in the freshwater survival of Chinook salmon for the Skagit River basin.

The positive effects of peak flow reductions in the upper Skagit River on Chinook egg-to-outmigrant survival are most evident during major flood years (Figure 5-7). During major floods occurring during 1991, 1996, 2004, and 2007 (water year), reductions in peak flows in the upper Skagit River resulted survival rates that were up to 3.5 times higher than those calculated under natural (without project) conditions. During these major flood years, freshwater survival rates of Chinook in the Skagit were predicted to be 2.8 times greater on average than natural survival rates.

As described below in Section 6.1.2.2.6, fry survival can also be substantially affected by stranding (Pflug and Mobrand 1989). Connor and Pflug (2004), demonstrated that Upper Skagit Summer Chinook salmon population have benefited substantial from flow controls that began to be implemented in 1981 that improved both spawning and incubation conditions and reduced the incidence of fry stranding.

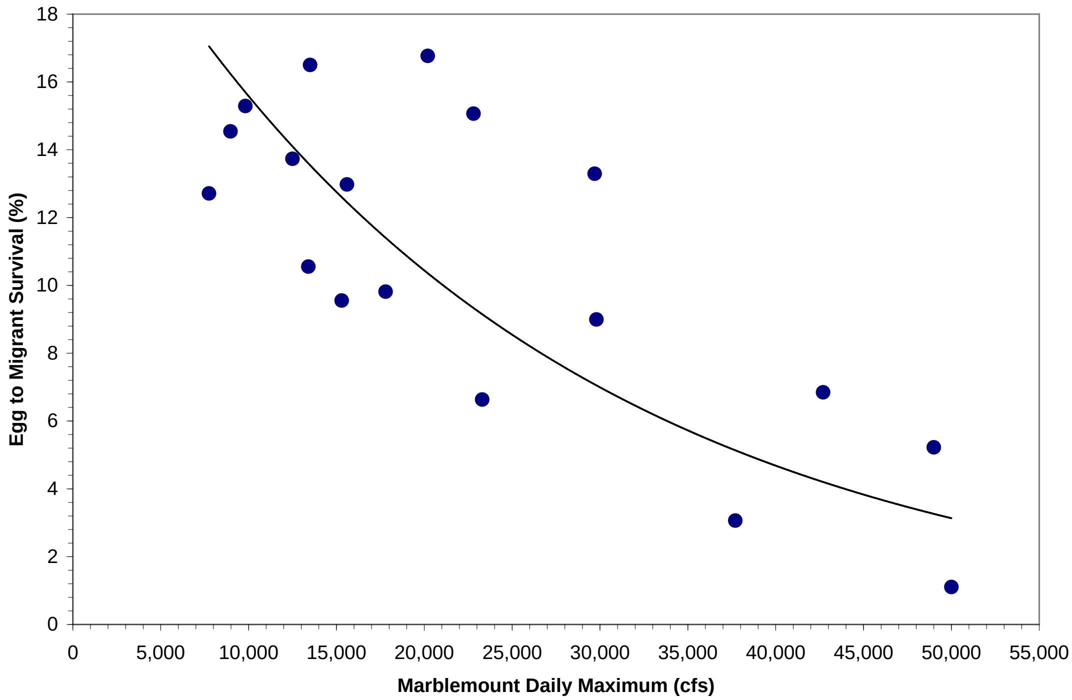



**Figure 5-5. Relationship between peak flows for the Skagit River at Marblemount and egg-to-smolt survival for Chinook salmon in the Skagit River basin.**

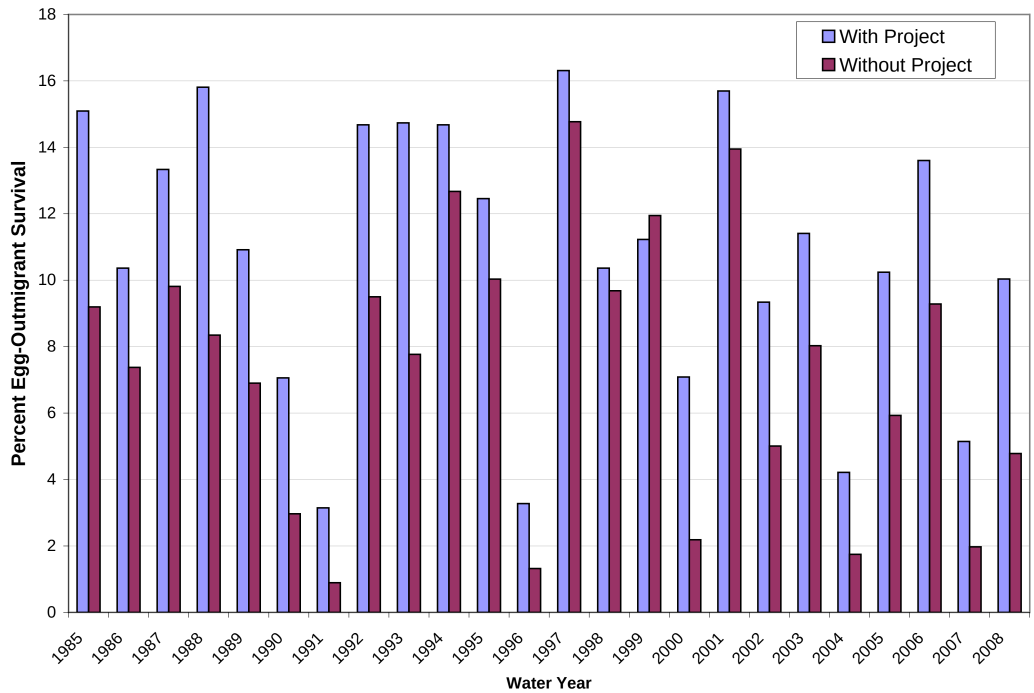



**Figure 5-6. Comparison of egg-to-outmigrant survival rates for Chinook salmon in the Skagit Basin predicted under existing (with project) and natural (without project) conditions.**

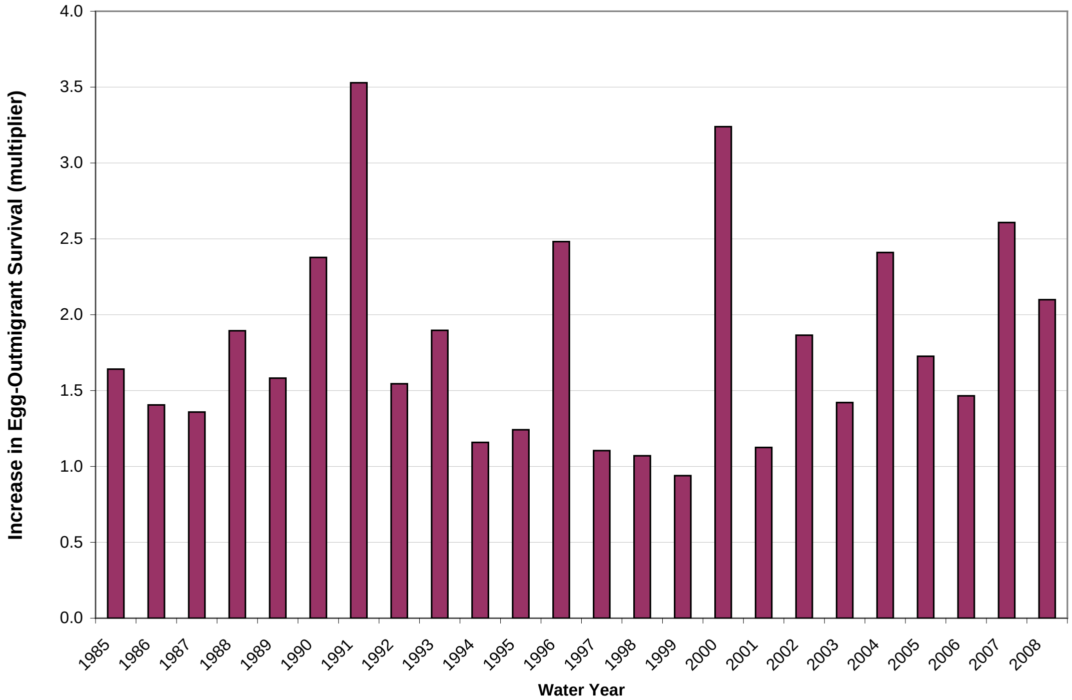



**Figure 5-7. Predicted increases in egg to outmigrant survival rates for Chinook salmon resulting from the fish management flows at the Skagit Hydroelectric Project.**

## 5.1.1.3.2. Marine Survival

Beamer et al. (2005a) estimated marine survival for each of the Chinook salmon life history forms under both low and high ocean survival conditions (Table 5-1) based upon a scales analyzed from returning adults. Ocean survival rates were highest for yearling smolts, and result of their larger size at outmigration. Survival rates of subyearling parr and tidal rearing outmigrants was less than half of that of yearling smolts, and survival was lower by an order of magnitude for fry migrants that do not use pocket estuary habitats. SRSC and WDFW (2005) attribute the low ocean survival of sub-yearlings largely to a shortage of delta rearing habitat and loss of pocket estuaries, which can also be confounded by peak flow events.

**Table 5-1. Estimated marine survival for four Chinook salmon life history strategies.**

| Life History Type | Low Survival (low regime) | Average Survival (low regime) | Average Survival (high regime) |
|---|---|---|---|
| Yearling Smolts | 0.251% | 1.191% | 3.494% |
| Parr migrants | 0.109% | 0.518% | 1.519% |
| Tidal delta rearing | 0.109% | 0.518% | 1.519% |
| Pocket estuary rearing fry migrants | 0.109% | 0.518% | 1.519% |
| Residual fry migrants (fry migrants that don't find pocket estuary habitat) | 0.013% | 0.060% | 0.175% |

Data source: Beamer et al. (2005a).

#### 5.1.1.4. Spawner Age Structure

Lower Skagit Fall Chinook Salmon, Upper Skagit Summer Chinook Salmon, and Lower Sauk Summer Chinook salmon populations are managed as a single unit for harvest by the fisheries co-managers (WDFW and treaty tribes). Consequently, some life history information, such as the age structure of returning adults, is only available for summer/fall run fish as a whole. The summer/fall Skagit River Chinook salmon spawn primarily at 4 years of age with significant numbers of 3-year-old and 5-year old fish (PSIT and WDFW 2009). Analysis of estimated age structure for the 1981 through 2001 brood years reported in PSIT and WDFW (2009) indicated age 4 accounted for an average of 66.7 percent of the escapement, while age 2 and 3 accounted for about 23.5 percent and age 5 accounted for 9.8 percent[2]. The age structure of returning adults appears to be highly variable from year to year. The proportion of age 4 fish in the management unit ranged from 43.2 percent to 83.9 percent over the 21 year period. The age structure reported in PSIT and WDFW (2009) is consistent with earlier analysis by Orrell (1976) that found 4-year old fish accounted for 73.4 percent of the gill net sampling catch between 1965 and 1972 while 3-year old fish accounted for 9.6 percent, and 5-year old fish accounted for 16 percent. About 1.1 percent of the catch were 6-year old fish. Orrell (1976) suggested that 2-year old (jacks) and 3-year old Chinook salmon were under-represented in the gill net catch because of the large mesh size used and this conclusion was supported by the fact that fish less than 60 cm in length, which is the smallest size caught by gill net, represented 27 percent of the Chinook salmon caught by seining near Hamilton (RM 40).

Analogous to the summer/fall Chinook salmon runs, the Upper Sauk Spring Chinook Salmon, Suiattle Spring Chinook Salmon, and the Upper Cascade Spring Chinook salmon populations are managed as single unit by the fisheries co-managers. The spring Chinook salmon of the Skagit River basin spawn primarily at 4 years of age with significant numbers of 2-, 3-, and 5-year-old fish (PSIT and WDFW 2009). Analysis of estimated age structure for the 1981 through 2001 brood years reported in PSIT and WDFW (2009) indicated age 4 accounted for an average of 66.0 percent of the spring escapement, while age 2 and 3 accounted for about 10.1 percent and age 5 accounted for 23.7 percent. Compared to the summer/fall run Chinook salmon management unit, there is a higher proportion of age 5 fish and lower proportion of age 2/3 fish, while the proportion of age 4 fish are similar. This difference likely reflects the fact that a larger proportion of spring-run fish outmigrate as yearlings compared to summer/fall-run Chinook salmon.

#### 5.1.1.5. Abundance, Productivity, and Diversity

The PSTRT generally adopted the long-term abundance and productivity recovery targets developed by the WDFW and treaty tribes co-managers (NMFS 2006) (Table 5-2). The targets are based upon two particular points on a Beverton-Holt stock recruitment curve developed for each population under average marine survival conditions. The high productivity target is the spawners needed to obtain maximum sustainable yield (MSY) and the low productivity target is the number of spawners needed at the point where the unit replacement line (1.0 recruit per spawner) crosses the curve.

[2] PSIT and WDFW (2009) used validation runs of the Fishery Regulation Assessment Model (FRAM) to estimate age structure.

**Table 5-2. Chinook salmon recovery spawner planning targets and recent escapement in number of fish.**

| Chinook Salmon Population | Low Productivity Planning Target[1] (Range) | High Productivity Planning Target[2] (ret/spawner) | Geometric Mean 2005 to 2009 | | Trend | | Percent Hatchery Fish |
|---|---|---|---|---|---|---|---|
| | | | Escapement (Range) | Prod. | 1974 – 2009 | 1998-2009 | |
| Lower Skagit Fall | 16,000 (16,000 - 22,000) | 3,900 (3.0) | 2,401 (1,053 – 3,508) | 0.78 | 0.98 | 0.99 | 0.2 |
| Upper Skagit Summer | 26,000 (17,000 - 35,000) | 5,380 (3.8) | 11,270 (5,290 – 16,608) | 0.92 | 1.01 | 1.00 | 2.0 |
| Lower Sauk Summer | 5,600 (5,600 - 7,800) | 1,400 (3.0) | 628 (250 – 1,095) | 0.67 | 0.97 | 0.98 | 0.0 |
| Upper Cascade Spring | 1,200 (1,200 - 1,700) | 290 (3.0) | 349 (223 – 478) | 0.86 | 1.04 | 1.03 | 0.3 |
| Upper Sauk Spring | 3,030 (3,000 - 4,200) | 750 (3.0) | 597 (282 – 1,043) | 1.29 | 1.01 | 1.07 | 0.0 |
| Suiattle Spring | 610 (600 - 800) | 160 (2.8) | 295 (108 – 518) | 0.64 | 0.98 | 0.95 | 0.0 |

Source: NMFS (2006); Connor, E. (2010, pers. comm.).

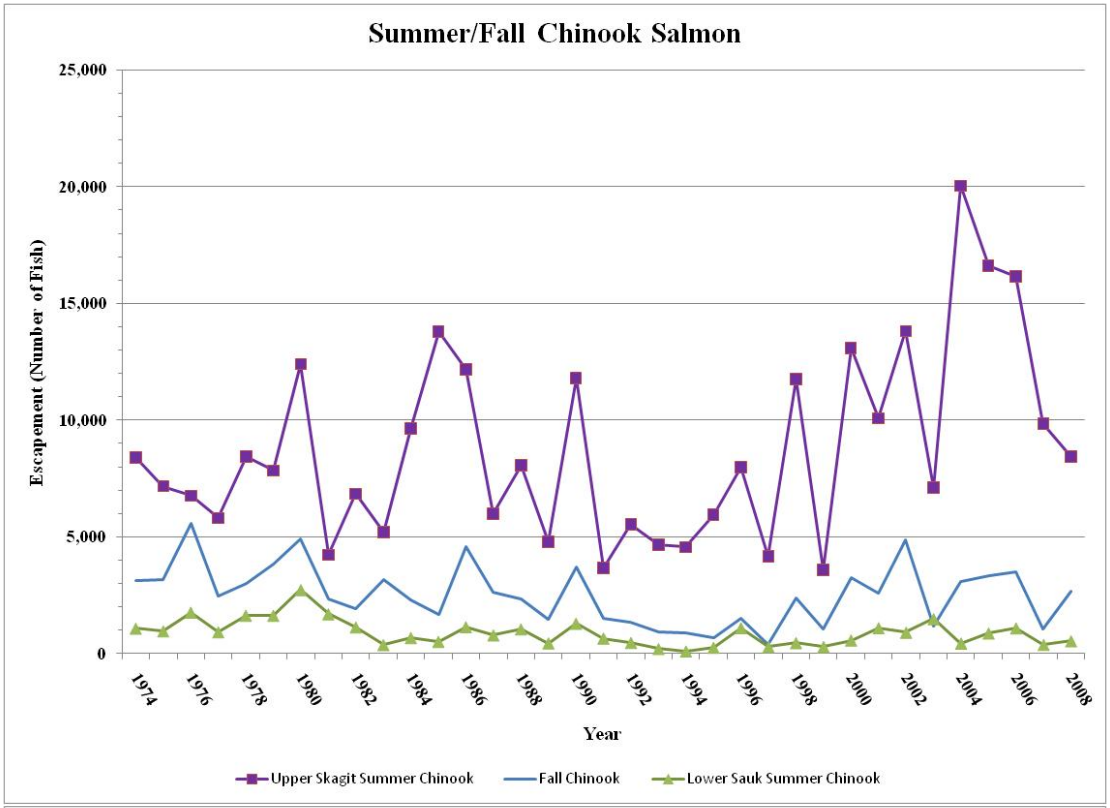
1, Low productivity targets are at the equilibrium (carrying capacity) point where productivity is 1.0 return per spawner.

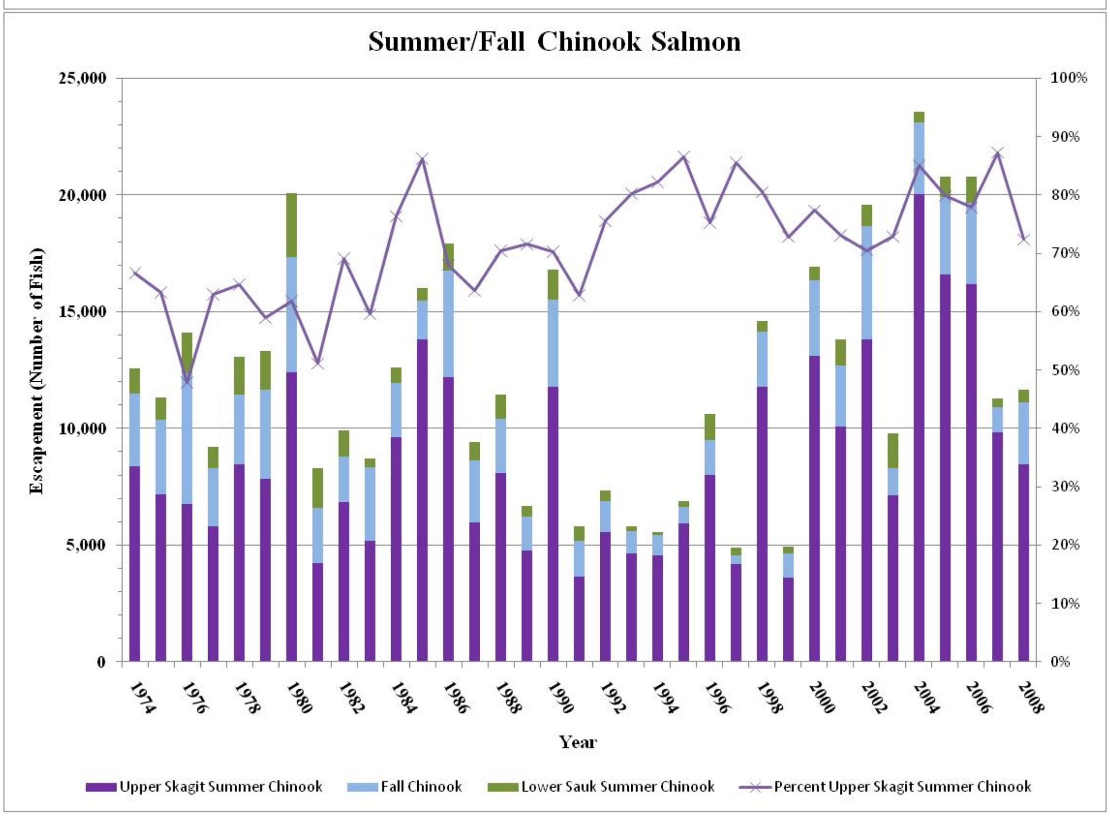
2, High productivity targets are at the point of maximum sustained yield (returns per spawner).

Recovery targets are defined for the six individual populations (Table 5-2). The Upper Skagit Summer Chinook salmon population accounts for about half of the summer/fall Chinook salmon stock with high productivity abundance targets under a recovered condition of 5,380 fish at the point of maximum sustainable yield and 26,000 fish at the equilibrium point (NMFS 2006). At MSY the Lower Skagit Fall Chinook salmon population is expected to account for just over a third (3,900 fish) and the Lower Sauk Summer Chinook salmon population accounts for just over one-eighth (1,400 fish) of the stock. High productivity targets are 3.0 recruits per spawner for the Lower Skagit Fall and Lower Sauk Chinook salmon populations and 3.8 recruits per spawner for the Upper Skagit Summer Chinook salmon population.

Escapement data indicate the Upper Skagit Summer Chinook salmon population has exceeded the high productivity target each year since 2000 with a mean escapement of 11,270 fish for return years 2005 to 2009 (Figure 5-8). The escapement was also within the low productivity planning range during 2004, 2005, and 2006. In contrast, the Lower Skagit Fall Chinook salmon population has only exceeded the high productivity goal once (2002) since 2000 and mean escapement for return years 2005 to 2009 is 2,401 fish (Figure 5-8). Similarly, the Lower Sauk Summer Chinook salmon population has exceeded the high productivity goal once (2003) and mean escapement for return years 2005 to 2009 is 628 fish (Figure 5-8). There is an increasing trend in the proportion of the summer/fall stock that is derived from the Upper Skagit Summer Chinook salmon population with an average of 72.5 percent between 2005 and 2009. Based upon mean escapement values in Good et al. (2005), the upper Skagit Summer Chinook salmon population often provides over 25 percent of the wild Chinook salmon summer and fall escapement in Puget Sound, demonstrating its importance to the ESU. Mean Skagit productivity from 2005 to 2009 is less than 1.0 recruit per spawner for each of the summer and fall populations (Table 5-2). Estimates of the Skagit summer/fall management unit for productivity has ranged from 0.7 to 9.3 recruits per spawner for brood years 1981 to 2001 with an average of 3.1 recruits per spawner (Figure 5-9), suggesting they may be near the high productivity targets. Productivity tends to vary substantially and is affected by cyclical changes in ocean conditions (Mantua et al. 1997). Both the Lower Skagit Fall and the Lower Sauk Summer Chinook salmon populations demonstrate a slight downward trend over the last ten years while the Upper Skagit Summer Chinook salmon population demonstrates no trend.

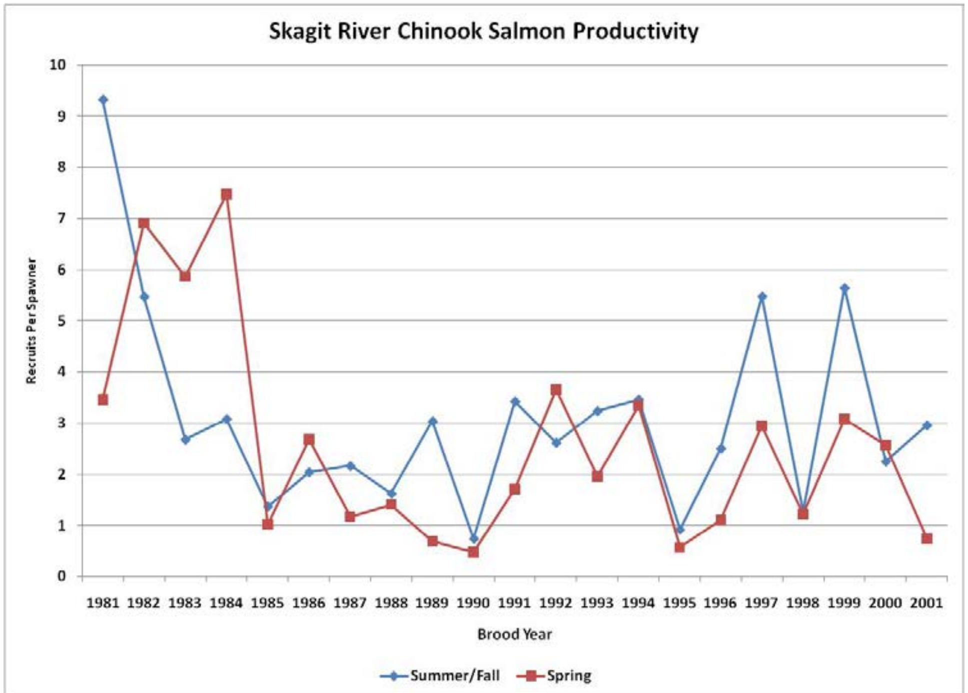
Targets for the Skagit River spring Chinook salmon populations based upon stock-recruitment models are substantially lower than for the fall/summer populations. The targets predicted by a population viability analysis (PVA) modeling conducted by NMFS suggest that numbers may need to be substantially higher than these levels for long-term population survival. Abundance and productivity targets under a recovered condition with average marine survival conditions for Upper Sauk Spring Chinook salmon are 750 fish at MSY and 3,030 recruits per spawner at the point of equilibrium (NMFS 2006) (Table 5-2). Targets for the Suiattle Spring Chinook salmon are 160 fish at MSY and 610 fish the point of equilibrium and for the Upper Cascade Spring Chinook salmon population targets are 290 fish at MSY and 1,200 recruits at the point of equilibrium (NMFS 2006). High productivity targets are 3.0 recruits per spawner for the Upper Cascade and Upper Sauk spring Chinook salmon populations and 2.8 recruits per spawner for the Suiattle Spring Chinook salmon population.




Source: SKAGITSASSI2009.xls.

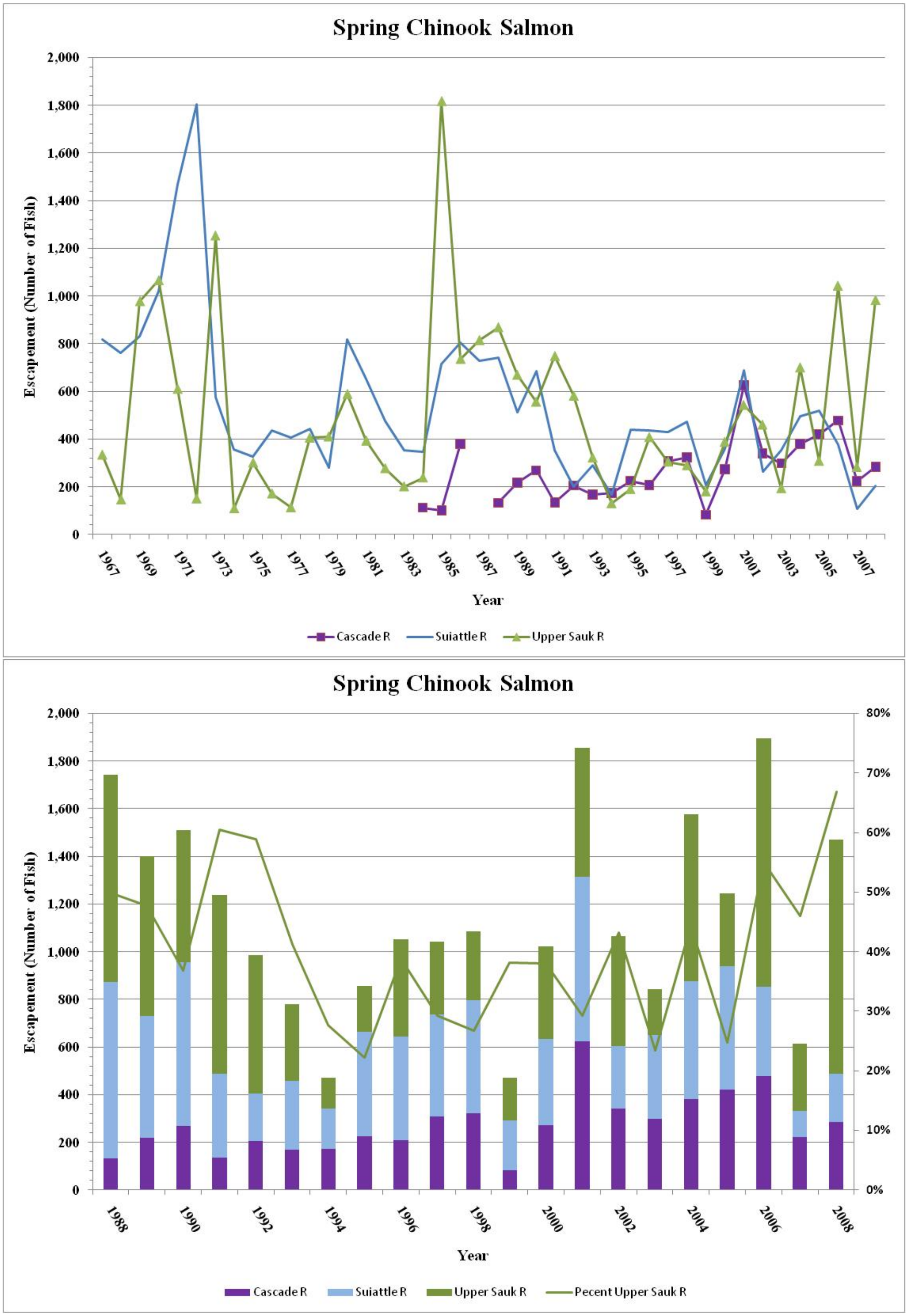
**Figure 5-8. Skagit River summer and fall Chinook salmon escapement and proportion of the run that is Upper Skagit River Summer Chinook salmon 1974 to 2008.**




Data Source: PSIT and WDFW (2009).

**Figure 5-9. Skagit summer/fall and spring Chinook salmon productivity for brood years 1981 to 2001.**

The Upper Sauk River accounts for the highest proportion (about 41% since 1998) of the Skagit River basin spring Chinook salmon production (Figure 5-10). The geometric mean escapement for return years 2005 to 2009 is 597 fish for the Upper Sauk Spring, 295 fish for Suiattle Spring, and 349 fish for the Cascade River Spring Chinook salmon populations (Figure 5-10) (SkagitSASSI2009.xls). Estimated escapement levels for spring Chinook salmon populations from 1967 to 2008 are provided in Figure 5-10; however, WDFW modified their survey methods in 1995 such that older estimates may not be comparable to more recent estimates (Connor 2010a, pers. comm.). From 2000 to 2008, the Suiattle Spring Chinook salmon population has exceed its high productivity target eight times, while the Upper Cascade Spring Chinook salmon population has exceeded its target six times, and the Upper Sauk Spring Chinook salmon population has exceeded its target twice. All of the spring Chinook salmon populations in the Skagit River basin are considerably below the low productivity planning targets and ranges. Mean Skagit productivity from 2005 to 2009 is less than 1.0 recruits per spawner for the Cascade and Suiattle spring Chinook salmon populations (Table 5-2). The Sauk River Spring Chinook salmon population is the only Skagit River Chinook salmon population with average productivity greater than 1.0 return per spawner in recent years. Trend analysis for returns over the last 10 years indicate and increasing trend for the Upper Cascade and Upper Sauk Spring Chinook salmon populations and a declining trend for the Suiattle Spring Chinook salmon population. Skagit River spring Chinook salmon productivity for brood years 1981 to 2001 averaged 2.6 recruits per spawner (Figure 5-9) (PSIT and WDFW 2009). WDFW (2002b) reported that smolt to adult survival for the Skagit River spring Chinook salmon yearlings released by the Marblemount hatchery averaged 0.51 percent for brood years 1990 and 1993 through 1997 while




Source: SKAGITSASSI2009.xls.

**Figure 5-10. Skagit River spring Chinook salmon escapement 1967 to 2008 for individual populations (top) total spring-run escapement and percent Sauk River fish 1988 to 2008 (bottom). Data incomplete for the Cascade River.**

fingerling releases from brood years 1993 through 1997 averaged 0.49 percent. Poaching is considered a substantial problem for the Suiattle Spring Chinook salmon population that reduces escapement levels (SRSC and WDFW 2005).

Many of the Skagit River Chinook salmon populations demonstrate escapement levels that are markedly higher during even years when pink salmon do not spawn. This pattern is particularly evident between 2002 and 2008 for Upper Sauk River Spring Chinook salmon and between 1995 and 2004 for the Upper Skagit Summer Chinook salmon population (Figure 5-8., Figure 5-10). Unlike most other Skagit Chinook salmon, there does not appear to be a discernable pattern of higher Upper Cascade Spring Chinook salmon escapement during even numbered years when there are no pink salmon returning to spawn.

Spatial, temporal, and genetic diversity is important for maintaining population viability because it reduces the risk that stochastic events such as landslides, droughts, or floods will adversely affect all components of a population, it allows populations to use a wider range of habitat patches, and genetic diversity allows the population to adapt to changing environmental conditions (McElhany et al. 2000). Diversity in the Skagit River Chinook salmon populations is expressed primarily through a combination of their age of outmigration and age of return, but also through the spatial variability of habitat used by spawners and juveniles. Because all of the populations have multiple life history strategies during outmigration (including fry, delta rearing, parr rearing, and yearling) and variable ages of return (primarily ages 2 through 5, plus the occasional age 6 fish), they expresses a diverse life history that helps them to persist in the event of relatively low survival in any particular location/period over the life cycle.

The different juvenile life history strategies utilize different areas of the river, delta, and nearshore environment that contribute to spatial diversity. However, many of these areas are considered degraded, which adversely affects spatial diversity. In particular, the Skagit estuary and freshwater tidal delta has been identified as one of the major bottlenecks affecting population productivity and abundance. The summer and fall Chinook salmon populations that have a higher proportion of sub-yearling outmigrants that extensively use the delta region are more affected by degraded delta conditions. Rearing habitat limitations to Chinook salmon are also very evident in the middle Skagit, which limits the number of fish parr migrants that outmigrate from the Skagit watershed.

Spatial diversity is characterized by adult spawner use of tributaries and off-channel habitat as well as mainstem spawning areas. Spatial diversity is reduced for some populations because of degraded spawning habitat in lower tributary reaches. The lower Skagit Fall Chinook salmon population appears to be the most severely affected by degraded tributary conditions and loss of off-channel habitat in the lower river.

The Lower Sauk Summer Chinook salmon population is expressed primarily through their age of outmigration and age of return, with little spatial diversity. The best Chinook salmon spawning in the lower Sauk is located between the Suiattle River and Darrington as a result of complex channels patterns and lots of accumulated gravel. The only major tributary to this section of the river aside from Dan Creek, was identified as severely degraded in Beamer et al. (2000), is the Suiattle River, which has naturally high sediment levels from glacial retreat occurring in its headwaters. Given the relatively low abundance and spatial diversity of the population and the risk of lahars from Glacier peak, the Lower Sauk Summer Chinook salmon population appears to be at relatively higher risk of extinction from a population viability perspective.

Similarly, diversity in the Suiattle Spring Chinook salmon population is expressed primarily through their age of outmigration and age of return, with relatively high spatial diversity due to spawning in a number of tributaries. Little to no spawning is believed to occur in the mainstem of the Suiattle River because of naturally high sediment loads. Two of the larger tributaries, Tenas and Big Creek, have been adversely affected from land use practices, while other tributaries within the USFS wilderness area are in relatively good condition. Overall, the Suiattle Spring Chinook salmon population appears to be in a generally declining trend from a population viability perspective with the lowest recorded returns occurring in 2007 with 108 adults.

Diversity in the Upper Sauk Spring Chinook salmon population is expressed primarily through their age of outmigration and age of return, with low to moderate spatial diversity due to spawning in the White Chuck River and the North Fork and South Forks of the Sauk. Of these three streams, both the White Chuck River and North Fork Sauk River (i.e., Sloan Creek WAU) are considered to be in relatively good condition, while the South Fork Sauk River (i.e., Monte Cristo WAU) was identified as degraded based upon the screening tool developed by Beamer et al. (2000). However, the South Fork Sauk River has also been identified as being in good condition and one of the most important spawning reaches for bull trout based upon redd and spawner surveys (Downen 2006a). The Upper Sauk Spring Chinook salmon population appears to be improving from a population viability perspective, demonstrating an upward trend in returns since the low in 1994 of 130 adults.

Diversity in the Upper Cascade Spring Chinook salmon population is expressed primarily through their age of outmigration and age of return, with relatively high spatial diversity due to spawning in a number of tributaries. The Cascade Middle WAU (Marble Creek, Sibley Creek, Found Creek, Kindy Creek) and the Cascade Pass WAU (Sonny Boy Creek, South Fork Cascade River, North Fork Cascade River) are all considered to be in relatively good condition (Beamer et al. 2000) and as part of the USFS Wilderness area, some of the best preserved habitat in the Skagit Basin. Consequently, the current spawning distribution appears comparable to historical conditions. Overall, the Upper Cascade Spring Chinook salmon population appears to be in a generally increasing trend from a population viability perspective with the lowest recorded returns occurring in 1999 numbering 83 adults.

#### 5.1.1.6. Threats

Good et al. (2005) identified the following threats to the Puget Sound Chinook salmon ESU:

- Blocked habitat
- Changes in flow regime
- Sedimentation
- High water temperatures
- Streambed instability

- Loss of estuarine habitat
- Loss of large woody debris
- Loss of pool habitat
- Artificial propagation
- Harvest

With the exception of perhaps artificial propagation, all of the threats affect one or more of the Skagit River Chinook salmon populations. While artificial propagation of spring, summer, and fall Chinook salmon does occur at the Marblemount Hatchery, the magnitude of the programs are relatively small and used primarily for conservation and as indicator stocks for wild Chinook salmon populations. Good et al. (2005) states the Skagit River is the only basin in the Puget Sound ESU considered to have low numbers of naturally spawning hatchery fish. Specific threats to habitat conditions in the Skagit River Basin include agricultural practices in the lower basin, forest practices in a number of tributary streams, and hydroelectric development. Most of the basin is rural, but nearly all towns and any associated urbanization are found adjacent to the mainstem Skagit River or its major tributaries and can be considered minor from a basin-wide perspective, but locally important as a potential threat to habitat conditions. A substantial portion of the upper basin is designated as Wilderness Area, Wild and Scenic River, National Park, or Provincial Park. These designations have helped to reduce the overall threat level in the basin and contributed to a general recognition that the Skagit River basin, on a relative basis, is in the best condition of the basins in the Puget Sound ESU.

#### 5.1.1.7. Limiting Factors

SRSC and WDFW (2005) and Smith (2003) identified limiting factors in the Skagit River Basin and potential future recovery actions that would increase the number of recruits from one life stage to the next, increase the capacity of constraining habitats, and increase life stage survival rates. The following limiting factors were identified and assessed primarily on a qualitative basis in SRSC and WDFW (2005) (Table 5-3):

- Life-stage recruitment (seeding) levels;
- Degraded riparian zones;
- Poaching;
- Dam operations;
- Sedimentation and mass wasting;
- Flooding;
- High water temperatures;
- Hydromodification;
- Water withdrawals;
- Loss of delta habitat and connectivity;
- Loss of pocket estuary habitat and connectivity;

**Table 5-3. Summary of limiting factors to Skagit River Chinook salmon populations and qualitative impairment levels.**

| Limiting Factor | Skagit River Chinook Salmon Population | | | | | |
|---|---|---|---|---|---|---|
| | Lower Fall | Upper Summer | Lower Sauk Summer | Cascade Spring | Upper Sauk Spring | Suiattle Spring |
| Life-stage recruitment (seeding) levels | Likely adequate | Likely adequate | Indeterminate | Indeterminate | Indeterminate | Likely adequate |
| Riparian zones | Heavily degraded | Significantly degraded | Heavily degraded in some areas | Little degradation | Moderate degradation | Significant degradation |
| Poaching | Significant | Significant | Significant | Significant | Significant | Highly Significant |
| Dam operations | Affected, but substantially mitigated via Baker Hydroelectric Project and Skagit Hydroelectric Project Settlement Agreements | | | | | |
| Sedimentation and mass wasting | Very poor | Relatively good | Poorest in system | Unimpaired | Impaired | Poor from natural and anthropogenic sources |
| Flooding | Especially severe | Risk reduced by flood control | Most affected population | Low risk | Low risk | Low risk |
| High water temperatures | Impaired in many tributaries | Unimpaired | Unimpaired | Unimpaired | Unimpaired | Unimpaired |
| Hydromodification | High impairment | Mitigated | Impaired in some locations | Unimpaired | Impaired in three locations | Impaired in four locations |
| Water withdrawals | Significant risk | Potentially at risk | Potentially at risk | Unimpaired | Potentially at risk | Unimpaired |
| Loss of delta habitat and connectivity | Affected | Affected | Affected | Affected | Affected | Affected |
| Loss of pocket estuary habitat and connectivity | Affected | Affected | Affected | Affected | Affected | Affected |
| Availability of prey fish species | Affected | Affected | Affected | Affected | Affected | Affected |
| Habitat destruction and degradation | Affected | Affected | Affected | Affected | Affected | Affected |
| High seas survival | Affected | Affected | Affected | Affected | Affected | Affected |

Primary Source: SRSC and WDFW (2005) with updates from PSE (2004) and Smith (2005b).

- Availability of prey fish species;
- Habitat destruction and degradation; and
- High seas survival.

All of the limiting factors identified in SRSC and WDFW (2005) were considered important to one or more of the Skagit River Chinook salmon populations with the factors of sedimentation, flooding, hydromodification (off-channel habitat), delta habitat, and pocket estuary habitat examined in greater detail.

As a screening tool, Beamer et al. (2005b) developed an index of watershed impairment based upon the hydrologic maturity of vegetation and road density within Watershed Accounting Units (WAUs). It was hypothesized that the watershed impairment index, in conjunction with peak flow level during incubation, could be used to estimate the total egg to fry survival for Skagit River wild Chinook populations. An important component to their model was the proportion of the spawning habitat for each population that was considered impaired versus functioning.

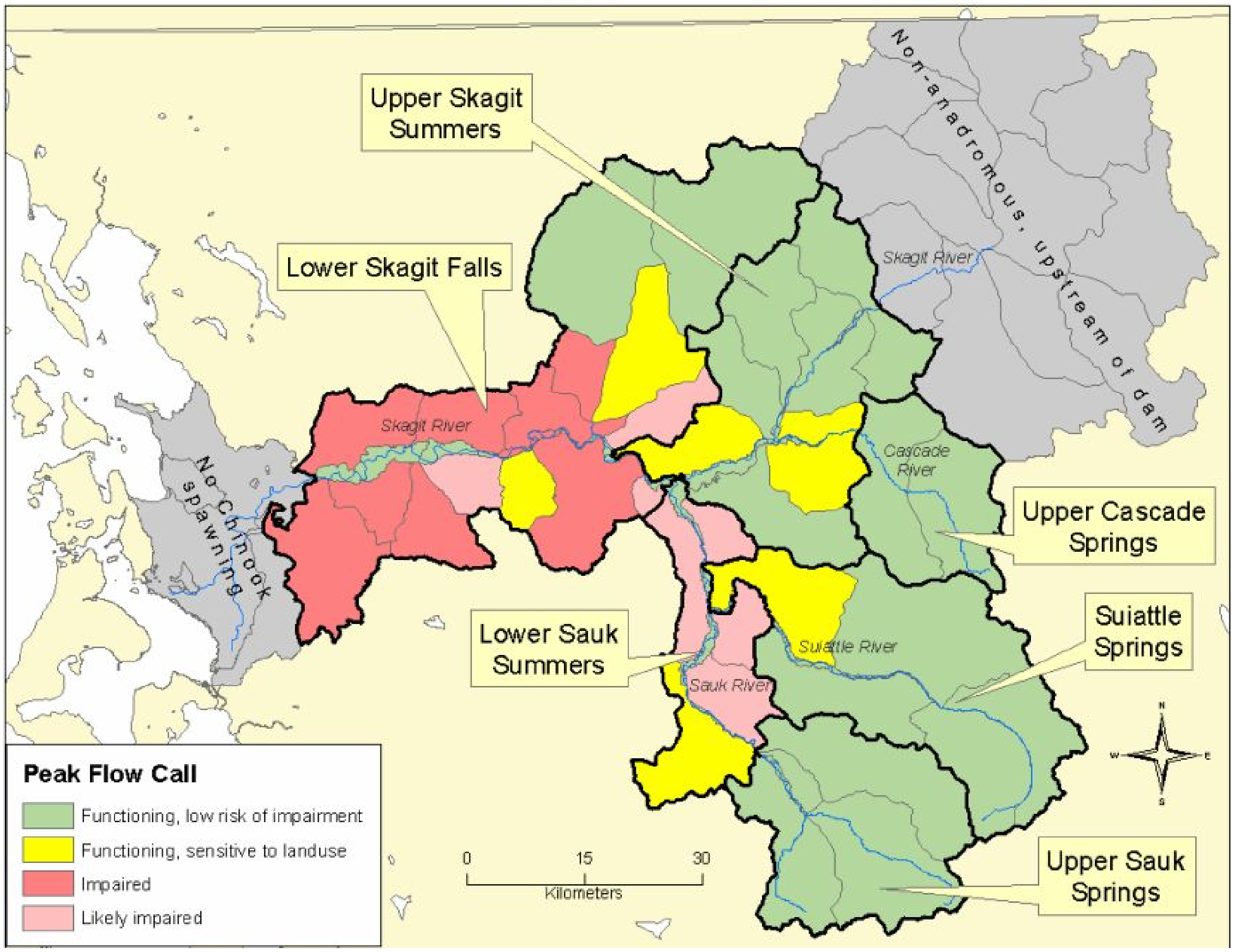
For the lower Skagit Fall Chinook salmon population, 100 percent of the escapement was considered adversely affected by impaired spawning conditions. In contrast, only about 7 percent of Upper Skagit Summer Chinook salmon escapement spawn under impaired conditions (i.e., those that spawn in the lower Cascade River) which is because the majority of the upper Skagit is located within federal lands that are protected by the National Park Service or in USFS wilderness status. Sauk River flows are partially derived from glacial runoff and fine sediment loads from the Suiattle River can be relatively high and have a large influence on conditions in the lower Sauk River (SRSC and WDFW 2005). Based upon the watershed impairment index developed by Beamer et al. (2005b), 100 percent of Lower Sauk Summer Chinook salmon escapement spawn under impaired conditions.

Spring Chinook salmon populations are generally less likely to be affected by sediment loads from anthropogenic sources compared to the Lower Skagit Fall Chinook salmon population and Lower Sauk River Summer Chinook salmon population because many of the locations where they spawn are protected. However, portions of the area used by Sauk River and Suiattle River Spring Chinook salmon spawners can be affected by glacial runoff and fine sediment loads that can be relatively high (SRSC and WDFW 2005). Based upon the watershed impairment index developed by Beamer et al. (2005b), about 25 percent of Upper Sauk and 20 percent of Suiattle Spring Chinook salmon spawn under impaired conditions. Although the mainstem Suiattle River has high natural sediment loads, most spring Chinook salmon are believed to spawn in the clear-running tributaries unaffected by glacial sediment. Upper Cascade River flows are also partially derived from glacial runoff; however, fine sediment loading from glaciers is not considered a limiting factor and most of the subbasin is designated as wilderness area (SRSC and WDFW 2005). Based upon the watershed impairment index developed by Beamer et al. (2005b), the Upper Cascade River is in good condition and 100 percent of the Upper Cascade Spring Chinook salmon spawn in functioning habitat conditions.

The Skagit River Recovery Plan also evaluated levels of hydrologically immature vegetation and road density as screening-level indicators of hydrologic impairment (Beamer et al. 2005b). Watershed Administrative Units (WAUs) with more the 50 percent area in a hydrologically immature vegetation condition and more than 2 km/km$^2$ road density were considered to be "very likely impaired" while WAUs exceeding only one of the criteria were considered "likely impaired." Floodplain reaches were rated separately using the weighted average of upstream WAUs, except those behind reservoirs. Assessment of hydrologic conditions in the Skagit Basin indicated a significant portion of the Skagit River downstream of the confluence with the Sauk River was either "impaired" or "likely impaired"(Figure 5-11) (Beamer et al. 2005b). However, as drainage area increases, changes in peak flow become increasingly difficult to discern in large part because of decreasing proportion of drainage area affected by harvest and roads, the interaction with harvest and other land uses, and increasing de-synchronization of peak runoff hydrographs with difference in distances, aspects, and elevations between contributing catchments as drainage area increases (Beschta et al. 2000; Coe 2004; Grant et al. 2008). Portions of the basin downstream of the Skagit Hydroelectric Project and Baker Hydroelectric Project have a reduced risk of peak flow-related effects because of flood control. The Sauk River, Cascade River, and many of the smaller tributaries do not have flood control and peak flow events from these tributaries, both natural and influenced by land use practices, have a higher likelihood of expressing peak flow-related effects in downstream reaches. The Sauk River, in particular, has demonstrated high peak flow events in recent years that are more frequent then occurred historically (Figure 5-3).

Life stage modeling reported in SRSC and WDFW (2005) suggested that recovery actions could have a large effect on the capacity for life history stages that use pocket estuaries and tidal delta areas with anticipated increases in capacity by 214 percent (70,000 to 220,000 fish) and 60 percent (2.25 million to 3.6 million fish), respectively. More modest increases in capacity were anticipated for yearling freshwater rearing habitat and parr migrant habitat with a 31 percent increase in each (107,000 to 140,000 yearlings and 1.3 million to 1.7 million parr).

The SRSC and WDFW (2005) conclusions are generally supported by the results from modeling conducted by Greene and Beechie (2004) and Greene et al. (2005). Greene and Beechie (2004) examined how density dependence at different life stages might affect overall survival. Their work suggested that ocean and nearshore conditions were important in all model scenarios, but the importance of tidal delta conditions was dependent upon how Chinook salmon reacted to density limitations and whether restoration efforts improved the quality or quantity of delta habitat. Greene and Beechie (2004) suggested that density dependence can result in increased emigration from a limiting habitat rather than a reduction in survival. Greene and Beechie (2004) included a Skagit-specific model that suggested increases in stream area is more important than delta conditions if density dependent mortality is included in the model. Greene et al. (2005) suggested four environmental factors: flood recurrence interval, tidal delta conditions, bay conditions, and ocean conditions during the first and second years at sea, could be used to explain spawner-recruit relationships for Skagit River Chinook salmon populations. While Greene et al. (2005) and SRSC and WDFW (2005) recognized it is unlikely that high seas survival rates can be controlled, they also suggested that understanding their effect on annual production is important and for making decisions on management actions, such as habitat restoration, that can affect production during other portions of the life cycle.




Source: From Beamer et al. (2005b).

**Figure 5-11. Peak flow impairment levels.**

### 5.1.1.8. Skagit River Chinook Salmon Status – Conclusions

The six Chinook salmon populations in the Skagit River are some of the healthiest Chinook salmon populations in the Puget Sound ESU, but continue to have threats to their viability. WDFW (2002a) downgraded two of the populations from healthy to depressed, upgraded one population from depressed to healthy, and categorized as depressed one population whose status was previously unknown (Table 5-4). WDFW (2002a) does not identify what criteria are used for status calls. Upper Skagit Summer Chinook salmon and Upper Sauk Spring Chinook salmon populations were downgraded although population numbers appear to be trending upwards from 1992 to 2001(Figure 5-8., Figure 5-10). In contrast, the Upper Skagit Summer Chinook salmon populations were categorized as healthy in 1992 while abundance levels were declining over the previous 10 years.

**Table 5-4. Summary of the status of Skagit River Chinook populations.**

| Population | 1992 Status[1] | 2002 Status[1] | Planning Target[2] Productivity | | 2005-2008 Geometric Mean Escapement[3] | 1998-2009 Trend |
|---|---|---|---|---|---|---|
| | | | Low | High | | |
| Lower Skagit Fall | Depressed | Depressed | 16,000 | 3,900 | 2,401 | Slight Decline |
| Upper Skagit Summer | Healthy | Depressed | 26,000 | 5,380 | 11,270 | No Trend |
| Lower Sauk Summer | Depressed | Depressed | 5,600 | 1,400 | 628 | Slight Decline |
| Upper Sauk Spring | Healthy | Depressed | 3,030 | 750 | 597 | Strong Increase |
| Suiattle Spring | Depressed | Healthy | 610 | 160 | 295 | Declining |
| Upper Cascade Spring | Unknown | Depressed | 1,200 | 290 | 349 | Slight Increase |

1. WDFW (2002a).
2. NMFS (2006)
3. SKAGITSASSI2009.xls

Over the more recent 1999 to 2008 period, two of the populations appear to have strong increasing escapement trends, two have slight increasing trends, one population has a declining trend, and one population has no apparent trend (Table 5-4). From a long-term perspective (30 to 40 years), the spring Chinook salmon populations all appear to currently have substantially lower abundance levels than historical levels. Positive viability aspects include relatively high diversity through the demonstration of multiple juvenile life history strategies (fry, delta rearing, parr, and yearling), multiple return ages, and for most of the populations relatively high spatial diversity through the use of tributary streams for spawning in addition to mainstem spawning. Negative aspects include the loss of substantial amounts (around 60%) of delta rearing habitat, which has likely reduced the survival of outmigrants, particularly those using the delta rearing life history strategy. The Skagit River Chinook Recovery Plan (SRSC and WDFW 2005) has identified the loss of Skagit River delta, pocket estuarine, and riverine rearing habitat in the middle and lower Skagit River as major limiting factors. Land use practices and hydromodification have increased the adverse effects of scour over historical conditions while land use practices, particularly historic forest practices, have increased sediment loads in many watersheds. In some stream reaches, such as the lower Sauk River and lower Suiattle River, sediment from anthropogenic sources has occurred in addition to a relatively high base-load of sediment from retreating glaciers.

Some of the variability in Skagit River Chinook salmon escapement numbers may be due to pink salmon, which only return to spawn during odd-numbered years. Most of the Skagit River Chinook salmon populations and Skagit River chum salmon show an obvious pattern of higher escapement levels during even-numbered years over a substantial portion of the available escapement record. Pink salmon escapement levels demonstrate extreme variability. For example, in 1995 and 2001 over 850,000 pink salmon returned to the Skagit River while during

1997 and 2005 less than 100,000 pink salmon returned. Ruggerone and Goetz (2004) and Ruggerone and Nielsen (2005) have examined these patterns and suggested that early marine survival is often reduced during years when pink salmon fry are present because of competition resulting from high abundance, diet overlap, and an earlier time of entry into the ocean by pink fry. Because pink salmon have a 2-year life cycle and Skagit River Chinook salmon return predominately at age 4, a large pink escapement with good egg to fry production may adversely affect Chinook salmon escapement 4 years later.

### 5.1.2. Puget Sound Steelhead

The aquatic action area falls within the Puget Sound Steelhead distinct population segment (DPS) that was listed as threatened on May 11, 2007 (72 FR 26722). The DPS includes all naturally spawned populations of steelhead from streams and rivers flowing into Puget Sound, the Straits of Juan Fuca from the Elwha River eastward and south of the Nooksack River and Dakota Creek, plus 2 hatchery programs. There are two genetically distinct forms of *O. mykiss* (Scott and Gill 2008). Skagit River steelhead belong to the coastal form found west of the Cascade Mountains. Populations have been defined based upon run timing (winter, summer) and geographic location. WDFW (2002a) identifies three winter steelhead stocks in the Skagit River (Mainstem Skagit, Sauk, Cascade) and three summer steelhead stocks (Finney Creek, Sauk, Cascade). There is virtually no information on Finney Creek summer steelhead population (WDFW and WWTIT 1994; WDFW 2002a). The Puget Sound Steelhead Biological Review Team (BRT) reported on 22 steelhead populations in the Puget Sound ESU (NMFS 2005); with most of these based upon the SASSI designations (WDFW 2002a). The Skagit River included three steelhead populations: Skagit River Winter Steelhead, Sauk River Summer Steelhead, and Cascade River Summer Steelhead. NMFS is currently identifying the demographically independent steelhead populations in the Skagit and preliminary conclusions suggest there are likely no summer steelhead populations in the Skagit River (Connor 2010b, pers. comm.). Summer steelhead appear to be present in numbers in the Skagit which are far lower than those required to define an independent population. Many of the steelhead that are have are thought to be summer steelhead are actually winter steelhead exhibiting a relatively late spawning periodicity. Critical habitat for the Puget Sound DPS has not been defined. For the purposes of this BE, the following descriptions use the groupings from NMFS (2005).

#### 5.1.2.1. Skagit River Winter Steelhead

The Skagit River Winter Steelhead population spawns in the mainstem between RM 22.5 and 94.1 plus the tributaries of Nookachamps, Alder, Diobsud, Grandy, Pressentin, Finney, Jackman. Rocky, O’Toole, Cumberland, Day, Sorenson, Hansen, Illabot, Bacon, Goodall, and Jones creeks. Unmarked wild steelhead are captured in the Baker River trap and returned to the Skagit River near Hamilton following the collection of scale samples (PSE 2009). The WDFW (2002a) report winter steelhead also spawn in the Sauk River and Cascade River, but the spawning areas are continuous from the mainstem Skagit River. In the Sauk River spawning occurs from its confluence with the Skagit River to RM 41, portions of the South Fork Sauk River, the Suiattle River, the White Chuck River, and a number of tributaries such as White Creek, Dan Creek, Murphy Creek, and Falls Creek. The spawning distribution in the Cascade River is unknown.

Skagit River Winter Steelhead enter the river beginning in November (NMFS 2005). Spawning occurs from March through June with peak spawning occurring during May. Fry emergence peaks in early August (WDFW 2004). About 82 percent of winter steelhead in the river undergo smoltification and outmigration at age 2 and about 18 percent outmigrate at age 3 (NMFS 2005). Outmigration occurs primarily from late April through early June (WDFW 2004). A few winter steelhead outmigrate at age 1 or age 4, but each account for less than 1 percent of the outmigrants.

Most (about 57%) Skagit River Winter Steelhead spend one winter in the ocean before returning to the river the following winter to spawn (Scott and Gill 2008). A substantial proportion (about 42%) also return after two winters in the ocean, with the remainder (about 1%) returning after three winters. In combination with the age at outmigration, the highest proportion (about 44%) of returning adult winter steelhead are age 4 (primarily 2.2[3]), followed by about 26 percent age 5 (primarily 2.3). Most Skagit River winter steelhead die after spawning. However, a small, but significant number of steelhead return to the ocean as kelts and may be repeat spawners. Scott and Gill (2008) reported that up to 14 percent of the Skagit River winter steelhead run may be repeat spawners with an average of 6 percent.

General habitat use during freshwater rearing by steelhead is described in Scott and Gill (2008). Steelhead may use a variety of habitat types, but often use higher velocity water and migrate farther into headwaters than other salmon, which is why steelhead are more widely distributed in the higher gradient tributaries within the Skagit Basin than Chinook, coho, pink, or chum salmon. As steelhead juveniles grow, they tend to move away from stream edges and towards faster moving water and may move downstream to larger streams if crowding occurs. During winter, many steelhead juveniles will move back into smaller tributaries to avoid high flows and utilize structures such as boulders, LWD jams, root-wads, and undercut banks as cover.

The Skagit River steelhead smolt outmigration occurs during the spring with peak densities typically occurring in late April and early May (Kinsel et al. 2008). Tracking of acoustic-tagged Skagit River steelhead juveniles indicate they spend relatively little time in the Skagit River delta (Connor et al. 2009). Wild steelhead migrate through the lower river and estuary over a few hours to less than a week while hatchery smolts remain in the river about 2-3 weeks. After leaving the river most smolts head north through Deception Pass and then out the Strait of Juan de Fuca. However, some smolts will travel a longer route south around Whidbey and through Possession Sound and Admiralty Inlet. The total travel time to the Pacific Ocean is two to three weeks. Sampling in a number of pocket estuaries by the Skagit River System Cooperative (e.g., Beamer 2007; Beamer et al. 2006; Beamer et al. 2009) have captured few steelhead, which generally supports the tracking study conclusion that juvenile steelhead move rapidly from the Skagit River to the Pacific Ocean.

There is very little information on Skagit River steelhead egg to fry or fry to smolt survival rates in the Skagit River. Similar to Chinook salmon described above, it is generally understood that river flows and fine sediment are important factors that may adversely affect these life stages (Bjornn and Reiser 1991). However, the magnitude or frequency of adverse effects of peak flows and scour on steelhead is likely to be less than for Chinook salmon because of the location and timing of spawning and incubation. Considering both fall- and spring-run fish, spawning

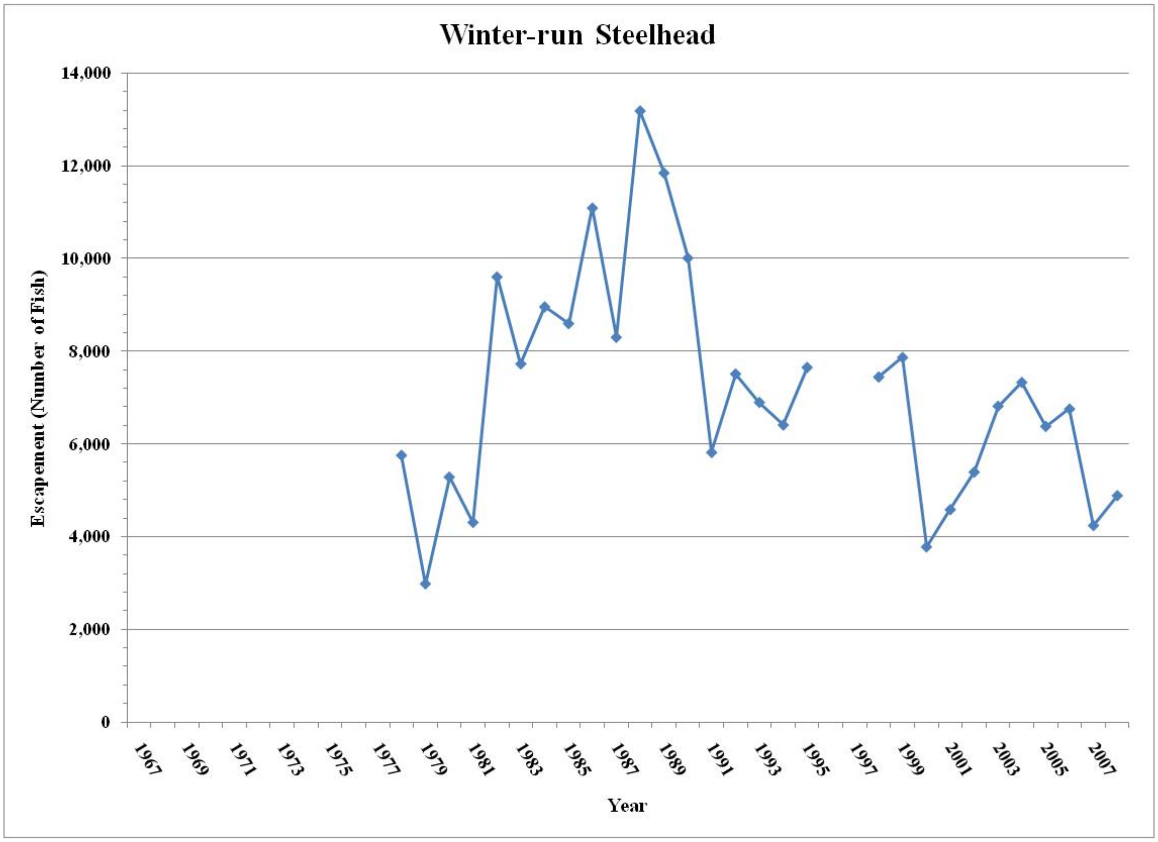
[3] Ages follow the NMFS BRT practice (NMFS 2005) denoting freshwater age at outmigration followed by a ".", then the ocean age at first spawning.

and incubation of Chinook salmon eggs occurs during mid-July through January (WDF and WWTIT 1994; SRSC and WDFW 2005) and during the latter part of this period floods from rain-on-snow events can be severe. In contrast, steelhead eggs incubation occurs during the spring and early summer when flows are primarily from annual winter snow pack melt. For the 67 Water Years from 1942 to 2008[4], annual peak flow events occurred 12 times (18%) between April and August during the steelhead incubation period while 47 (70%) occurred during the Chinook salmon incubation period (Oct 22 to February 15 according to Kinsel et al. 2008). Furthermore, the median peak flow events that occurred during the steelhead incubation period were 43,600 cfs (maximum 92,300 cfs), while the median during the Chinook salmon incubation period was 71,600 cfs (maximum 152,000 cfs). Consequently, incubating Chinook salmon eggs and alevins are more likely to be severely affected from peak flows than steelhead. On the other hand, steelhead juveniles typically have a longer freshwater residence period than Chinook salmon juveniles, especially those that outmigrate as sub-yearlings, and thus may have a higher risk of being affected by natural and human-caused disturbances in the freshwater system.

On a relative basis, the Skagit River supports one of the strongest runs of winter steelhead in the Puget Sound ESU. Most Puget Sound steelhead populations, including the Skagit River, have had severe declines in recent years (NMFS 2005). The 2004 to 2005 geometric mean escapement was 5,798 fish with a range of 4,242 to 7,332 fish (Figure 5-12). Although relatively strong compared to other Puget Sound populations, the recent escapement levels are substantially lower than occurred in the 1980s and continue to show a downward trend. NMFS (2005) estimated a growth rate of 0.997 for Skagit River winter steelhead return years 1995-2004, while Scott and Gill (2008) estimated growth at 1.01 (return years analyzed were not reported). Growth rates of less than one indicate a decline in population growth. The mean number of recruits per spawner between 1995 and 2004 was 1.46, but the trend in recruits per spawner had a significant negative slope because the number of recruits per spawner was less than one for many of the years (NMFS 2005). Scott and Gill (2008) consider the relative risk of extinction for Skagit winter steelhead as low. The relatively high abundance of Skagit River winter steelhead is likely an important factor contributing to this conclusion.

Diversity in the Skagit River winter steelhead population is expressed primarily through their age of return and relatively high spatial diversity due to spawning in a number of tributaries. While the current spawning distribution appears to still be fairly broad, habitat conditions in many tributary streams have declined compared to historical conditions because of land use practices. Nevertheless, compared to other Puget Sound watersheds, the Skagit River basin generally has a higher level of habitat diversity (WDFW 2008). Because the population includes a mix of ages when smoltification occurs, a mix of ages when maturation occurs, a modest level of repeat spawners, and a broad number of spawning tributaries, the population expresses a relatively diverse life history that helps it to persist in the event of relatively low survival in any particular location/period over the life cycle.

[4] USGS Gage 12200500 Skagit River near Mount Vernon, WA.




Source: SKAGITSASSI2009.xls.

**Figure 5-12. Winter-run steelhead escapement 1978 to 2008.**

### 5.1.2.2. Sauk River Summer Steelhead

The Sauk River summer steelhead population spawn primarily in the South Fork Sauk River with some spawning in the North Fork Sauk River and possibly in the mainstem near their confluence (WDFW 2002a). Sauk River Summer Steelhead enter the river from July through mid-October (WDFW and WWTIT 1994). Spawning occurs from mid-April through early June (WDFW 2002a). Fry emergence peaks in early August (WDFW 2004). Outmigration is likely similar to the mainstem Skagit winter population which occurs primarily from early April through early June (Kinsel et al. 2008).

No information is available for the Sauk River Summer Steelhead population on age of outmigration, age of maturation, percent repeat spawners, escapement levels, or returns per spawner. Harvest management of Skagit River steelhead is targeted for winter-run fish because there is no summer steelhead hatchery program and no allowable harvest of wild summer steelhead. The viability of this population is unknown. Many of the steelhead that were classified as summer run fish by WDFW (2002a) may actually be late spawning winter run fish. Summer steelhead are likely present in the Sauk River, but in very low numbers (less than 20 per year; Barkdull 2010, pers. comm.). These numbers are far under the threshold used by Puget

Sound TRT for designating demographically independent populations (Connor 2010b, pers. comm.).

#### 5.1.2.3. Cascade River Summer Steelhead

The location of spawning by the Cascade River summer steelhead population is not known, but likely in the upper reaches and north and south forks. (WDFW 2002a). Cascade River summer steelhead enter the river from June through mid-October (WDFW and WWTIT 1994). Spawning occurs from mid-January through early May (WDFW 2002a). Fry emergence peaks in early August (WDFW 2004). Outmigration timing is likely similar to the mainstem Skagit winter population which occurs primarily from early April through early June (Kinsel et al. 2008).

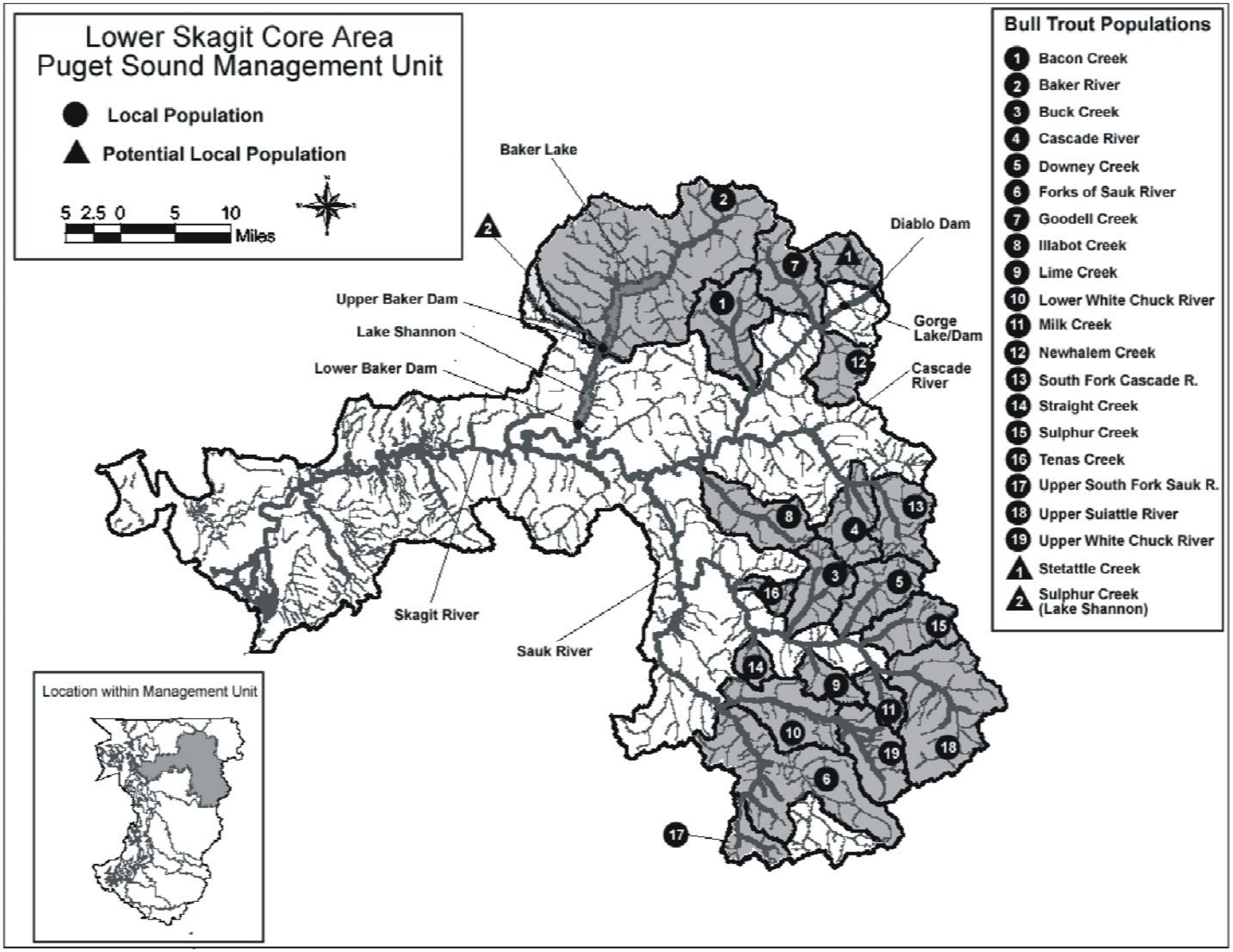
No information is available for the Cascade River summer steelhead population on age of outmigration, age of maturation, percent repeat spawners, escapement levels, or returns per spawner. Harvest management of Skagit River steelhead is targeted for winter-run fish because there is no summer steelhead hatchery program and no allowable harvest of wild summer steelhead. The viability of this population is unknown. The population status of the Cedar River summer steelhead population is currently being evaluated by the NOAA Puget Sound Steelhead Technical Recovery Team. Summer steelhead are likely present in the Cascade River, but in very low numbers (less than 20 per year) (Barkdull 2010, pers. comm.). These numbers are far under the threshold used by the Puget Sound TRT for designating demographically independent populations (Connor 2010b, pers. comm.).

### 5.1.3. Bull Trout

The Skagit River system is part of the Puget Sound Management Unit of the Coastal-Puget Sound DPS of bull trout (USFWS 2004). The Coastal-Puget Sound DPS is unique because it is the only DPS that includes anadromous bull trout and overlaps with the distribution of Dolly Varden trout (*S. malma*). The Coastal-Puget Sound DPS is listed as threatened by the USFWS (64 FR 58910). The Puget Sound MU includes eight core areas and 57 local populations. The Skagit River system accounts for two of the core areas (Lower Skagit and Upper Skagit) and 27 of the local populations. USFWS (2004) has tentatively identified one additional potential local population in the Upper Skagit Core Area and two in the Lower Skagit Core Area. The two core areas are attributable to historic migration barriers in the Gorge and Diablo areas of the river and delineated by Diablo Dam. The Skagit River system is considered to have some of the healthiest bull trout populations and is one of the few river systems in the western United States where harvest (of fish 20 inches or greater in length with a 2 fish daily limit) is allowed.

#### 5.1.3.1. Lower Skagit Core Area

The Lower Skagit Core Area includes the mainstem Skagit River and all tributaries downstream of Diablo Dam, which also includes Gorge Lake and those drainages upstream of Shannon and Baker dams. Bull trout in the Lower Skagit Core Area exhibit resident, anadromous, fluvial, and adfluvial life history patterns (Ross, Baker, and Gorge reservoirs) and therefore may be found widely throughout the area. The Lower Skagit Core Area includes 19 local populations and two potential populations based primarily upon their spawning distribution (Figure 5-13) (USFWS 2004). The USFWS (2008) considers the Lower Skagit Core Area to be one of four core areas




Source: USFWS (2004).

**Figure 5-13. Local bull trout populations in the Lower Skagit Core Area.**

(includes Upper Skagit Core Area, Middle Fork Salmon River, and Lake Koocanusa) at low risk of extirpation out of 121 core areas in the United States.

A genetics study recently compared samples collected from juveniles captured in the Upper Baker River, Sulphur Creek (tributary to Lake Shannon), the Lower Baker downstream passage facility (Lower Baker Gulper), Illabot Creek, and Sauk River, and adult bull trout captured in the Baker River trap downstream of Lower Baker Dam (Small et al. 2009). Comparisons were also made to baseline collections previously made from Illabot Creek, Sauk River, and Upper Baker. The objective of the study was to evaluate the origin of bull trout captured at upstream and downstream passage facilities for the Baker Project and characterize juvenile bull trout sampled in the Baker River Basin. The results indicated that Sulphur Creek and Upper Baker River bull trout were distinct populations. Capture of Upper Baker River bull trout in both of the downstream passage facilities at Upper and Lower Baker Dams suggested some Baker River bull trout continue to express a migratory life history pattern. Capture of fish with a Sauk River ancestry in the downstream traps at Upper Baker Dam and adults in the Baker River trap, suggested that past transport of Sauk River bull trout into Baker Lake has resulted in the introgression of Sauk River genes into the Upper Baker River population.

A genetics study has also been completed for bull trout in the upper Skagit River with samples collected from Bacon Creek, Illabot Creek, Goodell Creek, Cascade River, Ross Lake, and Lightening Creek. The results suggest that bull trout in the upper Skagit river drainage above the gorge section of the Skagit (i.e., Gorge reservoir and above) are genetically distinct from bull trout in the lower Skagit River. Bull trout populations in the upper Skagit are relatively similar to one another, and form a major grouping that suggest long term geographical isolation from lower Skagit bull trout populations downstream of Gorge Dam (Smith and Naish 2010). One important implication from Smith and Naish (2010) is that the Stetattle Creek local population that drains to Gorge Reservoir should be included as part of the Upper Skagit Core Area rather than the Lower Skagit Core Area. This study has also found that Dolly Varden trout are more widespread than formerly assumed, and are likely present in the majority of tributaries to Gorge, Diablo, and Ross reservoirs. Dolly Varden trout have been were found to be the dominant species in Stetattle Creek (Gorge Lake), and in Lighting Creek (Ross Lake). The upper Skagit likely supports the only sympatric populations of bull trout and Dolly Varden trout in the United States.

Movement of mature fluvial bull trout towards staging and spawning areas occurs in July and August (peak in mid-July) while anadromous fish migrate through the lower river during June and July (Connor et al. 2009). Bull trout spawning occurs in mid-September through mid- to late November as water temperatures decline to below 8°C, with peak spawning occurring in October (Downen 2006a). The specific duration of incubation and emergence timing for bull trout in the lower Skagit River has not been determined. Bull trout generally have a relatively long incubation period such that the time to fry emergence may take more than 200 days and occurs from early April through May (USFWS 2004).

After spawning, bull trout in the lower Skagit River Core Area disperse downstream to overwintering and foraging areas during October through November (Connor et al. 2009). Overwintering and foraging habitat for fluvial populations predominately includes larger pools and deep runs in the upper reaches of the mainstem Skagit River, but may also include the Sauk River (USFWS 2004). Post spawning anadromous bull trout outmigrate to the estuary during February through April with peak movements in mid-March (Connor et al. 2009). Goetz et al. (2004) reports that some bull trout may switch between fluvial and anadromous behavior patterns in alternate years.

Describing length at age for bull trout is difficult because of large differences among the different life history strategies. Resident bull trout are the smallest of the life history strategies and most non-migratory bull trout are seldom larger than 300 mm in length (Goetz et al. 2004) with maturation usually occurring in fish 200 to 250 mm in length (Kraemer 2003). In contrast, migratory (fluvial and anadromous) bull trout may grow larger than 600 mm in length with fish using an anadromous life history strategy typically reaching the largest size (Table 5-5) (Kraemer 2003). Migratory bull trout mature at age 4 and around 450 mm (Goetz et al. 2004; Kraemer 2003). Kraemer (2003) reported that all fish in his sample spawned every year once reaching maturity and this pattern is unusual because individuals tend to spawn every other year in most other populations.

**Table 5-5. Average (range) length (mm) at age back calculated from scales from anadromous and fluvial bull trout collected from the mainstem Skagit River and SF Sauk River.**

| | Fluvial | | Anadromous | |
|---|---|---|---|---|
| **Age** | **Mean Length (Range)** | **Sample Size** | **Mean Length (Range)** | **Sample Size** |
| **1** | 65.3 (28 – 120) | 81 | 63.7 (27 – 106) | 118 |
| **2** | 133.3 (63 – 208) | 83 | 146.2 (242 – 120) | 120 |
| **3** | 240.3 (145 – 332) | 77 | 299.0 (142 – 436) | 120 |
| **4** | 356.7 (225 – 513) | 64 | 426.8 (229 – 532) | 89 |
| **5** | 428.6 (320 – 619) | 31 | 505.4 (333 – 620) | 55 |
| **6** | 479.7 (331 – 651) | 13 | 555.0 (391 – 647) | 32 |
| **7** | 550.8 (458 – 684) | 6 | 582.3 (456 – 659) | 15 |
| **8** | 525.0 (497 – 553) | 2 | 571.2 (507 – 622) | 5 |
| **9** | | 0 | 628.3 (585 – 719) | 3 |

Data source: Kraemer (2003).

In the upper Skagit River young bull trout may rear in tributary streams until age 4 and become predominately piscivorous after age 2 (Lowery 2009a). After age 4, larger fluvial bull trout move into the mainstem Skagit River (Lowery 2009a). However, Goetz et al. (2004) reports age 2 and 3 year old bull trout with a mean size of 144 mm (range 91-198 mm) is typical for the first migration from the Skagit River to an estuarine environment. While the overall timing for migration into the estuary is very broad, from mid-February to early September, most outmigration occurs during May and June (Goetz et al. 2004). Anadromous bull trout typically use marine and tidally influenced freshwater habitats during the spring and summer, but then return to riverine habitats for overwintering and spawning (Goetz et al. 2004). Approximately 20 percent of tagged fish in marine and tidally influenced freshwater habitats showed site fidelity from year to year and 40 to 70 percent demonstrated within season site fidelity (Goetz et al. 2004).

A diet study that included fluvial bull trout captured from the Bacon Creek, Illabot Creek, and the mainstem Skagit River from Gorge Powerhouse to the confluence with the Sauk River demonstrated that bull trout have a diverse and opportunistic diet that included substantial seasonal changes in their foraging on aquatic insects, salmon eggs, resident fish, salmon parr, and salmon carcasses (Lowery 2009a; Lowery 2009b). Bioenergetics modeling completed by Lowery (2009a) suggested that bull trout foraging may be having an adverse effect on steelhead return abundance in the Skagit River above the Sauk River. Additional discussion of this interaction is provided in Section 6.1.2.2.6. Within nearshore waters anadromous bull trout predominately eat surf smelt followed by Pacific sand lance, unidentified fish, and Pacific herring (Goetz et al. 2004). Age 1 and 2 anadromous bull trout eat significant amounts of shrimp and become almost exclusively fish eaters by age 4 (Goetz et al. 2004).

The USFWS (2004) considered the Lower Skagit River Core Area to be at an overall diminished risk of adverse effects from stochastic events because there are numerous (19) well-distributed local populations. However, the USFWS have further downgraded the overall risk of extirpation in this core area to low (USFWS 2008). USFWS (2004) expressed concern about Gorge Lake, which has only one potential population (Deer Creek) and is isolated by Gorge and Diablo Dams and suggested the establishment of additional local populations, if possible in tributaries such as Stetattle Creek, would reduce the adverse risks of having restricted connectivity with upstream and downstream local populations. Field surveys conducted by SCL and UW in 2008 confirmed that bull trout are spawning and rearing in Stetattle Creek, suggesting this is a local population (Connor 2010b, pers. comm.). Recent survey information indicates both bull trout and Dolly Varden trout spawn in Stetattle Creek, and co-exist within Gorge Reservoir (Smith and Naish 2010).

Lowery (2009a) conducted winter snorkeling in the mainstem reach between Newhalem and Rockport during 2008 and estimated a population size of 1,602 bull trout greater than 300 mm (age 4+) and 179,265 bull trout less than 300 mm (age 1-3). There appears to be a general consensus that bull trout populations in the lower Skagit River are generally healthy and abundance is at least on the order of thousands of fish (USFWS 2004). In the early 2000s the Lower Skagit Core Area spawning population may have been on the order of tens of thousands of individuals (Kraemer 2008, pers. comm.). One population of concern is the Baker River population above Upper Baker Dam, which have shown declines in the anadromous life history strategy. A trap and haul facility is present below Lower Baker Dam and downstream entrainment reduction measures are being implemented.

WDFW has conducted spawning surveys for bull trout for use as an index of bull trout abundance. From 1988 to 1996, redd surveys were performed on a 3.5 mile (5.6 km) reach in the upper South Fork Sauk River. During this period the number of redds observed ranged from 4 to 56 and averaged 34 (6.1 per kilometer) (WDFW 1998). Beginning 2001, WDFW restarted the redd survey program and expanded surveys to include Bacon Creek. In 2002 SCL funded further expansion of surveys and WDFW recently conducted snorkel and redd surveys with the purpose of identifying areas suitable as index reaches in the following streams:

- Bacon Creek (up to 4 reaches totaling 13.6 km)
- Downey Creek (3 reaches - 10.1 km)
- Goodell Creek (3 reaches - 8.2 km)
- Illabot Creek (5 reaches - 6.9 km)
- Sauk River (up to 6 reaches - 20.3 km)

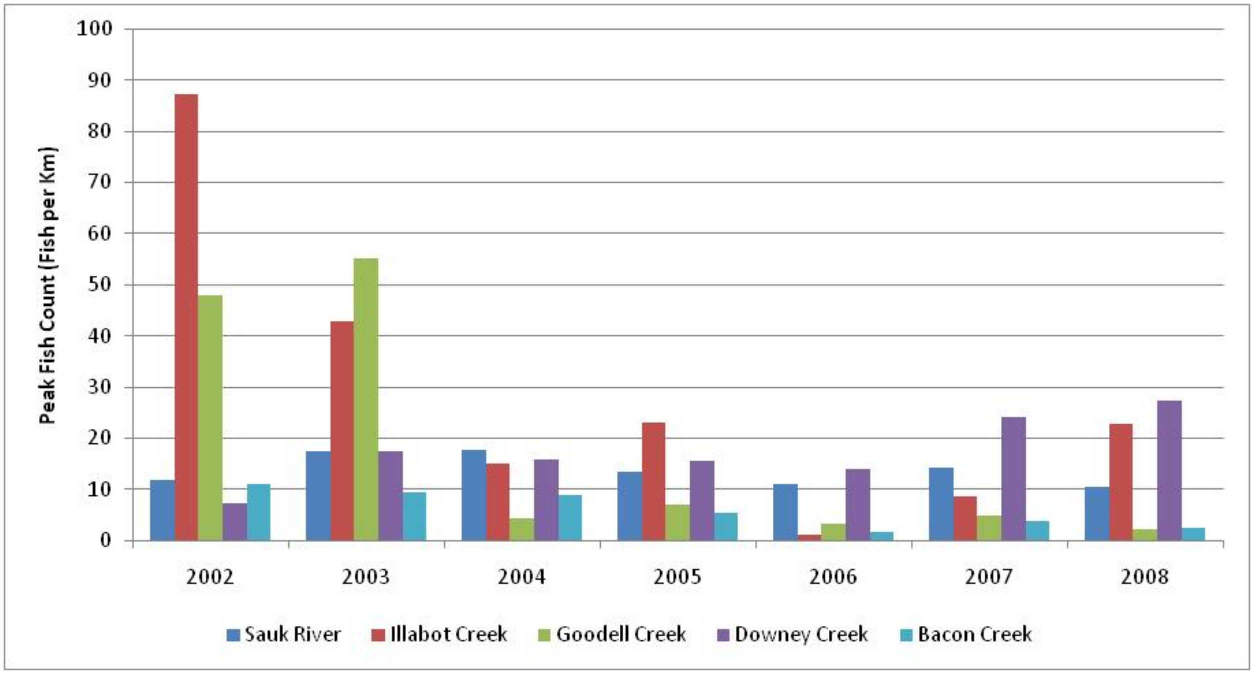
Exploratory snorkel and spawning surveys by WDFW have also documented redds or mature adults in Buck Creek, Cascade River, Kindy Creek, Marble Creek, Lime Creek, Sulphur Creek, Fire Creek, and Pumice Creek. The surveys have confirmed that bull trout spawning in the Lower Skagit Core Area is wide spread. The surveys also suggest that spawning populations have declined in several streams over the period 2002 to 2008. Illabot Creek and Goodell Creek had relatively high numbers of adult fish counted prior to spawning during 2002 and 2004 with an average of 48.4 and 35.9 fish per kilometer, respectively, but densities declined to an average of 10.9 and 3.5 fish per kilometer, respectively, during the period 2006 to 2008 (Figure 5-14). Similarly, the average cumulative redd density for the Sauk River and Illabot Creek were 38.1 and 46.2 redds per kilometer, respectively, during the first three years of the surveys, but 6.5 and 11.3 redds per kilometer over the last three years. Only one of the streams, Goodell Creek, shows an increase in average fish per kilometer (13.5 to 21.8) in the latter three years compared to the first three years and only one stream, Downey Creek, shows an increase in average redds per kilometer (3.4 to 18.5), while all other streams show declines. Downen (2006a) suggested the October 2003 flood and a landslide in Goodell Creek may have adversely affected the populations, low flows and warm temperatures were likely a factor for low numbers in 2005, and poaching at a low flow passage barrier may be affecting the Downey Creek population. Bull trout spawning runs in the Sauk River, Illabot Creek, and Downey Creek all appear to be trending upwards since the relatively low spawning runs in 2006, but are substantially lower than runs observed in the early 2000s.

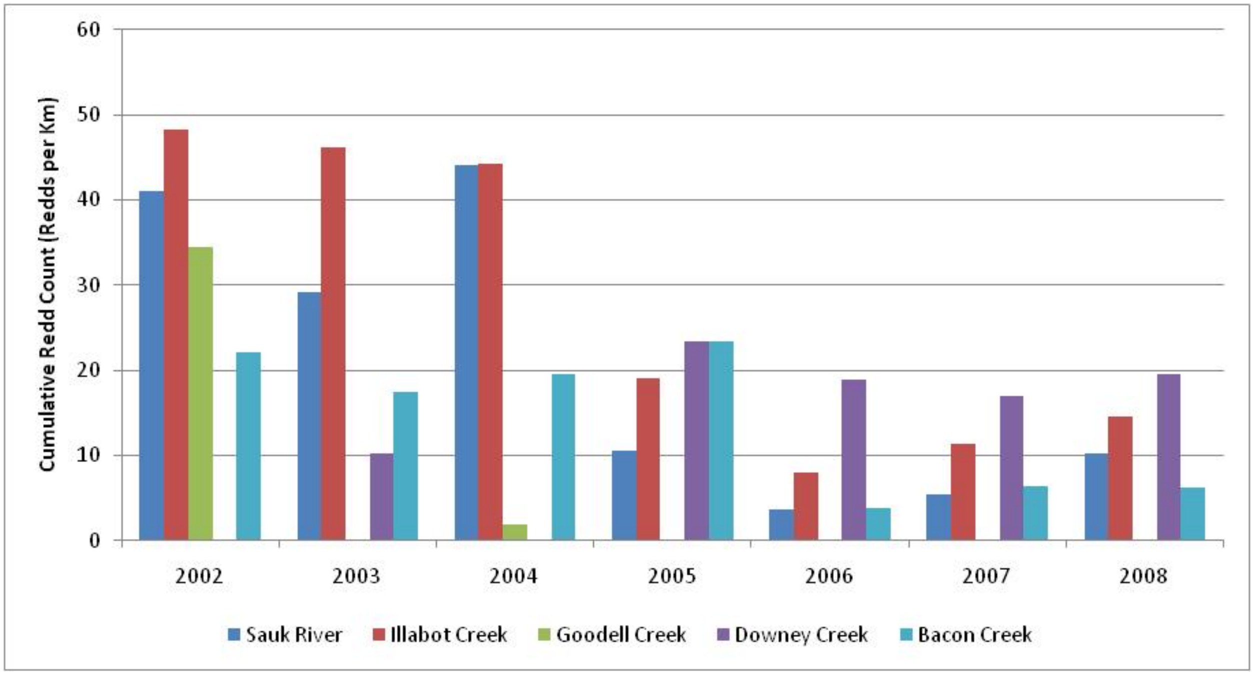
Capture of bull trout sub-adults by scoop and screw traps located in Mount Vernon have also provided an index for the anadromous component of the Lower Skagit Core Area. Capture efficiency for bull trout is not estimated as part of the trapping program, but is likely much lower than other species captured at the trap because bull trout outmigrants are generally larger and more effective at evading capture. The mean number of age 1 and older native char captured in the traps from 1990 to 2007 is 198.2 fish with a range of 31 fish to 452 fish (Figure 5-15).

Brook trout do not appear to be a severe problem in the Lower Skagit River Core Area. However, brook trout are present in Ross Lake (USFWS 2004) and Gorge Lake (Downen 2006b) and presumably are occasionally entrained into the lower Skagit River. USFWS (2004) identified brook trout as a significant concern in the Puget Sound Management Unit and suggested monitoring of brook trout should be implemented to evaluate their abundance and level of risk to bull trout.

#### 5.1.3.2. Upper Skagit Core Area

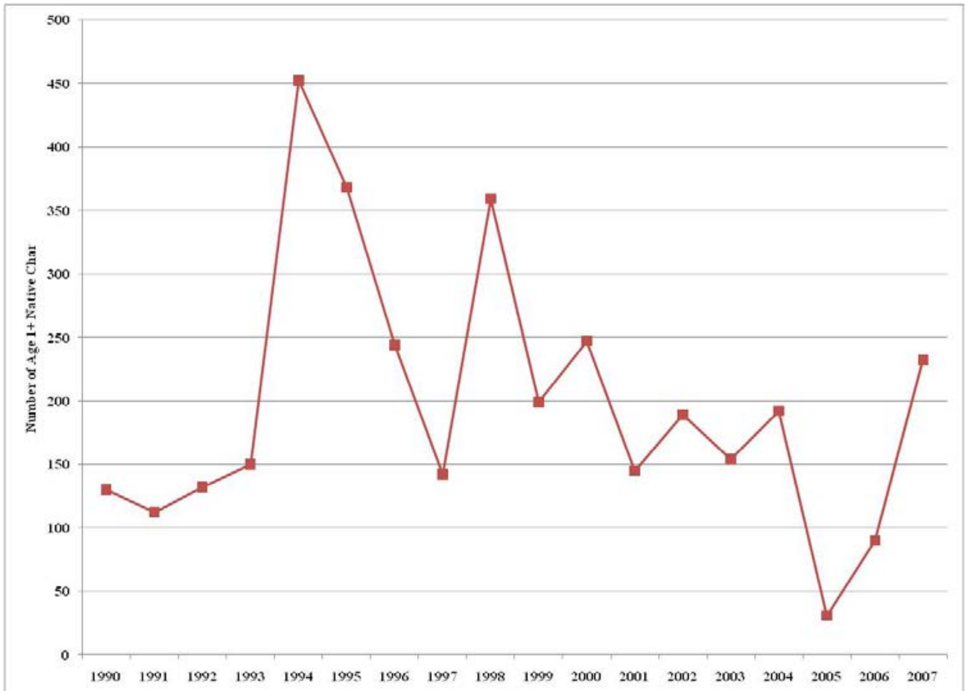
The Upper Skagit Core Area includes the Skagit River and tributaries upstream of Diablo Dam, including the portions of the Skagit River drainage in British Columbia (Figure 5-16.) (USFWS 2004). Most of the area is within the North Cascades National Park (U.S.), Pasayten Wilderness




Data Source: Downen (2009), Downen (2008), Downen (2006a).

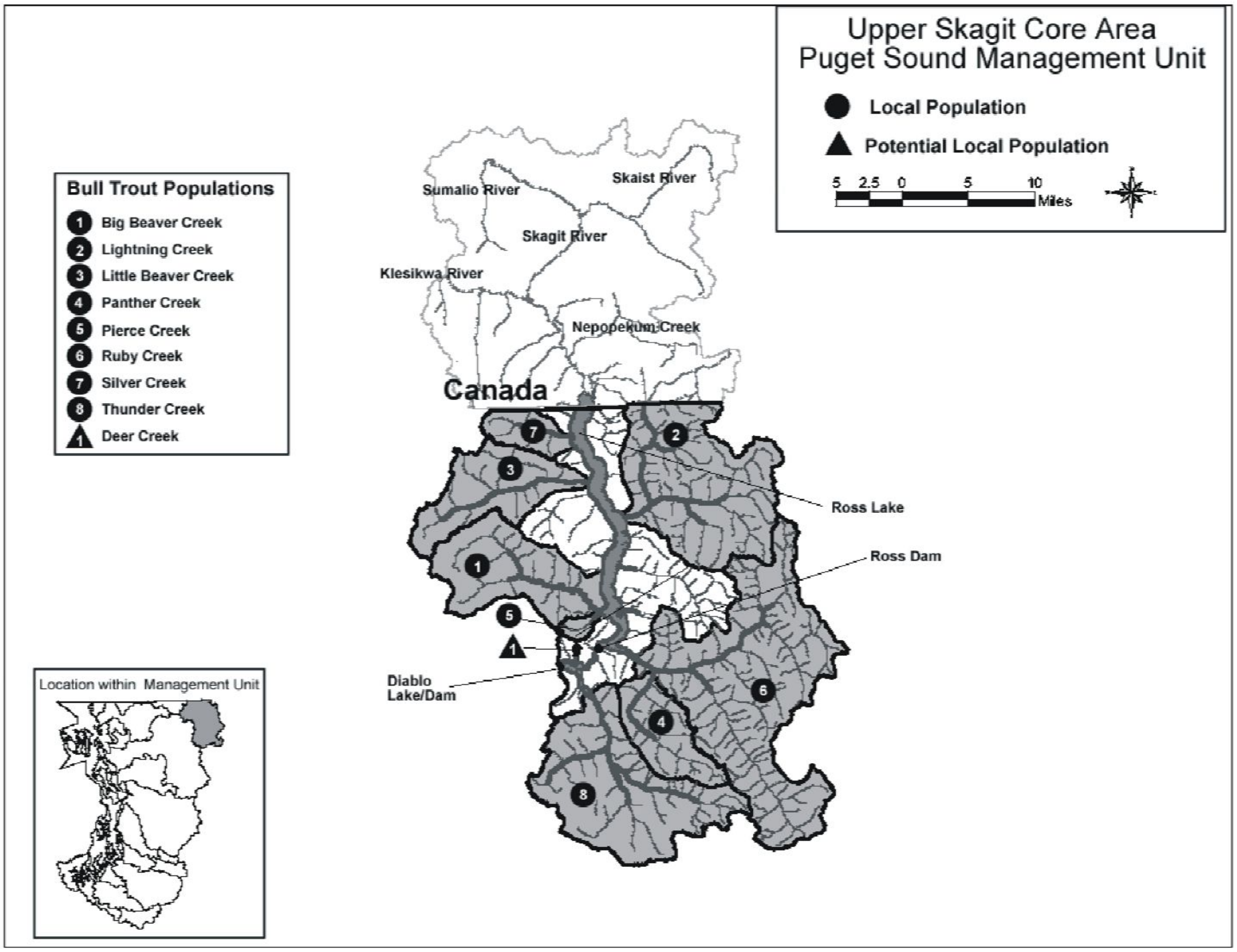
**Figure 5-14. Peak bull trout adult count density (top) and cumulative redd count density (bottom) in five streams. Redd surveys were not conducted in Goodell Creek during 2003 and 2005 to 2008.**




Source: Kinsel et al. (2008).

**Figure 5-15. Catch of age 1 and older native char at the traps located in Mount Vernon 1990 to 2007.**

(U.S.), or Skagit Valley Provincial Park (BC) and consequently protected from most land use activities. Genetic analysis indicates Dolly Varden trout are also present in this core area, but generally upstream of areas used by bull trout (Spruell and Maxwell 2002). McPhail and Taylor (1995) found that of the 101 char sampled in the Skagit River Basin in British Columbia upstream of Ross Lake, about 20 percent were pure Dolly Varden trout, 8 percent were pure bull trout, about 12 percent) were $F_1$ (i.e., first generation) bull trout/Dolly Varden trout hybrids, and about 59 percent were Dolly Varden trout with a maternal bull trout marker present in their genome, which indicated interbreeding between bull trout females and Dolly Varden trout males in the past. McPhail (as cited in USFWS 2004) suggested the creation of Ross lake allowed previously separated bull trout and Dolly Varden trout populations to mix. In contrast to these findings, a recent baseline genetic study of the Skagit River conducted by the University of Washington indicates that bull trout and Dolly Varden trout co-exist in the Ross, Diablo, and Gorge reservoirs (Smith and Naish 2010).` Dolly Varden trout in Diablo Reservoir likely spawn in Thunder Creek (Glense 2007, pers. comm.). These finding suggest that the Upper Skagit is the only core area where these two native char species are known to co-exist in the United States. Within the United States portion of this core area, adfluvial and resident life history patterns predominate, although some fluvial fish may be present in Ruby Creek, which is the largest tributary draining into Ross Lake (excluding the Skagit River). The resident and fluvial life history patterns are also demonstrated by bull trout in the British Columbia portion of the core area.




Source: USFWS (2004).

**Figure 5-16. Local bull trout populations in the Upper Skagit Core Area.**

**Table 5-6. Number of bull trout observed and number of surveys conducted in tributaries to Ross Lake 2000 to 2006.**

| Stream Name | Number of Bull Trout Observed (Number of Surveys) | | | | | |
|---|---|---|---|---|---|---|
| | **2000** | **2001** | **2002** | **2003** | **2004** | **2006** |
| Big Beaver Creek | 13 (3) | 17 (7) | 36 (7) | 1 (1) | 8 (3) | 25 (5) |
| Devils Creek | 3 (3) | 0 (2) | 0 (1) | N/A (0) | N/A (0) | N/A (0) |
| Lightning Creek | 4 (3) | 14 (7) | 1 (2) | N/A (0) | 2 (1) | 0 (1) |
| Little Beaver Creek | 2 (3) | 1 (3) | N/A (0) | N/A (0) | N/A (0) | N/A (0) |
| Ruby Creek | 13 (4) | 14 (7) | 6 (3) | N/A (0) | 3 (1) | 1 (3) |

Data source: R2 Resource Consultants (2009).

Excluding drainages entirely with British Columbia, the Upper Skagit Core Area includes eight local populations (Ruby Creek, Panther Creek, Lightning Creek, Big Beaver Creek, Little Beaver Creek, Silver Creek, Pierce Creek and Thunder Creek) and one potential population (Deer Creek). Historically, passage barriers located at the steep valley walls adjacent to the Skagit River prevented use of tributary streams, such as Big Beaver Creek, by fluvial bull trout (USFWS 2004). Construction of Ross Dam and creation of Ross lake inundated some of these barriers and made the tributaries accessible for use by adfluvial bull trout.

Ruby Creek is the largest tributary entering Ross Reservoir, with the exception of the upper Skagit River. Ruby Creek is over 23 miles long and enters Ross Reservoir from the left bank at RM 106.2, upstream of the dam (Williams et al. 1975). The lower five miles of Ruby Creek were surveyed in late October and early November 1997, and no redds were observed. One female bull trout, 18 inches long, was observed in a large pool about 0.7 miles upstream of the mouth of Ruby Creek during snorkel surveys in fall 1997, when the water temperature was 5°C. During subsequent surveys on December 3, 1997, one male and one female bull trout (16 and 18 inches long, respectively) were observed in a pool near the mouth of Ruby Creek. Six large bull trout were observed in Ruby Creek on October 9, 1998 during snorkel surveys. Four of these fish were holding in pools located just above the Ross Reservoir inundation zone, while two fish were in pools located in the lower 0.3 miles of Ruby Creek. Two fish appeared to be in post-spawning condition, while the remaining four did not appear to have spawned yet. All bull trout were between 17 and 23 inches long. No bull trout were observed in the reservoir downstream of the thermal mixing zone (Connor 1999, pers. comm.). Surveys conducted in the lower reaches of Ruby Creek primarily from late August through October in years 2000 to 2004 and 2006 resulted in observations of up to 14 bull trout per year (R2 Resource Consultants 2009) (Table 5-6). During a snorkel survey conducted by R2 in 2009, approximately 100 adult bull trout were found holding at the mouth of Ruby Creek (Connor 2010b, pers. comm.).

Pierce Creek enters Ross Reservoir downstream of Big Beaver Creek at RM 109.5. Juvenile native char were seen about 100 yards upstream of the mouth during a snorkel survey of the lower creek, in October 1998. Two large bull trout were observed in Ross Reservoir about 50 yards downstream of the confluence with Pierce Creek. These fish were holding in thermal refugia isolated at 13°C, when the ambient reservoir temperature was 17°C (Connor 1999, pers. comm.).

Big Beaver Creek (RM 109.6) is the second largest tributary entering Ross Reservoir. Surveys of the lower two miles in 1997 did not find any redds. No bull trout were observed during snorkel surveys on 4 December 1997, and 9 October 1998. High turbidity during the 1998 survey impaired visibility. The lower reach of Big Beaver Creek contains poor habitat for spawning and is dominated by sand and silt, with occasional patches of gravel in riffles at the bends in the stream (Connor 1999, pers. comm.). Surveys conducted in the lower reaches of Big Beaver Creek primarily from late August through October in years 2000 to 2004 and 2006 resulted in observations of up to 36 bull trout per year (R2 Resource Consultants 2009) (Table 5-6).

No native char were observed in Devils Creek (RM 113.7) during snorkel surveys conducted in October 1997 and 1998. Devils Creek contains numerous boulder and bedrock cascades that may make upstream fish passage difficult and preclude extensive use by native char (Connor 1999, pers. comm.). R2 Resource Consultants (2009) observed 3 bull trout (three surveys) in Devils Creek during 2000, but none in 2001 (two surveys) and 2002 (one survey) (Table 5-6).

Lightning Creek provides some of the best habitat conditions of the tributaries entering Ross Reservoir. Snorkel surveys in October 1997 found seven large bull trout 16-18-inches long. Three bull trout were observed within the reservoir just below Lightning Creek, one about 0.2 miles upstream of the mouth, and two in a mid-channel pool at about RM 0.5. Another bull trout was seen below the falls, at about RM 0.6. The sex of these fish was not determined. A survey conducted in December 1997 revealed one female bull trout about 14-inches long in Ross Reservoir, approximately 300 feet downstream from the confluence of Lightning Creek and Ross Reservoir. A snorkel survey in October 1998, found 10 bull trout ranging from about 16 to 22 inches long holding at the mouth of Lightning Creek, just within the inundation zone of Ross Reservoir. Two fish were emaciated and appeared to have recently spawned, and several large, ripe females were seen with this group (Connor 1999, pers. comm.). R2 Resource Consultants (2009) conducted from one to seven surveys during the years 2000 to 2002, 2004, and 2006 and observed up to 14 bull trout (2001) each year (Table 5-6). Recent genetics analysis found that 24 of 32 fish sampled in Lightning Creek were Dolly Varden trout (Smith and Naish 2010). Consequently, there is some concern about the population structure within Lightning Creek and the extent of use by bull trout.

Little Beaver Creek enters Ross Reservoir at RM 130.4 from an extremely steep and narrow canyon, which may be difficult for upstream migrating fish to surmount. Three snorkel surveys were conducted in Little Beaver Creek in October and December 1997, and October 1998. No fish were observed during either survey in 1997, but in 1998 one bull trout was observed in cold water just above the thermal mixing zone between Little Beaver Creek and Ross Reservoir (Connor 1999, pers. comm.). R2 Resource Consultants (2009) observed 2 bull trout (three surveys) in Little Beaver Creek during 2000 and one bull trout in 2001 (three surveys) (Table 5-6).

Snorkel surveys were conducted in Silver Creek, which enters Ross Reservoir at RM 124.8, during October 1997 and 1998. No fish were observed during either survey. Hozomeen Creek (RM 126.0) is the northernmost of the creeks surveyed. A snorkel survey was conducted in October 1997 and no fish were observed (Connor 1999, pers. comm.).

Ross Lake pool elevations must be above 1,596 feet for bull trout to access Big Beaver Creek and Lightning Creek (R2 Resource Consultants 2009). As described in Section 2.1.1.1, normal pool elevation during the summer is 1,602 feet. Beginning in early September, after Labor Day, the drawdown begins in order to reach maximum pool elevation requirements on November 15 and December 1. By December 1 pool elevation is required to be at 1,592 feet. Consequently, bull trout access to these creeks can be affected by seasonal weather and the annual drawdown for flood control. During low flow years, such as 2001, these barriers may be exposed for substantial periods, restricting access for spawning (R2 Resource Consultants 2009). In addition to the Canadian Skagit River itself, Lightning Creek and Ruby Creek appear to have the largest adfluvial runs of bull trout in Ross Lake (USFWS 2004).

Spawn timing in the Upper Skagit Core Area is similar to the Lower Skagit Core Area. Bull trout begin to migrate towards spawning areas in late summer (mid- to late September). Pre-spawning adults have been observed to stage at the mouth of spawning tributaries and also move up to and hold in groundwater pools while they ripen. Spawning occurs in late September through late November with peak spawning occurring in October. Radio-tracking of bull trout in Ross Lake suggests that activity related to spawning migrations occurs at night (R2 Resource Consultants 2009). Radio-tracking of Skagit River bull trout has also suggested that fish commonly move back and forth across the U.S.-Canada border (Nelson et al. 2004). Ongoing acoustic tracking studies indicate bull trout migrate to foraging areas in Ross Lake including the mouths of Ruby, Lightning, and Big Beaver creeks where juvenile rainbow trout concentrate.

Age analysis of pectoral fin rays collected from 85 char collected in British Columbia indicated 11 percent of sampled fish were older than age 8 (Table 5-7) (Nelson et al. 2004). These char were likely adfluvial bull trout from Ross Reservoir. Weighted mean lengths based upon the midpoint of 20 mm length categories from char captured in the Upper Skagit River above Ross Lake, have a greater average length at age compared to bull trout sampled in the Lower Skagit River (Table 5-5). However, the nominal age at length differences between the Upper and Lower Skagit River samples may be an artifact of different aging methodology rather than true demographic differences. The maximum size of fish sampled (i.e., 719 mm for an anadromous bull trout from the Lower Skagit River, and 700-719 mm from the Upper Skagit River) were similar, but the maximum age of Upper Skagit River char was 11 years compared to 9 from the Lower Skagit River. Aging of bull trout from scales can be biased low for fish older than 5 years because annuli become increasingly difficult to distinguish (Connor 2010a, pers. comm.). Consequently, age at length information for bull trout should be viewed cautiously for older/larger fish.

**Table 5-7. Weighted mean, minimum, and maximum length (mm) at age using midpoints from 20 mm length categories for 85 char captured in the upper Skagit River, B.C.**

| Age | Mean | Min | Max | Sample Size |
|---|---|---|---|---|
| 3 | 360 | 310 | 430 | 6 |
| 4 | 412 | 310 | 510 | 11 |
| 5 | 494 | 350 | 590 | 15 |
| 6 | 555 | 410 | 690 | 17 |
| 7 | 559 | 450 | 690 | 13 |
| 8 | 573 | 430 | 710 | 14 |
| 9 | 600 | 490 | 690 | 4 |
| 10 | 615 | 590 | 630 | 4 |
| 11 | 550 | 550 | 550 | 1 |

Data source: Nelson et al. (2004).

When considered in conjunction with local bull trout populations in the British Columbia portion of the basin, the USFWS (2004) considers the Upper Skagit Core Area to be at a diminished risk of adverse effects from stochastic events. However, the USFWS have further downgraded the overall risk of extirpation in this core area to low (USFWS 2008). USFWS (2004) had concerns about tributaries to Diablo Lake because only one local population is present (Thunder Creek), and it is isolated by Gorge and Diablo Dams such that only recolonization from local populations above Ross Dam could occur if a catastrophe affected the population.

Although the population status of bull trout and Dolly Varden trout in the Upper Skagit Core Area is uncertain because of the lack of long-term spawning index information, it is "presumed healthy" based upon a general understanding of watershed conditions (mostly pristine), the relatively large number of tributaries used for spawning (USFWS 2004), and observations of bull trout in Ross Lake and its tributaries. The core area is currently considered at low risk of extirpation (USFWS 2008). Nelson et al. (2004) estimated the bull trout spawning population size in the upper Skagit River between Sumallo River and the US-Canada border as 183 fish, 247 fish, and 265 fish during July, September and October of 2004, respectively. The population in the Sumallo River is estimated to be about 50 to 60 fish (Nelson 2006 as cited in Triton Environmental 2008). These population estimates should be regarded cautiously; Triton Environmental (2008) found considerable difficulties separating bull trout and Dolly Varden trout using counts of branchiostegal rays occurred in the field; many of their field-based designations were wrong based upon genetic testing of tissue samples,

Historically, rainbow trout were the predominate forage fish used by bull trout in Ross Lake (Connor 2010b, pers. comm.). Recent surveys in Ross Lake have indicated a steep increase in the abundance of redside shiner. Based upon mark-recapture estimates, the number of adult bull trout in the upper Skagit core area was estimated to exceed 1,000 fish (Nelson et al. 2005). The Puget Sound Bull Trout Recovery Plan (USFWS 2004) also stated that the number of bull trout likely exceeded 1,000 fish in the upper Skagit core area. Based upon annual snorkel surveys, the number of bull trout in the mainstem Skagit River in B.C. has been increasing over the last decade, with the greatest number of fish observed during the 2009 surveys (Jesson 2010, pers. comm.). Bull trout are known to be opportunistic in their use of forage and in lakes this is predominately fish. It is currently believed that redside shiner have replaced rainbow trout as the primary forage fish for bull trout in Lake Ross and is responsible for the increased abundance of bull trout spawners. The reason for the increase in redside shiner is unknown.

The presence of brook trout is a concern in Ross Lake. The brook trout originate from historical lake stocking by Wash. Dept. of Game, including Hozomeen Lake (Glesne 2009, pers. comm.). USFWS (2004) reported brook trout is the dominate species in Hozemeen Creek while bull trout are no longer present. Brook trout have also been observed in Silver, Lightning, and Canyon Creeks. Brook trout are considered a threat by the National Park Service (NPS), especially in light of climate change (Rawhauser 2010, pers. comm.). The NPS is pursuing a program to reduce the numbers of brook trout in the upper Skagit. Genetics studies have confirmed bull trout – brook trout hybrids are present in Gorge and Diablo reservoirs (Smith and Naish 2010).

### 5.1.4. Marbled Murrelet

The marbled murrelet was federally listed as threatened under the ESA in 1992 due to loss of breeding habitat and mortality associated with gill net fishing and oil spills (57 FR 45328-45337). This species ranges from Alaska to the central California coast and populations have declined throughout this area over the last 30 years (http://www.natureserve.org/explorer/servlet/NatureServe). A recent review of its status by the USFWS found that the

California/Oregon/Washington marbled murrelet population is a Distinct Population Segment (DPS) that continues to be subject to a broad range of threats, such as nesting habitat loss, habitat fragmentation, and predation (USFWS 2009). Based on this assessment, the USFWS concluded in January 2010 that removing the species from the list of threatened species is not warranted (75 FR 3424).

The marbled murrelet is a diving seabird that forages in nearshore marine habitats preying on small fish and invertebrates. Marbled murrelets in the Pacific Northwest usually nest in old growth forests and select large, old trees with branches that support mats of epiphytes (McShane et al. 2004). Typically, nests are widely distributed in suitable habitat but occasionally occur within close proximity to one another.

Marbled murrelets lay only one egg on the limb of a large conifer tree and probably nest only once a year, although there is some evidence of renesting if the initial attempt fails (Desanto and Nelson 1995). Nesting in Washington occurs over an extended period from late April through late August (McShane et al. 2004). Incubation lasts about 30 days and chick rearing takes another 28 days. Both adults incubate the egg in alternating 24-hour shifts for approximately 30 days. During the nestling period, the parents travel daily between the marine waters and the nest to deliver food to the chick. Although murrelets are known to fly into their nesting areas and roost in large trees year around, most flight activity near the nest sites is concentrated during the breeding season. Most activity occurs in the hour before and after sunrise and again at dusk which maximizes diurnal feeding time in marine waters and reduces the risk of predation while moving to and from nest areas (Naslund and O'Donnell 1995). Murrelets often use rivers as flight corridors (McShane et al. 2004).

Marbled murrelets have exhibited "occupied" behaviors up to 4,400 ft elevation and have been detected in stands up to 4,900 ft in the north Cascade Mountains (USFWS 2009). The distance inland that marbled murrelets breed is variable and is influenced by a number of factors, including the availability of suitable habitat, climate, topography, predation rates, and maximum forage range (McShane et al. 2004). In Washington, the primary range is considered to extend 40 miles inland from marine habitats, but occupied habitat has been documented 52 miles from the coast (Hamer 1995; Madsen et al. 1999) and the species has been detected up to 70 miles inland. Due to the loss of late successional forest habitat and its replacement with urban development and early successional forests in the Puget Trough, much of the remaining suitable nesting habitat for marbled murrelets east of Puget Sound is a considerable distance from the marine environment (> 20 miles) (USFWS 1997). Habitat fragmentation and proximity of human activity appears to increase the risk of predation on marbled murrelets by American crows (*Corvus brachyrhynchas*) and Stellar's jays (*Cyanocitta stelleri*). Marbled murrelets are highly vulnerable to nest site predation. Most active murrelet nests that have been detected and monitored have been found to fail, and most failures appear to be the result of predation (McShane et al. 2004).

At-sea breeding population estimates for marbled murrelets in Puget Sound and the Strait of San Juan de Fuca have fluctuated in the years 2000 through 2008, with no discernable increasing or decreasing trend; however, additional years of data are needed before a population change can be detected with high confidence (Lance et al. 2009). Recent data on nest success and adult:juvenile ratios at sea continue to confirm that murrelet reproduction in Washington, Oregon, and California is too low to sustain populations (USFWS 2009).

### 5.1.5. Northern Spotted Owl

The northern spotted owl was federally listed as threatened in June 1990 (65 FR 5298-5300), with the final recovery plan for the species published in May 2008 (USFWS 2008). The spotted owl is a state-listed endangered species in Washington. There are no specific population recovery goals in this plan; instead the plan focuses on addressing the threat represented by barred owls and on maintaining and improving habitat for spotted owls, particularly on federal lands (USFWS 2008). In Washington, populations of spotted owls are thought to have declined precipitously since 1990; however, the current number of occupied territories is unknown because not all areas have been or can be surveyed annually (USFWS 2008).

In northern Washington and southwestern British Columbia most spotted owls detections are below 5,000 ft (1500 m) elevation (Gutiérrez 1996). Dense forested areas are utilized for daytime roosting, and roosting and nesting sites are typically within a few hundred yards of one another. Though diets vary seasonally and according to prey availability, spotted owls feed mostly on small mammals, with flying squirrels (*Glaucomys sarbinus*) and woodrats (*Neotoma* spp.) the primary prey species (USFWS 2008). Northern spotted owls typically lay eggs in late March of April. After the incubation and brooding period, the young usually start flying nearby between May and June, and parental care continues into September (USFWS 2008). Young disperse from the nest area during late summer and fall, often dispersing many miles. During the non-breeding season, adults either remain within their home range surrounding their nest, or move to other areas as far as 20 miles from the nest (USFWS 2008).

The primary threats to northern spotted owls are habitat loss and fragmentation, increased human disturbance, and predation and inter-specific competition with barred owls. There is also evidence that increased barred owl populations have reduced spotted owl site occupancy, reproduction, and survival (USFWS 2008). In areas where barred owls have become more common than spotted owls, such as in the western North Cascades, barred owls out-compete spotted owls (Herter and Hicks 2000). Hybridization between the two species is also a major threat to spotted owls (Hamer et al. 1994).

### 5.1.6. Grizzly Bear

Grizzly bears were listed by the USFWS as threatened in 1970 (35 FR 16047-16048). In the lower 48 states, remnant populations currently occur in Washington as well as Idaho, Wyoming, Montana. The Grizzly Bear Recovery Plan (USFWS 1993) includes the North Cascades as one of the six ecosystems in which grizzly bears are known to have occurred within the decade prior to listing. Approximately 41 percent of the North Cascades recovery zone is within a National Park and designated wilderness areas. Recovery goals for the North Cascades region are to 1) maintain current population, 2) provide protection under state and federal laws, and 3) collect baseline data on population status and habitat (USFWS 1993).

The NOCA and adjacent wilderness areas are believed to have suitable habitat to support grizzly bears (USFWS 1993). The grizzly bear population in the North Cascades Ecosystem, which includes British Columbia and Washington, has been estimated at <50 bears on based on sighting data (Grizzly Bear Outreach Project web site http://www.washingtongrizzlies.org/; accessed July 2, 2010). Population estimates based on DNA hair sampling methods are lower, about 6 bears for the entire ecosystem or 0.39 bears/100 sq miles (0.15 bears/100 km) (Romain-Bondi et al. 2004). Natural recovery of grizzly bears in this region is considered unlikely due to the demographic and environmental stochastic events associated with small populations (Romain-Bondi et al. 2004).

Grizzly bears are omnivorous and opportunistic feeders. While their diet is often dominated by herbaceous material, they will prey on almost any available food including ground squirrels, ungulates, carrion, and garbage. Grizzly bears need high-protein high-carbohydrates foods in order to survive denning and post-denning periods. In the North Cascades region, grasses, roots, bulbs, tubers, and fungi are important food, especially in the spring after bears emerge from den sites. High quality foods such as berries, nuts, and fish are important in some areas (Interagency Grizzly Bear Committee 1987).

Home ranges of grizzly bears encompass a mosaic of numerous habitat units or types. This phenomenon also may be related to the breadth of the species food habits. Use of cover varies with sex, age, reproductive status, human activity, or management (hunted or unhunted populations). Mating occurs from May through July with a peak in mid-June. Grizzly bears spend up to 6 months in dens beginning in October or November. Denning habitat is characterized by steep slopes where wind and topography cause accumulation of deep snow not likely to melt during warm periods (USFWS 1993); typically this habitat occurs above 5,670 feet in the North Cascades (Almack 1986). No den sites have been identified in the North Cascades but suitable denning habitat is not considered a limiting factor in this area (Almack 1986).

### 5.1.7. Gray Wolf

The gray wolf was federally listed as an endangered species in all states except Minnesota and Alaska in 1978 (43 FR 9607-9615). It was delisted in May 2009 in the eastern third of Washington and most of the Northern Rocky Mountain Region, including Montana, Idaho, Oregon, as well as in several states in the Great Lakes Region (74 FR 15123). The 1987 recovery plan for the gray wolf in the Northern Rocky Mountain Region did not include any population recovery goals for this species in Washington and no gray wolf critical habitat was designated in Washington (USFWS 1987). The gray wolf remains federally listed as endangered in central and western Washington.

Wolves are carnivorous and typically prey on large ungulates; however, they will also feed on fish, carrion, small mammals, rabbits, and birds. Wolves may travel as far as 43 miles within a 24 hour period to hunt and range over greater distances during dispersal. Key components of wolf habitat are: 1) sufficient, year-round prey base of ungulates and alternative prey; 2) suitable denning and rendezvous sites; and 3) adequate space with minimal exposure to humans (USFWS 1987).

Gray wolves were formerly common throughout most of Washington, but declined rapidly from being aggressively killed as ranching and farming by Euro-American settlers expanded between 1850 and 1900 (WDFW 2009). Between 1991 and 1995, there were 20 confirmed wolf sightings in Washington, 16 in the Cascades (Almack and Fitkin 1998). There are currently two known wolf packs in Washington—one in Okanogan County, first confirmed in 2008, and the other in Pend Oreille County, documented in 2009.

With the exception of the reservoirs and the towns of Newhalem and Diablo, there is abundant habitat suitable for cover, dens, and rendezvous sites for the gray wolf in the North Cascades, and large areas that are isolated from humans. Prey may be limited, however, because this region does not currently support large ungulate populations, particularly west of the Cascade crest (WDFW 2009).

### 5.1.8. Canada Lynx

The Canada lynx was state listed as threatened in Washington in 1993 and federally listed as threatened in 2000. Primary threats to the species include habitat loss and over utilization (trapping) (FR 65 FR 16051-16086). Critical habitat was designated in 2006 (71 FR 53355-53361) and revised in 2009 by the USFWS (74 FR 8616). The revised critical habitat for Unit 4 (North Cascades) is limited to suitable habitat above 4,000 feet elevation north-central Washington in portions of Chelan and Okanogan counties. A state recovery plan was published in 2001 (Stinson 2001); there is no federal recovery plan to date for the lynx.

Lynx are closely associated with boreal forests because of their near-dependence on a single prey species—the snowshoe hare—which is mostly limited to this habitat type. Lynx typically occupy high elevation forests but can travel over 300 miles when dispersing during prey declines. Lynx populations in the northern boreal forest fluctuate on an approximate 10-year cycle in response to changes in snowshoe hare numbers. Cyclic variations in snowshoe hare-lynx populations are dramatic in Alaska and Canada but tend to be more moderate in Washington (Stinson 2001).

As of 2001, there were thought to be only about 100 Canada lynx in Washington, with most records from the northeastern and north central portions of the state, in the Selkirks, Kettle Range, Pasayten Wilderness, and North Cascades east of the crest (Stinson 2001). Extensive forest fires through lodgepole pine (*Pinus contorta*) stands in the Pasayten Wilderness Area in the mid-2000s may have reduced the population. Most evidence suggests that even historically lynx were scarce west of the Cascade crest (Stinson 2001).

## 5.2. Critical Habitat Designations

### 5.2.1. Chinook Salmon

Critical habitat for the Puget Sound Chinook Salmon ESU was designated by the NMFS on September 2, 2005 (70 FR 52630) (Figure 5-17, Figure 5-18, and Figure 5-19). All of the mainstem Skagit River up to Gorge Dam is designated as critical habitat, as well as portions of tributaries draining to the Skagit River.

### 5.2.2. Steelhead

Critical habitat has not yet been designated for the Puget Sound Steelhead DPS.

### 5.2.3. Bull Trout

Critical habitat for bull trout in the Puget Sound DPS was designated by the USFWS (70 FR 56212) September 26, 2005. (Figure 5-20, Table 5-8, Figure 5-21). More recently in January, 2010, the USFWS requested, and was granted, voluntary remand of the 2005 final rule and reconsidered critical habitat designations for bull trout (75 FR 2270). In the January 2010 proposed rule and November 2010 Final Rule (75 FR 63898), the USFWS identified nearly all streams and waterbodies, including the reservoirs as part of the Baker River and Skagit River hydroelectric projects, within the Skagit River basin are considered critical habitat.

### 5.2.4. Marbled Murrelet

Critical habitat for the marbled murrelet was designated in 1996 (61 FR 26255-26320) and the recovery plan was finalized in 1997 (USFWS 1997). In 2008, the USFWS considered revising the critical habitat designations but determined that the 1996 designation should remain in effect (73 FR 12067). The action area does not contain any designated marbled murrelet critical habitat. There is mapped critical habitat approximately 1 mile south of the Bacon Creek confluence with the Skagit River and the Illabot Creek wildlife WHL property (http://criticalhabitat.fws.gov/flex/crithabMapper.jsp [accessed March 9, 2010]).

### 5.2.5. Northern Spotted Owl

Critical habitat for the northern spotted owl was designated in 1992 and revised in 2008 (73 FR 47325-47374). The Northwest Washington Cascades Unit of critical habitat consists of approximately 393,500 ac (159, 200 ha) in Whatcom, Skagit, Snohomish, King, and Kittitas Counties, Washington, and is comprised of lands managed by the Mt. Baker-Snoqualmie and Wenatchee National Forests. This unit includes one area with approximately 18,200 ac (7, 400 ha) of habitat or habitat-capable in the adjacent Wilderness Areas and the North Cascades National Park. There is mapped critical habitat approximately 0.4 mile south of SCL's Illabot Creek WHL parcel and adjacent to SCL's Finney Creek WHL parcel (http://criticalhabitat.fws.gov/flex/crithabMapper.jsp [accessed March 9, 2010]).

### 5.2.6. Grizzly Bear

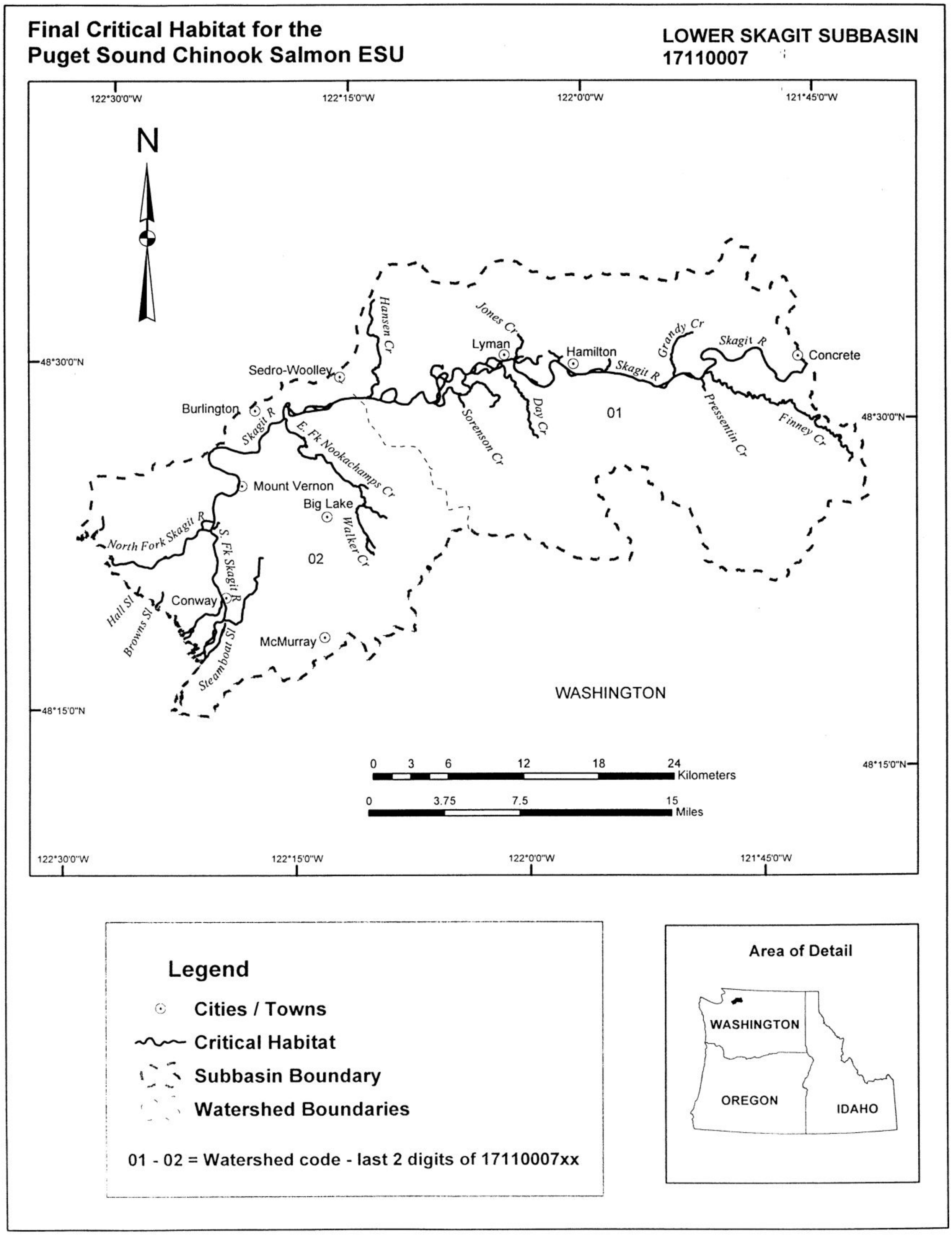
No grizzly bear critical habitat has been designated in or near the action area.

### 5.2.7. Gray Wolf

No gray wolf critical habitat has been designated in or near the action area.

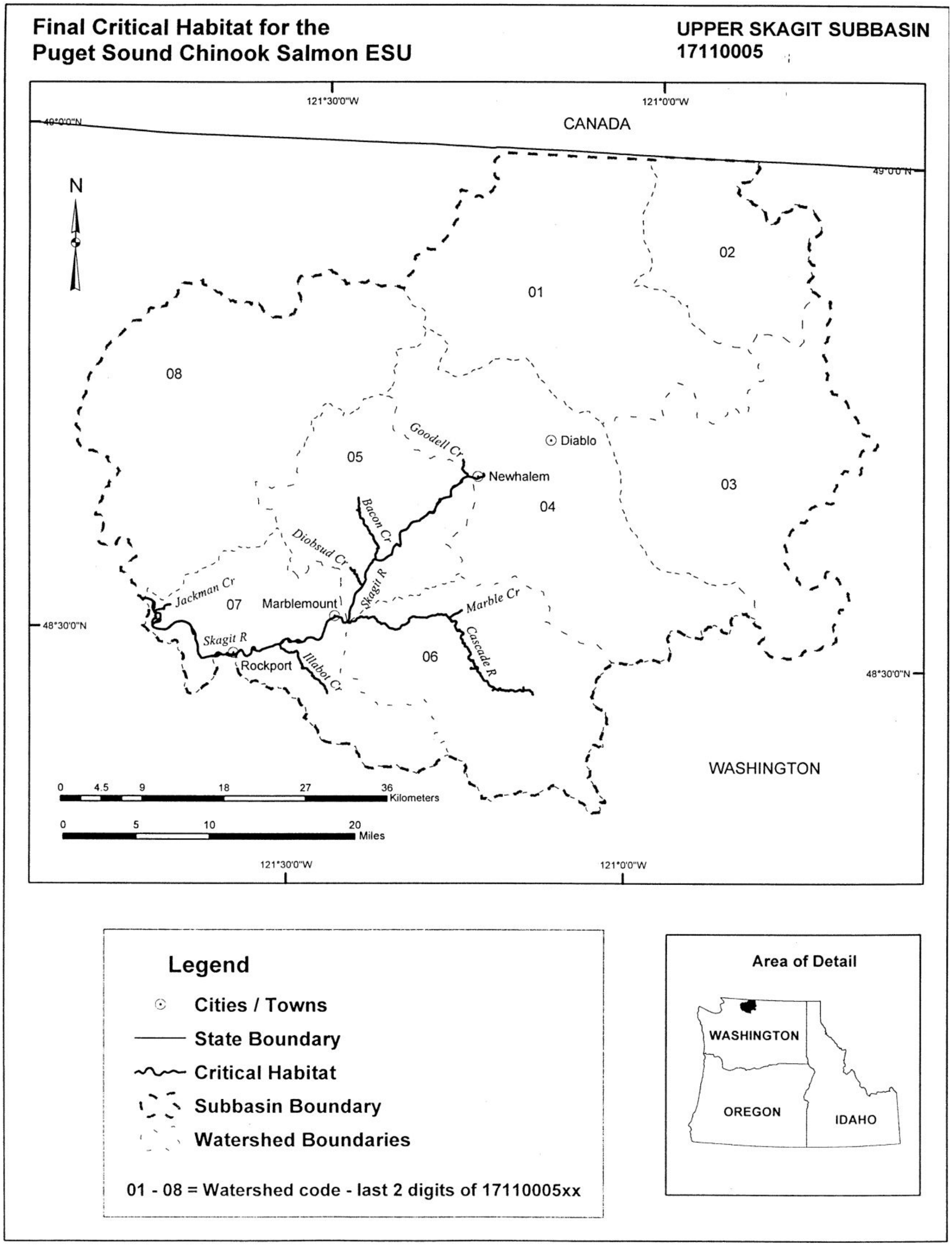
### 5.2.8. Canada Lynx

No lynx critical habitat occurs in or near the action area.



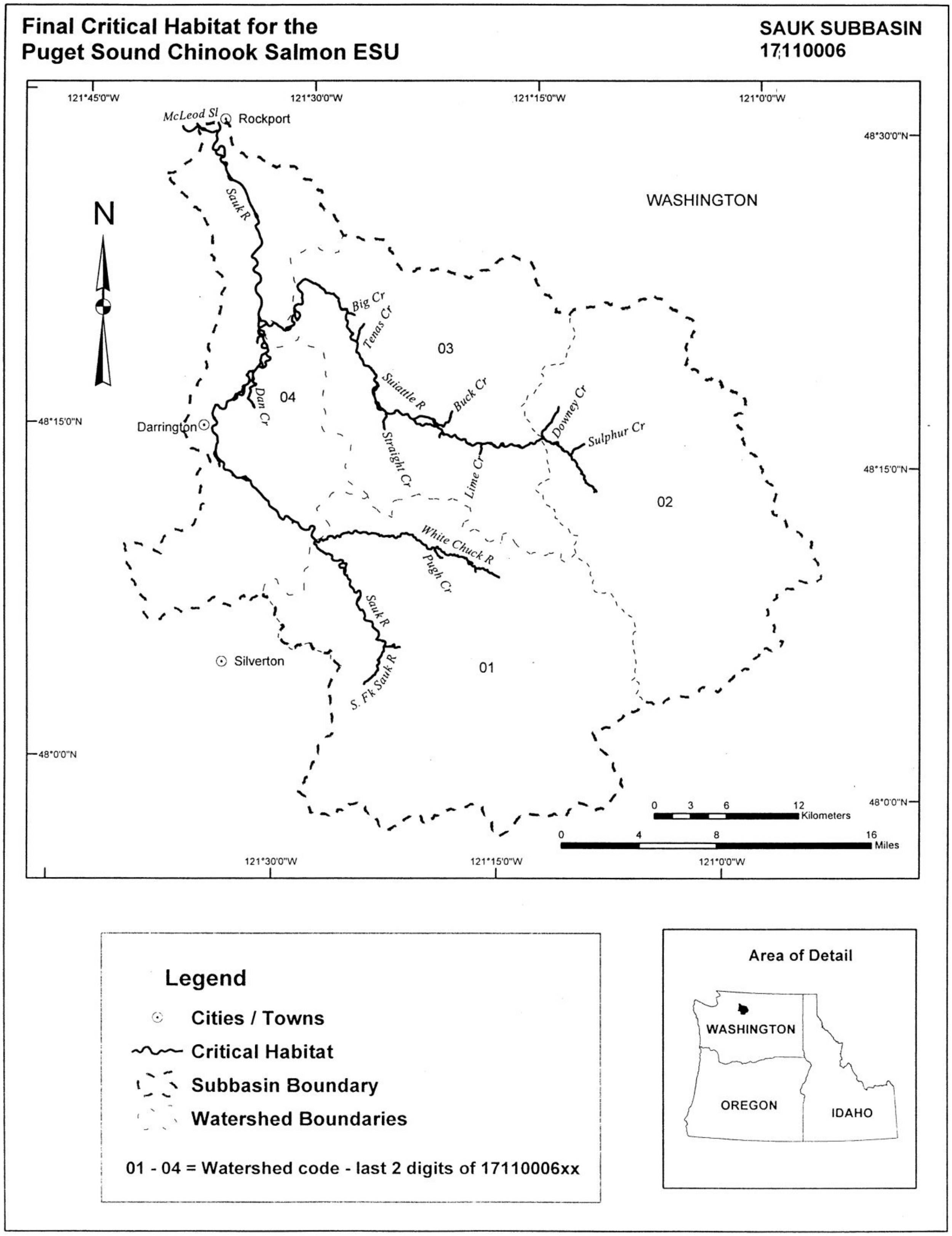

Source: 70 FR 52630.

**Figure 5-17. Critical habitat designated for Chinook salmon in the lower Skagit River subbasin.**



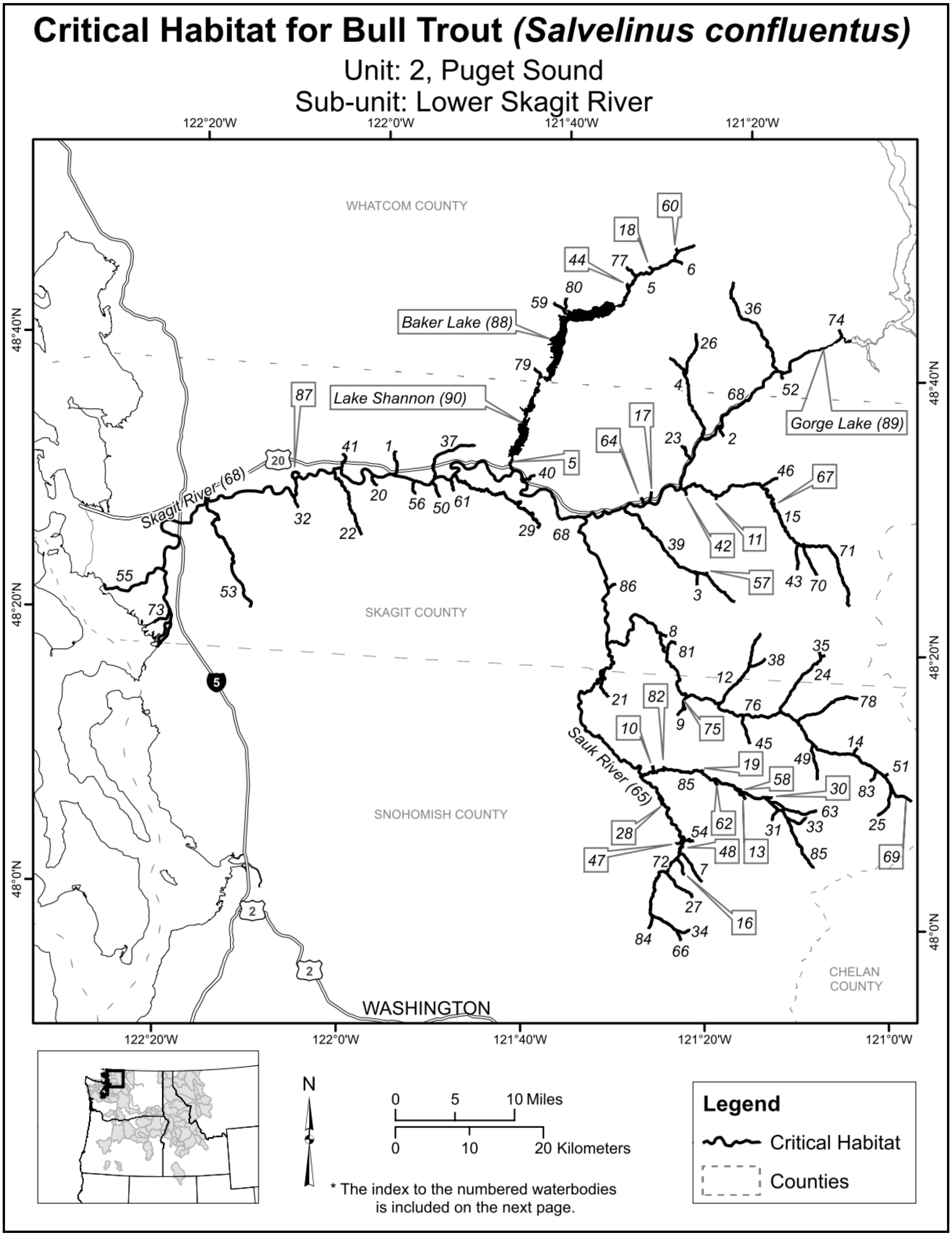

Source: 70 FR 52630.

**Figure 5-18. Critical habitat designated for Chinook salmon in the upper Skagit River subbasin.**




Source: 70 FR 52630.

**Figure 5-19. Critical habitat designated for Chinook salmon in the Sauk River subbasin.**




Source: USFWS (2010).

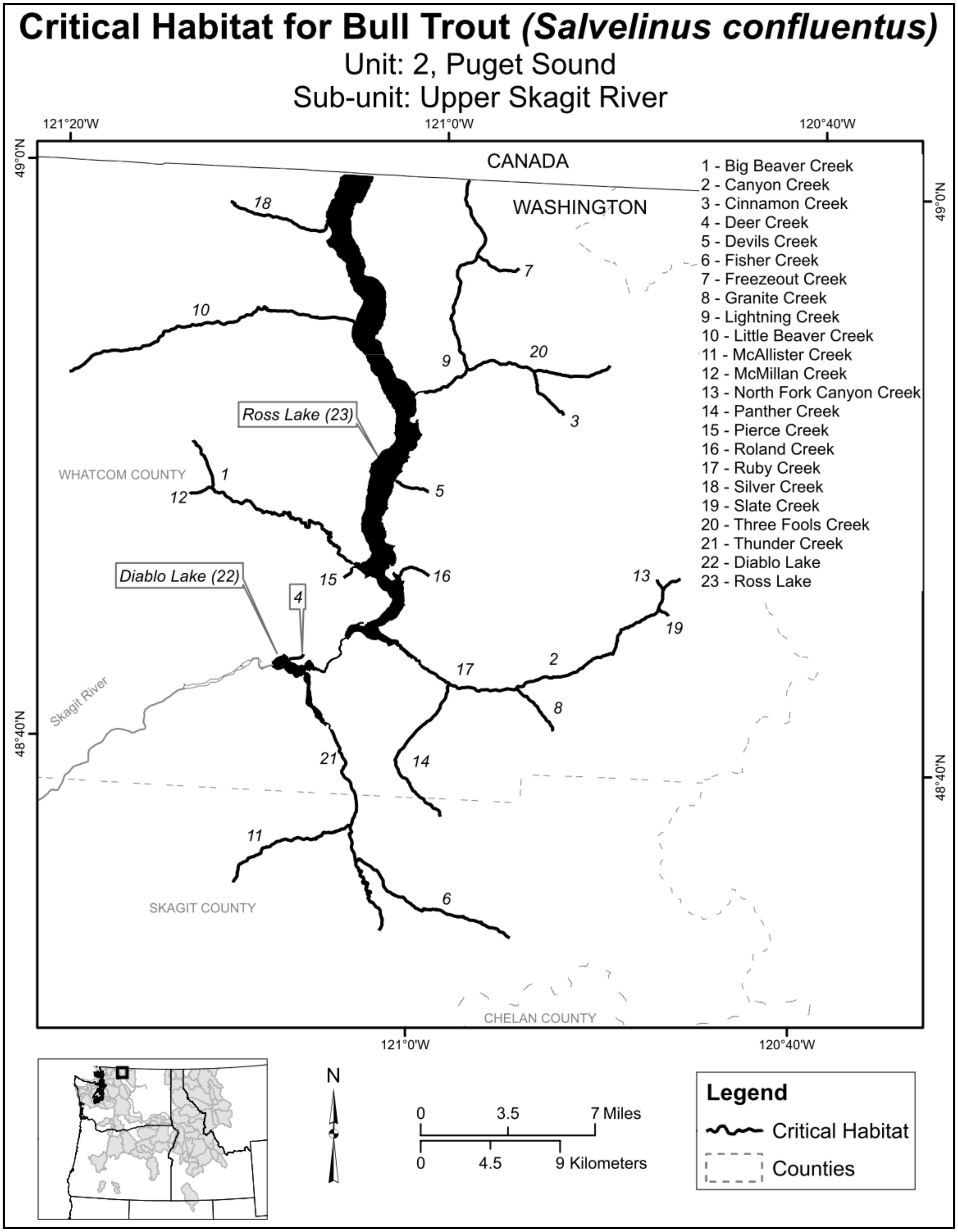
**Figure 5-20. Critical habitat designated for bull trout in the lower Skagit River.**

**Table 5-8. Stream codes for Figure 5-20 designating proposed critical habitat in the lower Skagit River basin.**

Unit 2: Puget Sound
Sub-unit: Lower Skagit

| | |
|---|---|
| 1 - Alder Creek | 47 - Martin Creek |
| 2 - Alma Creek | 48 - Merry Brook Creek |
| 3 - Arrow Creek | 49 - Milk Creek |
| 4 - Bacon Creek | 50 - Mill Creek |
| 5 - Baker River | 51 - Miners Creek |
| 6 - Bald Eagle Creek | 52 - Newhalem Creek |
| 7 - Bedal Creek | 53 - Nookachamps Creek |
| 8 - Big Creek | 54 - North Fork Sauk River |
| 9 - Black Creek | 55 - North Fork Skagit River |
| 10 - Black Oak Creek | 56 - O'Toole Creek |
| 11 - Boulder Creek | 57 - Otter Creek |
| 12 - Buck Creek | 58 - Owl Creek |
| 13 - Camp Creek | 59 - Park Creek |
| 14 - Canyon Creek | 60 - Pass Creek |
| 15 - Cascade River | 61 - Pressentin Creek |
| 16 - Chocwick Creek | 62 - Pugh Creek |
| 17 - Corkindale Creek | 63 - Pumice Creek |
| 18 - Crystal Creek | 64 - Rocky Creek |
| 19 - Crystal Creek | 65 - Sauk River |
| 20 - Cumberland Creek | 66 - Seventysix Gulch |
| 21 - Dan Creek | 67 - Sibley Creek |
| 22 - Day Creek | 68 - Skagit River |
| 23 - Diobsud Creek | 69 - Small Creek |
| 24 - Downey Creek | 70 - Sonny Boy Creek |
| 25 - Dusty Creek | 71 - South Fork Cascade River |
| 26 - East Fork Bacon Creek | 72 - South Fork Sauk River |
| 27 - Elliott Creek | 73 - South Fork Skagit River |
| 28 - Falls Creek | 74 - Stetattle Creek |
| 29 - Finney Creek | 75 - Straight Creek |
| 30 - Fire Creek | 76 - Suiattle River |
| 31 - Fourteenmile Creek | 77 - Sulphide Creek |
| 32 - Gilligan Creek | 78 - Sulphur Creek |
| 33 - Glacier Creek | 79 - Sulphur Creek (Lake Shannon) |
| 34 - Glacier Creek | 80 - Swift Creek |
| 35 - Goat Creek | 81 - Tenas Creek |
| 36 - Goodell Creek | 82 - Unnamed trib. (#1119) |
| 37 - Grandy Creek | 83 - Vista Creek |
| 38 - Horse Creek | 84 - Weden Creek |
| 39 - Illabot Creek | 85 - White Chuck River |
| 40 - Jackman Creek | 86 - White Creek |
| 41 - Jones Creek | 87 - Wiseman Creek |
| 42 - Jordan Creek | 88 - Baker Lake |
| 43 - Kindy Creek | 89 - Gorge Lake |
| 44 - Lake Creek | 90 - Lake Shannon |
| 45 - Lime Creek | |
| 46 - Marble Creek | |

Source: USFWS (2010).




Source: USFWS (2010).

**Figure 5-21. Critical habitat designated for bull trout in the upper Skagit River.**

# 6 ENVIRONMENTAL BASELINE AND CUMULATIVE EFFECTS

## 6.1. Status of Habitat Features within the Aquatic Action Area

The Skagit Basin has five major reservoirs: Lake Shannon, Baker Lake, Gorge Lake, Lake Diablo, and Ross Lake. There are also a number relatively small reservoirs (primarily for agriculture and water supply) and natural lakes and ponds that in general will not be discussed. As described previously, Lake Shannon and Baker Lake are impounded by Lower and Upper Baker Dams, respectively, and operated according to FERC license No. 2150 issued to Puget Sound Energy. These two reservoirs are located outside the action area and will not be discussed further in this section. Information about the Baker Project is available in (FERC 2006). The latter three reservoirs are impounded by Gorge Dam, Diablo Dam, and Ross Dam, respectively, operated by Seattle City Light under FERC License No. 553 are within the action area and will be the focus of this subsection along with the mainstem Skagit River from Gorge Dam downstream to the Sauk River. Because of the influence of the Cascade River and Sauk River, effects from the Skagit Hydroelectric Project to listed fish species are substantially diminished downstream of the Sauk River.

### 6.1.1. Water Quality

#### 6.1.1.1. Water Quality Standards

Water quality standards depend upon the designated uses for a water body that have been established by the state of Washington (Washington Administrative Code (WAC) 173-201A-030) (Table 6-1). In addition to the standards identified for the designated use (Table 6-2), Ecology (2006b) has also identified supplemental spawning and incubation criteria for specific reaches (Figure 6-1 and Figure 6-2). Water quality within the reservoirs complies with the quantitative water quality standards established for the designated uses. The Action Area is primarily within the Upper Skagit River Water Resource Inventory Area (WRIA) 4, which includes the Skagit River upstream of the Sauk River confluence, the Sauk River, the Cascade River, the Baker River and all associated tributary streams. The Skagit River and tributaries downstream of the Sauk River are in WRIA 3.

#### 6.1.1.2. Water Quality Conditions

Every two years the State of Washington prepares an Integrated Water Quality Assessment. Included in the assessment are streams on the Clean Water Act Section 303(d) list of impaired water bodies in need of a plan that describes the impaired segment’s Total Maximum Daily Load (TMDL) and measures to improve water quality in the segment.

Relative to State water quality standards Upper Skagit Basin WRIA 4 (upstream and including the Sauk River) is in good condition. Based upon Ecology (2008) there are currently no stream segments that have a prepared TMDL and there are only two segments within WRIA 4 that are on the 303(d) list (Table 6-3). With one exception, long-term monitoring records do not indicate any violations of water quality standards downstream of the Skagit Hydroelectric Project. Monthly samples are collected at the nearest USGS water quality data collection site at Marblemount (RM 78.1, approximately 16 RM below the Project), and data at this sampling site exist for the years 1959 through 2006 for: fecal coliform, dissolved oxygen, pH, temperature, turbidity, and other water quality parameters for which there are no numeric standards (Washington Department of Ecology web site). One segment located on the Skagit River near the mouth of the Cascade River is listed for temperature impairment. The other listed segment is Prairie Creek, which is a tributary of the Sauk River and listed for fecal coliform.

With the exception of water temperature relatively little water quality data has been collected in WRIA 4. However, it is believed that water quality in this area is in good to excellent condition because it is primarily managed as National Park, Provincial Forest, National Forest System (NFS), Wilderness Area, and National Recreation Area lands. Some parts of NFS and Skagit Provincial Forest lands were historically managed for timber harvest, but the level of harvest management has declined considerably in recent years and currently occurs primarily in portions of the basin downstream of Gorge Dam, in British Columbia, and within the Cascade River and Sauk River basins. Smith (2003) reported unpublished temperature data collected by the National Park Service in Zander Creek, Taylor Channel, Park Slough, Thunder Creek, Fisher Creek, Logan Creek, and McAllister Creek were generally "good." However, the temperature range regarded as "good" was not described.

**Table 6-1. Designated uses of water in the action area.**

| | Aquatic Life Uses | | | | | | Recreational Uses | | | Water Supply Uses | | | | Misc. Uses | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Water Body** | **Char Spawning/Rearing** | **Core Summer Habitat** | **Spawning/Rearing** | **Rearing/Migration Only** | **Redband Trout** | **Warm Water Species** | **Ex Primary Contact** | **Primary Contact** | **Secondary Contact** | **Domestic Water** | **Industrial Water** | **Agricultural Water** | **Stock Water** | **Wildlife Habitat** | **Harvesting** | **Commerce/Navigation** | **Boating** | **Aesthetics** |
| Skagit River mouth to Skiyou Slough (RM 25.6) | | ✓ | | | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| All tributaries to the mainstem Skagit River from the mouth to Skiyou Slough | | | ✓ | | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Walker Cr and Unnamed Cr[1] | ✓ | | | | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Skagit River and all tributaries upstream of Skiyou Slough except designated tributaries[2] | | ✓ | | | | | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Designated WRIA 4 tributaries[2] | ✓ | | | | | | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

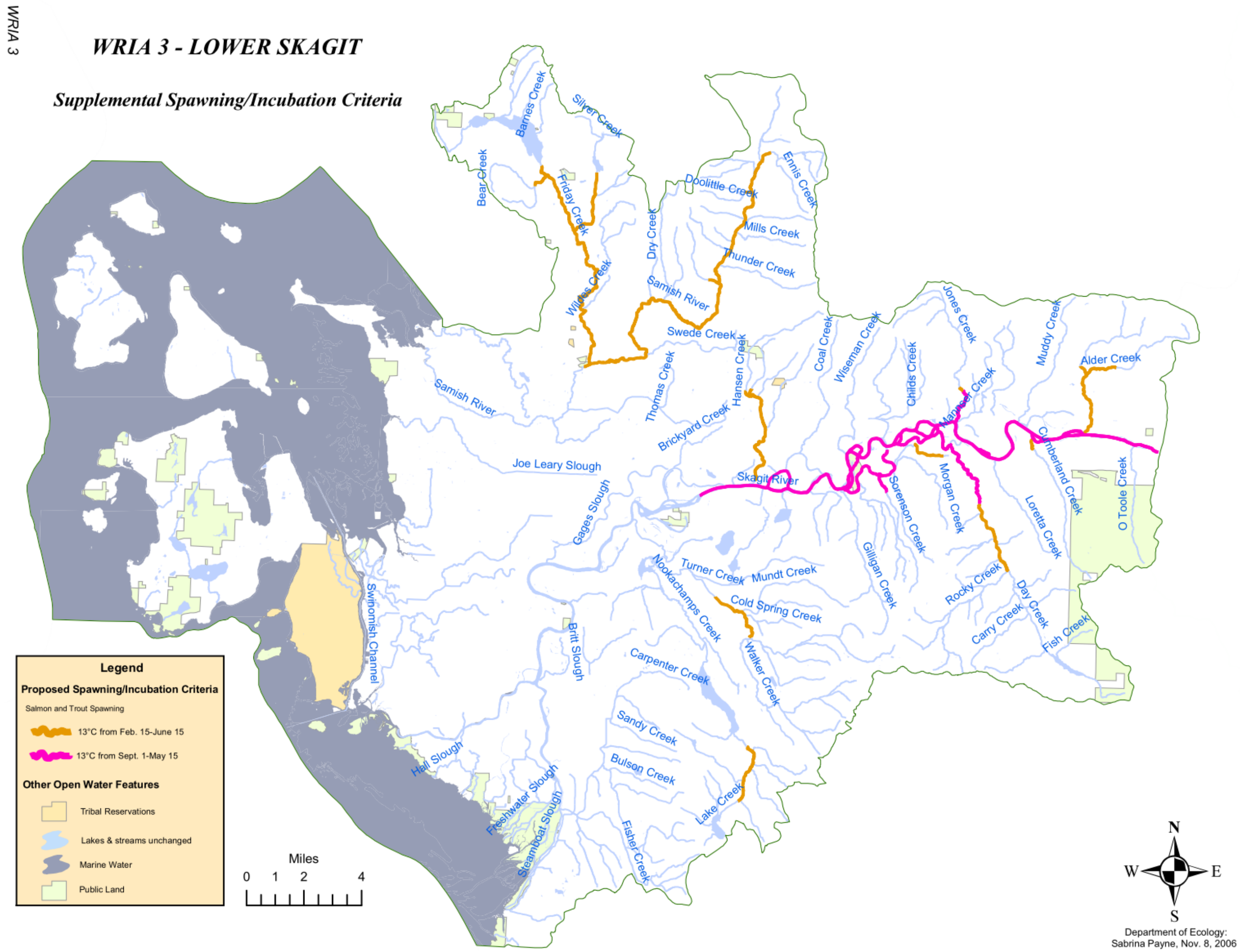
Source: WAC 173-201A.

1. Unnamed Creek at 48.3813N, 122.1639W.
2. Bacon Cr, Baker Lake, Bear Cr, Big Beaver Cr, Big Cr, Buck Cr, Cascade R and Boulder Cr, Circle Cr, Clear Cr, Diobsud Cr, Goodell Cr, Hozomeen Cr, Illabot Cr, Jordan Cr, Lightning Cr, Little Beaver Cr, Murphy Cr, Rocky Cr, Ruby Cr, Sauk R and Dutch Cr, Silver Cr, Stetattle Cr, Straight Cr, Suiattle R all tributaries above Harriet Cr, Sulfur Cr, Tenas Cr, Thunder Cr, White Chuck R.

**Table 6-2. Water quality criteria for the action area.**

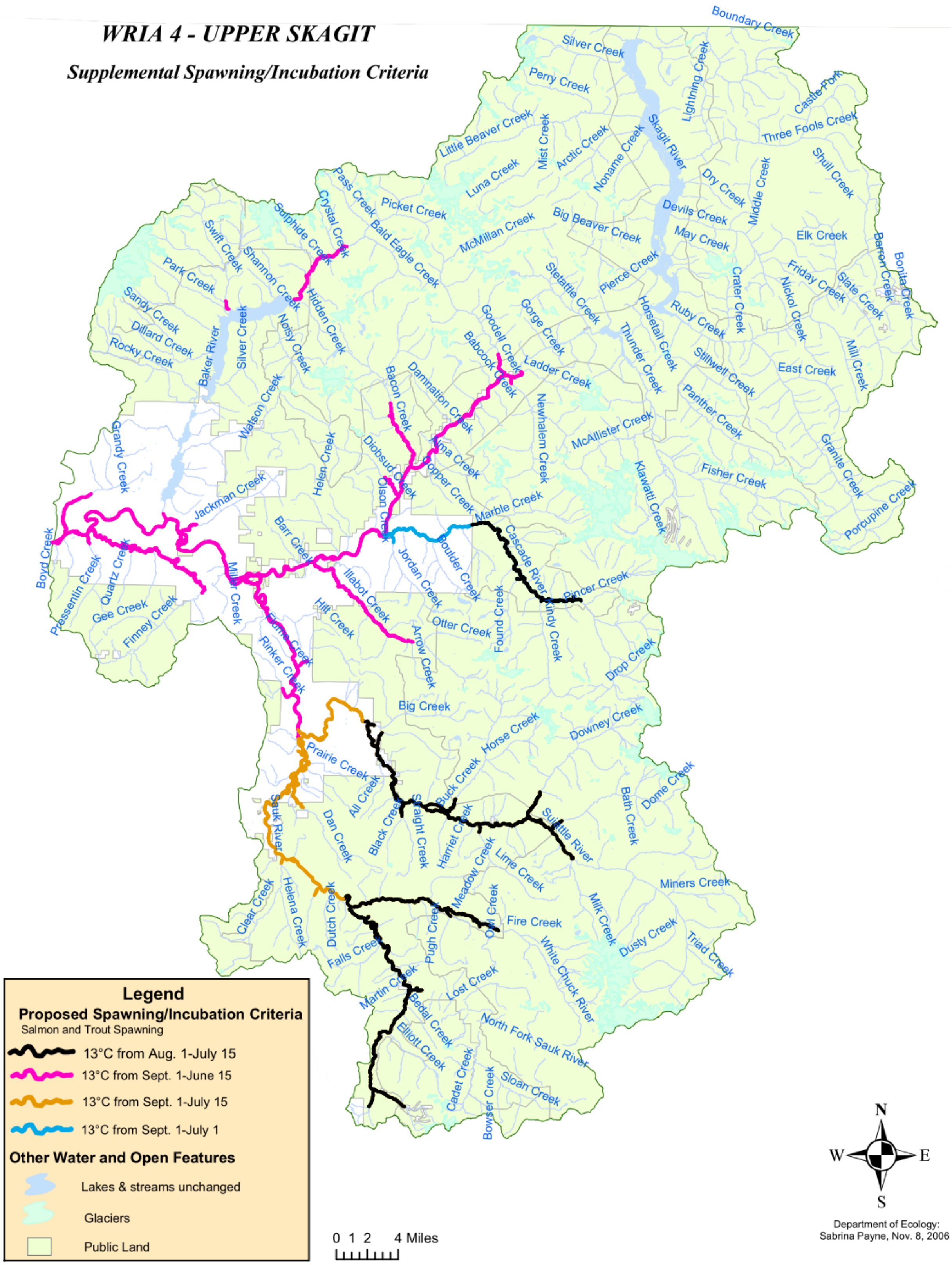
| Parameter | Water Quality Criteria |
|---|---|
| Fecal Coliform | Not to exceed a mean value of 50 colonies/100 ml with not more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 ml |
| Dissolved Oxygen | Lowest 1-Day Minimum:<br>*Char:* 9.5 milligrams per liter (mg/L)<br>*Salmon and trout spawning, core rearing, and migration*: 9.5 mg/l<br>*Salmon and trout spawning, noncore rearing, and migration*: 8.0 mg/l |
| | For lakes/reservoirs, human actions considered cumulatively may not decrease the dissolved oxygen concentration more than 0.2 mg/L below natural conditions. |
| Temperature | Maximum 7-day average of daily maximum temperature (7-DADMax):<br>*Char Spawning:* 9°C (48.2°F)<br>*Char Spawning and Rearing*: 12°C (53.6°F)<br>*Salmon and trout spawning: 13°C (55.4°F)*<br>*Core summer salmonid habitat(June 15 to Sept 15)*: 16°C (60.8°F)<br>*Salmonid spawning, rearing, and migration (Sept 15 to June 14)*: 17.5°C (63.5°F)<br>*Salmonid rearing and migration only*: 17.5°C (63.5°F) |
| | *Skagit River (Gorge bypass reach) from Gorge Dam (river mile 96.6) to Gorge Powerhouse (river mile 94.2).* Temperature shall not exceed a 1 day maximum temperature (1-DMax) of 21°C due to human activities. When natural conditions exceed a 1-DMax of 21°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C, nor shall such temperature increases, at any time, exceed t = 34/(T + 9). |
| | For lakes/reservoirs, human actions considered cumulatively may not increase the 7-DADMax temperature more than 0.3°C (0.54°F) above natural conditions. |
| Total Dissolved Gas | Not to exceed 110% of saturation at any point of sample collection. |
| pH | Within 6.5 to 8.5 pH units with human caused variation of:<br>less than 0.2 units for char and salmon and trout spawning, core rearing, and migration<br>less than 0.5 units for salmon and trout spawning, noncore rearing, and migration |
| Turbidity | Shall not exceed either a 5 nephelometric turbidity unit (NTU) increase over background when the background is 50 NTU or less; or a 10% increase in turbidity when the background is more than 50 NTU |

Source: WAC 173-201A




Source: Ecology (2006b).

**Figure 6-1. Supplemental spawning and incubation protection temperature criteria for WRIA 3 Lower Skagit River.**




Source: Ecology (2006b).

**Figure 6-2. Supplemental spawning and incubation protection temperature criteria for WRIA 4 Upper Skagit River basin.**

**Table 6-3. Water bodies in the Skagit River basin that currently have, or are in need of, preparation of a TMDL plan.**

| Water Body | Department of Ecology Listing ID(s) | WRIA | Category[1] | WQ Impairment Parameter |
|---|---|---|---|---|
| Skagit River | 6564 | 4 | 5 | Temperature |
| Prairie Cr | 42075 | 4 | 5 | Fecal coliform |
| Carpenter Cr, Fisher Cr Hansen Cr, Nookachamps Cr, Otter Pond Cr, Red Cr, Turner Cr | 6421, 6422, 6423, 6424, 6425, 6426, 6427, 6428, 6429, 6430, 6431, 6432 | 3 | 4A | Temperature |
| Brickyard Cr, Carpenter Cr, Fisher Cr, Gages Slough, Hart Slough, Hill Ditch, Kulshan Cr, Nookachamps Cr, Hansen Cr, Skagit R, SF Skagit R, NF Skagit R, Unnamed Creek, Wiseman Cr, | 7142, 7143, 7147, 7159,7175, 9752, 9755, 9757, 9765, 9767, 9770, 9773, 39628, 39629, 39630, 39632, 39643, 45651, 45663, 45700, 46272, 46305, 46315, 46323, 46327 | 3 | 4A | Fecal coliform |
| College Way Cr, Big Ditch/Maddox Slough, Coal Cr, Joe Leary Slough, Mannser Cr, Nookachamps Cr, Otter Pond Cr, Thomas Cr, Unnamed Creeks, Wiley Slough, Wiseman Creek, | 7177, 9756, 39607, 39608, 39609, 39658, 39661, 39662, 45650, 45681, 45807, 46296, 46356, 45687, 45070, 45663, 45669, 45827, | 3 | 5 | Fecal coliform |
| Big Ditch/Maddox Slough, Unnamed Cr | 6433, 7141 | 3 | 5 | Temperature |
| Big Ditch/Maddox Slough, Brickyard Cr, Coal Cr, Wiley Slough, College Way Cr, Fisher Cr, Hansen Cr, Hill Ditch, Joe Leary Slough, Mannser Cr, Nookachamps Cr, Thomas Cr, Unnamed Creeks, Willard Creek | 9216, 39610, 39611, 39612, 39659, 47520, 47521, 47564, 45202, 40819, 47588, 47583, 47594, 47624, 47627, 47663, 47970, 39633, 39634, 39635, 39636, 39637, 39644, 47568, 47572, 48021 | 3 | 5 | DO |
| Big Ditch/Maddox Slough, Brickyard Cr, Mannser Cr, Skagit R, Thomas Cr, Wiley Slough | 9203, 9217, 50865, 50885, 51061, 51086 | 3 | 5 | pH |
| Skagit R | 14036 | 3 | 5 | PCB |

Source: Ecology (2008).

1. Category 4A – Has a prepared TMDL. Category 5 – Needs a TMDL.

Warming of surface waters occurs in Ross Reservoir in late summer or early fall, when a stable thermocline is formed. Thermoclines have been recorded in the reservoir at depths of 40 to 60 m (SCL 1974). Although epilimnetic waters are relatively warm, summer reservoir elevations in Ross Reservoir are relatively high, and Project intakes generally withdraw waters from the cooler metalimnion. The maximum water temperatures recorded at the Ross intakes were 17°C and 16°C during August of 1972 and 1973, respectively. By late October 1973, surface waters had cooled to about 11ºC, and overturn occurred in early January (City of Seattle 1973).

Water quality data collected during 2000 to 2002 in Ross Lake and selected tributaries also indicates that Ross Lake stratifies during the summer with maximum surface water temperatures reaching 19.3°C while water below the thermocline (usually less than 2 m in depth) is generally around 10°C or less (R2 Resource Consultants 2009). The surface lake water was often warmer than that preferred by bull trout (12-14ºC) (Hillman and Essig 1998), but usually less than the 18°C water they would tend to avoid (Geist et al. 2004; Goetz 1989). However, the deeper water below the thermocline (about 95% of reservoir volume) provides for cool water. Water temperature and dissolved oxygen was also collected in Big Beaver Creek, Devil's Creek, Lightning Creek, Little Beaver Creek, Ruby Creek, near their mouths and within the influence of lake waters. Maximum daily stream temperatures in the tributaries to Ross Lake were not more than 13ºC. All other water quality parameters measured (pH and dissolved oxygen) were within the acceptable range for healthy trout and char populations (Spence et al. 1996). The low pH measurement at the mouth of Little Beaver Creek in August is likely the result of glacial snow melt.

Dissolved oxygen concentrations at the intake and tailrace of Ross Reservoir met or exceeded standards at all depths during sampling in summer 1972-73 (SCL 1974). Dissolved oxygen samples were also taken at eight stations upstream of Ross Dam during fall 1973, at 10-m depth intervals. While surface waters generally met dissolved oxygen standards, some samples taken from deep waters were at or below water quality standards. The lowest recorded dissolved oxygen concentration (6.7 parts-per-million [ppm]) was found nine miles upstream of the dam, in the hypolimnion at a depth of 55 m (3 m off the bottom) on November 7, 1973 (SCL 1974). Dissolved oxygen concentrations increased, and the depth of the thermocline decreased steadily with the onset of cool weather and the mixing of waters. Although dissolved oxygen concentrations in the hypolimnion may seasonally fall below water quality standards, the concentrations in the epilimnion are generally at or above dissolved oxygen standards. The lowest surface dissolved oxygen concentration was 9.0 mg/L measured mid-lake near Devils Creek in July 1973 (SCL 1974). These declines in dissolved oxygen concentrations are associated with periodic seasonal declines that result from thermal stratification, and this section of the Skagit is not 303(d) listed for dissolved oxygen. Dissolved oxygen measurements taken during 2009 indicate there is complete saturation in Ross Lake throughout the water column (Rawhauser 2010, pers. comm.).

As described above, the Skagit River from Gorge Dam (RM 96.6) downstream to Gorge Powerhouse (i.e., bypass reach) has a special condition status under State water quality standards, which mandates that water temperatures are not to exceed 21º C as a result of anthropogenic activities. Temperature monitoring conducted by SCL indicates that temperatures in the 2.7-mile bypass reach do not exceed this value (Envirosphere 1988).

Temperatures in the Skagit River are warmest in July, August, and September. Average daily temperatures of the Skagit River typically range between 8 °C and 11°C in July, while average daily temperatures in August and September typically range from 10°C to 11°C. Maximum daily temperatures of the Skagit River at Marblemount usually do not exceed 14°C during the warmest periods of the year.

Turbidity in reservoir areas upstream of the Project is influenced by seasonal runoff of silt and glacial flour and rain-on-snow events. Suspended sediments (turbidity) are carried by waters through the Project reservoirs and into the Skagit River below Gorge Powerhouse. Measurements from the south end of Ross Reservoir taken from March to December 1973 showed that maximum turbidity (Secchi depth: 3.3 m) occurred in late May, resulting from high spring flows. Mid-July to December Secchi depth readings varied from 7.5 to 11.7 m. During the previous year, 1972, the minimum depth of water transparency was recorded on June 30 at a Secchi depth of 1.4 m (SCL 1974). The project does not appear to exacerbate turbidity and suspended sediments, and the section of the Skagit River downstream of Gorge Powerhouse is in compliance with 303(d) standards for turbidity.

Supersaturation with atmospheric gas, primarily nitrogen, can occur when water spills over high dams, but this does not appear to be a problem for this Project. Total dissolved gas (TDG) monitoring conducted on July 10, 1997, revealed nitrogen saturation did not exceed the water quality standard of 110 percent saturation. Five spill conditions were tested in 1997 and readings for TDG were taken in the Ross Dam forebay and downstream of Gorge Dam powerhouse. The highest measurement, 110.4 percent of saturation, was taken downstream of the Gorge Dam powerhouse. However, a lower reading of 107.4 percent of saturation was taken on the opposite bank from water flowing through the bypass reach. The three Projects (Ross, Gorge, and Diablo) were not determined to have a cumulative effect on nitrogen saturation (Parametrix 1997). Even during spill events the bypass reach is shallow and turbulent. Consequently, water has an opportunity to de-gas over the 2.7 mile reach.

In contrast to the upper Skagit Basin, the lower Skagit Basin WRIA 3 has numerous stream segments that have had temperature or fecal coliform TMDLs prepared (Table 6-3). In addition, there are numerous segments on the current 303(d) list for temperature, dissolved oxygen, fecal coliform, or pH impairment that will require preparation of TMDLs and implementation plans. Most of the impaired stream segments occur in tributaries to the Skagit River. There are six impaired segments in the mainstem Skagit River downstream of the Sauk River. Of these, four segments are listed for fecal coliform, one segment downstream of the Interstate 5 bridge at Mount Vernon is listed for pH, and one stream segment near the Burlington Northern train bridge at Mount Vernon (T34 R04 S08) is listed for polychlorinated biphenyl (PCB) concentrations in cutthroat trout, largescale sucker, and mountain whitefish fillets. The farthest upstream segment listed for fecal coliform is just upstream of the confluence with Hansen Creek (RM 25.3), one is near Mount Vernon, one is in the North Fork and one is in the South Fork. Because they are relatively far away, it is unlikely that Project operations have any effect on water quality conditions in these impaired river segments.

Although there are no streams within the Skagit River Basin on the 303(d) list for impairment from turbidity, fine sediment is a water quality parameter of concern in many areas of the basin, primarily due to forest management and road building, but several streams draining Glacier Peak also have naturally high turbidity and fine sediment levels due to glacial runoff. Because of a low level of management upstream of Gorge Dam to the U.S.-Canadian border, the streams draining into Gorge, Diablo, and Ross reservoirs are considered to be in good condition from a sediment supply perspective. USFWS (2004) identified Finney Creek and Grandy Creek in the Lower Skagit Basin as having high sediment loads, while SRSC and WDFW (2005) using a GIS modeling approach suggested that all tributaries in the Lower Skagit bull trout core area except Alder Creek, Pressentin Creek, and East Lake Shannon were impaired. The lower reaches of the Sauk River and Suiattle River have been identified as having been impacted by silt and sediment from glacial runoff, while Corkindale Creek, Diobsud Creek, Damnation Creek, and the Jordan-

Boulder WAU were identified as impaired as a result of forest management activities (SRSC and WDFW 2005).

The storage of water in Ross Lake and withdrawals from the hypolimnion may have altered the historic temperature regime downstream of the Project, but no empirical data or modeling is available to estimate the magnitude of any potential regime shift. Water temperatures of the project meet water quality standards for the spawning and rearing of anadromous salmonids and bull trout rearing and populations are relatively robust. An altered temperature regime from dams was specifically identified as not being a significant issue or limiting factor by SRSC and WDFW (2005).

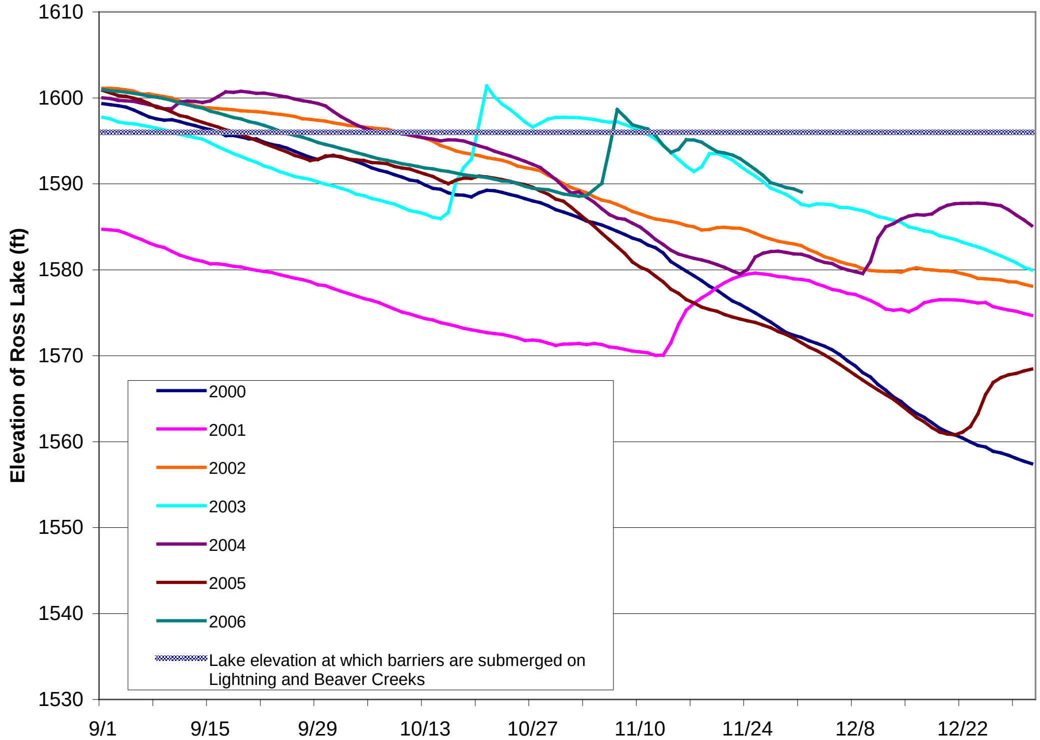
In conclusion, the Project has minimal impact on the water quality of the upper Skagit River. This river drains mountainous and glacial areas located mainly within national park and wilderness areas, and water flowing through the Project remains clean and cold throughout the year. This section of the Skagit River is not listed on the State's list of impaired water bodies. The Washington State Department of Ecology has stated in a letter to Seattle City Light that they support the water quality conditions for the Project. They also have acknowledged by letter that they waived their action on Section 401 due to situations beyond their control. (Washington Department of Ecology, letters October 7, 1991, and December 13, 1991) Furthermore, the Skagit River basin supports some of the healthiest fish populations in Washington, which reflects the excellent water quality conditions in the Project area.

### 6.1.2. General Status of Fish Habitat in the Skagit Basin

#### 6.1.2.1. Reservoir Habitat

Ross Lake covers 11,700-acres at the high water mark (1602.5 feet) in an average water year and is the largest reservoir in western Washington. It extends for approximately 24 miles, with the northern 1.5 miles in British Columbia. Shoreline length is approximately 54.5 miles. Ross Lake is a storage reservoir, and is drawn down in the fall and winter (Figure 6-3) for downstream flood control and to capture spring runoff, and refilled in the spring and summer. Glaciers draining to the basin contribute cool waters that provide excellent summer habitat for native bull trout and rainbow trout. At maximum drawdown permitted under the License, Ross Lake covers 4,400 acres at an elevation of 1,475 feet (City of Seattle 1973) and has a volume of 388,400 ac-ft.

The overall reservoir basin is deep, with steep shorelines, although the northern portion is relatively shallow (Looff 1995). At full pool, Ross Reservoir has a mean depth of 122.5 feet (Johnston 1989) and maximum depth near the dam is 400 feet (Looff 1995). One of the major effects of seasonal drawdown is the shift from lacustrine habitat to riverine habitat in the upper reservoir. As mentioned previously (Section 2.1.1.1), the seasonal drawdown to allow for flood control storage begins no later than October 1, with defined evacuated volume targets for November 15 and December 1. The reservoir must be maintained below 1,592 feet MSL between December 1 and March 15. The magnitude of drawdown varies from year to year depending upon snow pack and weather conditions and is coordinated with the Corps. On average, the seasonal drawdown is to approximately 1,528 feet MSL, which transforms about 7,886 acres of lacustrine habitat to about 5.3 miles of riverine habitat that drains into the reduced




Source: R2 Resource Consultants (2009).

**Figure 6-3. Reservoir elevation of Ross Lake, Washington during the fall spawning period of bull trout in 2000 through 2006.**

reservoir near the confluence of Silver Creek. At minimum pool (1,475 feet MSL) about 7,300 acres of lacustrine habitat becomes about 10 miles of riverine/delta habitat that drains into the reservoir near Little Beaver Creek.

Lands bordering Ross Lake are moderately to steeply sloped and forested. The generally thick, unconsolidated glacial till, alluvium, and outwash deposits along the Ross Reservoir shoreline are subject to erosion from waves, currents, freeze and thaw, groundwater discharge, and surface water flows (FERC 1995). Riedel (1990) estimated about 25 percent (14.4 miles) of the Ross Reservoir shoreline is in various stages of erosional retreat, with 1.7 acres per year estimated lost to shoreline erosion. Shoreline erosion can be exacerbated by drawdowns and result in localized increased turbidity in areas affected (Wright and Szluha 1980). Repeated drawdowns can result in finer materials, including nutrient-rich organic materials, gradually moving down into deeper waters leaving a relatively coarse material within the drawdown zone (Turner 1980).

Effects of the seasonal drawdown to trout and char because of changes to the amount of available lacustrine habitat have not been specifically examined for Ross Lake. The following is a general review of potential effects from the available literature. Adverse effects of seasonal drawdowns to lacustrine primarily occur within the littoral zone (Wright and Szluha 1980), which for most of Ross Lake is immediately adjacent to the shoreline. In non-fluctuating reservoirs the productivity and diversity of emergent vegetation, macrophytes, algae, and benthic macroinvertebrates (BMI) is generally the highest within the shallowest portions of the littoral zone and decreasing with depth (Wright and Szluha 1980). Shoreline areas are often where the highest density of large woody debris may be found, although in reservoirs such as the project area, stumps remaining from the original filling of the reservoir may be present in littoral or bathyl zones. Macrophytes are important sources of food, detritus, substrate, and cover for a variety of aquatic fauna (Wright and Szluha 1980).

The degree of adverse effects to macrophytes and BMI is dependent upon the duration of exposure and ability of fauna to utilize cover such as logs, roots, and vegetation mats that can provide some level of protection and increase the duration of exposure that can be withstood (Fillion 1967). Ice and snow can also provide some level of protection relative to sub-zero air temperatures (Paterson and Fernando 1969). During long periods of desiccation (50 days) and freezing temperatures (100 days) Paterson and Fernando (1969) found that most BMI died, including those that burrow deeply into the substrate. Production of chironomids and other benthic macroinvertebrates in a Missouri reservoir increased after the magnitude of fall drawdowns decreased (Benson and Hudson 1975). Many gastropods and mollusks can avoid desiccation of relatively long periods by burrowing into the substrate (Pennak 1953 as cited in Wright and Szluha 1980). Typically, BMI density and biomass are highest just below the drawdown zone in a reservoir and may result from higher levels of organic materials that filter in from the drawdown zone (Furey et al. 2006). Nevertheless, in general it appears that most literature suggests BMI community composition and density just below the drawdown zone declines relative to non-fluctuating water bodies, and the drawdown zone itself is severely affected. Over time the drawdown zone does become repopulated following re-inundation; however, the diversity of BMI may be reduced to fauna that have short generation times or have been able to effectively burrow in sediments (ISAB 1997). In contrast to the above, (Furey et al. 2006; ISAB 1997) found that density and biomass of BMI just below the drawdown zone in a reservoir located on Vancouver Island, British Columbia, that had experienced seasonal fluctuations for over 30 years was similar to a nearby natural lake with little fluctuation in water surface elevation. The available literature suggests that adverse effects to littoral habitat and BMI are likely occurring in Ross Lake within the drawdown zone. However, the magnitude of these effects is uncertain, as are the effects to higher trophic levels such as bull trout.

Other than spawning habitat, direct effects of drawdowns to fish using the littoral zone have also not been specifically investigated in Ross Lake. The effects described in the literature are usually a depression of spawning success for species that spawn in the drawdown zone or trapping and stranding of fish, especially fry. The dominate fish species in Ross Lake are salmonids that utilize the tributary streams for spawning. The drawdown generally occurs at a slow rate, such that trapping and stranding of fish is unlikely. Drawdowns will reduce the volume of the reservoir and the available littoral habitat that could be used by bull trout inhabiting the lake. In Chester Morse Lake, Washington, bull trout were found to occupy all areas of the lake, but most bull trout were observed in the profundal zone (Connor et al. 1997). Vertical gillnet and hydroacoustic sampling in Chester Morse Lake suggested bull trout were primarily benthic oriented during daylight hours and fish would leave these locations at night. The highest counts of bull trout occurred during moonless, cloudless nights. Little information is available about bull trout habitat use in lakes during the winter. Two radio-tracked bull trout in Lake Pend Oreille were observed at depths of 26 to 203 feet during fall and winter (Bassista et al. 2005). Bull trout are generally less active during winter months. McLellan et al. (2008) found that deep drawdowns, in addition to release location and water retention time, affected the likelihood of tag returns for stocked rainbow trout in Lake Roosevelt and hypothesized that increased entrainment was the mechanism for reduced returns. Almost complete drawdown of a reservoir is occasionally used a control method for undesirable fish species (ISAB 1997); however, drawdowns to that extent do not occur in Ross Lake.

SCL (1989) placed Ross Lake tributaries into three categories depending on effects to spawning habitat (for rainbow trout) within the drawdown zone of the lake or access to upstream spawning habitat:

- Access to tributaries unaffected by surface elevation
    - Many barriers above full pool and little spawning habitat
        - Devils Creek
        - Little Beaver Creek
    - No barriers present, spawning habitat in drawdown region affected
        - Roland Creek
        - Ruby Creek
        - Silver Creek
        - Skagit River
- Tributaries with decreasing alluvial fan spawning habitat as surface elevation increases
    - Arctic Creek
    - Dry Creek
    - Hozomeen Creek
    - No Name Creek
    - Pierce Creek
- Tributaries with increasing spawning habitat when barriers submerged
    - Big Beaver Creek (barrier submerged at elevation 1597)
    - Lightning Creek (barrier submerged at elevation 1596)

The second category of tributaries historically had spawning primarily restricted to the alluvial fans near the mouths of the creeks, with little spawning habitat available upstream. Inundation of the alluvial fans eliminated nearly all spawning habitat for these streams. In contrast, Big Beaver Creek and Lightning Creek historically had migration barriers at their mouths, and inundation allows access to substantial amounts of spawning habitat upstream of the barriers. SCL (1989) concluded the increase in spawning habitat gained from Big Beaver and Lightning creeks at full pool balanced the amount lost through inundation of alluvial fans.

Accumulations of drift logs, drift boom logs, sediment or debris within the drawdown zone at the mouths of tributaries could potentially block trout migration. As part of the Skagit FSA, SCL agreed to inspect tributary mouths on an annual basis in Diablo and Gorge reservoirs and selected tributaries in Ross Lake prior to April 1. The selected Ross Lake tributaries include

Lightning, Roland, Little Beaver, Big Beaver, Devils, Silver, Ruby, Arctic, Dry, Hozomeen, and Pierce creeks, but can be adjusted at the discretion of the NCC. Any transitory barriers identified during the inspections would be removed. While rainbow trout were originally the primary intended beneficiaries of this activity, bull trout may also benefit from the removal of obstructions.

Diablo Dam, located downstream from Ross Dam creates Diablo Lake which is 4.5 miles long, has a surface area of 910 acres and shoreline length of 14.6 miles (Table 6-4.), and used primarily for daily and weekly regulation of discharge from Ross Powerhouse. Full pool elevation is 1,205 ft MSL. Under normal operations Diablo reservoir ranges from elevation 1,205 to 1,201.5 feet. Occasionally, the reservoir is drawn down a few feet lower but rarely below elevation 1,197 feet. The upper 1.5 miles of Diablo Reservoir is the tailwater of the Ross project, and exhibits large fluctuating flows. At times during the daily drawdown, this area of the reservoir becomes more riverine in nature than lacustrine. Much of the land surrounding Diablo Dam consists of steep, exposed rock or talus sparsely covered with scattered conifers and shrubs. The remaining areas are moderately to steeply sloped and forested.

**Table 6-4. Surface area, volume, and shoreline length of Skagit River Hydroelectric Project reservoirs.**

| Reservoir | Surface Area (acres) | Volume (acre-feet) | Shoreline Length (mi) |
|---|---|---|---|
| Gorge Lake | 240 | 8,500 | 8.8 |
| Diablo Lake | 910 | 89,000 | 14.6 |
| Ross Lake | 11,700 | 1,435,000 | 54.5 |

The most downstream generating facility, Gorge Dam and Powerhouse, is located about 4 miles downstream of Diablo Dam. Gorge Lake is relatively narrow (generally less than 700 ft wide) and the smallest of the three Skagit reservoirs with a surface area of 240 acres (Table 6-4.) and fluctuates only a few feet from its full pool elevation of 875 ft MSL in order to provide maximum head for Gorge Powerhouse. The reservoir includes approximately 8.8 miles of shoreline. Both the Diablo and Gorge facilities are operated with water released from Ross Powerhouse and tributaries such as Thunder Creek. Some limited bull trout spawning habitat is present in the upper reservoir, within a mile of Diablo Dam (WDFW 1998), but it is uncertain if any bull trout actually spawn in this reach. The upper parts of the Gorge Reservoir between Diablo Dam and the Diablo Powerhouse may be dewatered when Gorge Reservoir is not at full pool (FERC 1996). There is very limited storage in the Gorge and Diablo reservoirs. Gorge Lake is aptly named for the cliffs and talus slopes comprising much of the area bordering the reservoir. The few flat areas adjacent to the reservoir are developed, and the remaining steep areas have been logged (Envirosphere 1988).

### 6.1.2.1.3. Wood Recruitment

Woody debris can be an important component of aquatic habitat in both riverine and reservoir habitats (Bjornn and Reiser 1991; Northcote and Atagi 1997). Woody debris provides habitat complexity, cover, and substrate for fish and macro invertebrates. As woody debris decomposes, it may also provide nutrients to the water column and sediments (Harmon et al. 1986). Large woody debris (LWD) in reservoirs can be divided into three categories, each with distinct biological functions, based upon wood location: 1) submerged LWD, 2) floating LWD, and 3) shoreline LWD; each of these three categories of LWD is described in more detail below.

Submerged LWD. The biological effects associated with submerged wood in reservoirs have been studied more thoroughly in systems containing warmwater fisheries than coldwater fisheries. Two reviews prepared by Ploskey (1985) and Laufle and Cassidy (1988) almost exclusively involve studies of warmwater lacustrine systems. During the late 1980s, several papers were published from field studies conducted in Wyman Lake, Maine, to determine the ecological importance of submerged pulpwood logs on fish (Moring et al. 1986; Negus 1987; Moring et al. 1989). All three of these papers showed that suckers and shiners were attracted to areas containing large concentrations of submerged logs, while yellow perch were more abundant in areas without logs.

A common practice observed throughout central and southeastern United States reservoirs is the retention of standing timber in new reservoirs to provide fish and wildlife habitat when they are filled (Laufle and Cassidy 1988). Studies have shown that such reservoir structures function well as fish attractants and produce higher standing crops of warmwater sportfish such as largemouth bass and crappie (Layher 1984; Willis and Jones 1984, as cited in Ploskey 1985).

In coldwater systems, selective clearing in the littoral zone and at the mouth of tributaries may reduce the accumulation of woody debris that could otherwise impede the movement, spawning, or feeding of salmonids (Faubert 1982, as cited in Ploskey 1985). Research on a small, uncleared reservoir located on the Falls River, British Columbia, determined the surfaces of standing flooded timber contained diverse and abundant periphyton and invertebrate communities (Bradley 1983). Timber in Project reservoirs were cleared prior to reservoir filling, leaving stumps throughout much of the reservoirs' bottoms. Stomach analysis of cutthroat trout and Dolly Varden trout from the reservoir showed that more than half of the prey taken by these two species was found on the submerged tree surfaces. These findings suggest that standing submerged timber was highly important to the production of these two salmonid species. Northcote and Atagi (1997) reviewed proposed plans to harvest submerged timber in Nechako Reservoir, British Columbia, and concluded that the removal of standing, floating, and submerged trees in the littoral zone would negatively impact those species of periphyton and invertebrates that colonize the surface of submerged timber. The authors suggested that a reduction in these taxa could impair the existing fish community's (including kokanee and rainbow trout) feeding, growth, and production potential.

Floating LWD. Information on the function of floating LWD in coldwater lakes and reservoirs is scarce. In warmwater lakes, floating rafts of wood provide rearing habitat and escape cover for juvenile fish, increase habitat complexity, and provide additional surface area for invertebrate production. On Cazenovia Lake, New York, Helfman (1979) observed that substantially greater numbers of juvenile warmwater species utilized the area directly beneath artificial floats compared to an adjacent empty frame control float. Predator species were also observed near the floats, but there was no evidence that the floating cover, rather than the presence of prey species, attracted the predators. Helfman (1979) suggested that the area of floats used in his experiments might have been too small to attract substantial numbers of predator fish species.

On the negative side, large accumulations of logs stored in lakes with poor circulation can lead to concentrated regions of reduced water quality. A study conducted in Babine Lake (647 square km in area), British Columbia, showed that zooplankton, the dominant food supply of juvenile sockeye salmon, was significantly lower in log-handling areas compared to log-free littoral zones (Power and Northcote 1991). Further, the authors' results suggested that log storage might negatively impact juvenile sockeye habitat by reducing water quality within the storage area.

The extent of use of floating debris rafts by salmonids is probably minimal and likely restricted to larger juveniles and smolts that have moved out of the littoral zones and into deeper habitats. In this scenario, floating debris rafts likely provide cover from terrestrial predators. However, floating debris rafts may also provide nesting platforms and potential resting areas for avian piscivorous predators.

Shoreline LWD. If woody debris is delivered to Ross, Diablo, or Gorge lakes, a portion could eventually become stranded on tributary deltas, the floodplain or gravel bars and, when inundated during high pool conditions, serve as littoral habitat for aquatic invertebrates and fish. As reservoir levels recede, some of the non-anchored pieces could float off of these areas and into the main portion of the reservoir.

Tabor and Piaskowski (2002) surveyed nearshore habitat use by juvenile salmon in lakes Washington and Sammamish in western Washington. They observed no significant difference in juvenile Chinook salmon densities between the open shoreline and woody debris/overhanging vegetation areas during the daytime, but at night, significantly more juveniles were observed in the open habitat (Tabor and Piaskowski 2002). Conversely, juvenile coho showed a significant preference for woody debris areas during the daytime, and although most moved into open areas at night, they were usually located within close proximity of the woody cover (whereas Chinook salmon would stray farther from the cover). During their Lake Sammamish surveys near the woody debris areas, Tabor and Piaskowski (2002) observed a large school of Chinook salmon and coho juveniles seeking refuge in the shallow nearshore area underneath woody debris after being chased by two mergansers. Surveys of two woody debris areas in Lake Washington showed that during early spring (February and March), juvenile Chinook salmon were observed directly under or within close proximity to the woody debris, but during April and May they were observed farther away from the wood (Tabor and Piaskowski 2002).

The distribution, amounts, and sources of submerged, floating, or shoreline LWD in Ross, Diablo, and Gorge reservoirs have not been quantified. Fluctuations in Lake Ross pool levels may affect wood recruitment indirectly by affecting the development of riparian trees adjacent to the drawdown zone. Wood recruitment mechanisms adjacent to lakes or reservoirs are primarily windthrow, senescence, or mass wasting events. Recruitment may also occur by transport from tributaries or the mainstem Skagit River, but the size of many of the tributaries may be too small to transport large wood pieces that could provide substantive habitat structure. Ross Dam prevents the transport of LWD from the upstream areas into Lake Diablo, Gorge Lake, and areas downstream of Gorge Dam. While some LWD recruitment occurs along the shorelines and from tributaries at Lake Diablo and Gorge Lake, this amount is likely a small fraction of what is recruited into Ross Lake and removed at Ross Dam because they have a relatively small shoreline area and relatively few tributaries that could contribute LWD. Removal of LWD and Ross, Diablo, Gorge dams likely reduces the availability and function of submerged, floating, and shoreline LWD in Diablo and Gorge lakes and the availability of LWD downstream of Gorge Dam. Current LWD conditions downstream of Gorge Dam are discussed in Section 6.1.2.2.

#### 6.1.2.1.4. Sediment

Based on observations at other dams and characteristics of the Skagit River system, Ross, Diablo, and Gorge lakes likely trap coarse and fine sediment delivered from tributaries. Sediment consists of bedload, the coarsest portion of the total sediment yield, and suspended load, which is fine enough to travel in suspension within the water column. Bedload and suspended sediment may be supplied from tributaries or from shoreline erosion, while only suspended sediment is transported from upstream mainstem reaches to reaches below Ross Dam. Sediment in tributaries originates on hillslopes and is delivered to stream channels via erosion or mass wasting. The downstream transport of the coarsest sediment is interrupted as transported material settles out in the low velocity reservoir environment. The location and composition of the trapped deposits from the tributaries is dependent upon local water velocity and the size composition of materials delivered from the tributaries. Deposits of sediments may have developed deltas near the mouths of tributaries but the size and location of these deltas have not been mapped in any of the three project reservoirs.

Delta channels may offer productive habitats that are used by spawning and rearing fish. Sediment has a role in aquatic habitat because it provides substrate for BMI, and aquatic and emergent macrophytes may become established among areas of fine sediment deposition. Macrophytes, in turn, provide habitat complexity, cover, and also provide substrate for BMI. BMI are an important food source for many of the fish species residing in Project reservoirs. Fine sediments that infiltrate coarse materials can adversely affect their suitability as spawning substrate. Suspended fine sediments can also settle on fish eggs, resulting in oxygen deprivation and mortality. Trapping also reduces the availability of coarse sediment downstream of Gorge Dam. Current spawning habitat conditions downstream of Gorge Dam are discussed in Section 6.1.2.2

### 6.1.2.2. Instream Habitat

#### 6.1.2.2.5. Upstream of Gorge Powerhouse

There are six tributaries that flow into the Gorge Reservoir watershed with about 54 miles of stream drainage of which about 28 miles are considered fish bearing and 1.5 miles are accessible to adfluvial fish (Table 6-5). Two of the tributaries are considered to have potential bull trout spawning habitat and Stetattle Creek is the largest (Table 6-5). Stetattle Creek drains Azure Lake. WDFW (1998) considers the lower 1.7 miles of Stetattle Creek and the mainstem Skagit from the reservoir to Diablo Dam the primary spawning area for this provisional local population.

Eight tributaries enter the Diablo Reservoir watershed with about 203 linear miles of stream drainage, about 63 miles of fish bearing stream, and a little over 11 miles of adfluvial fish habitat (Table 6-5). The largest tributary within this watershed is Thunder Creek (17.8 miles long) (Williams et al. 1975). WDFW (1998) suggests that most spawning occurs in the Thunder Arm area, including Fisher Creek. The lower section of Thunder Creek has been surveyed (R2 Resource Consultants 2009), and although no char or redds were observed in late October and early November, available habitat in the lower reach is considered "excellent" for spawning. The lower reach has abundant gravel substrate, dominated by small cobbles and large gravels, with long runs and glides at depths and velocities that are well suited for spawning char.

**Table 6-5. The length of fish bearing habitat available to salmonids above full pool for tributaries (excluding the Skagit River) to reservoirs of the Skagit River Hydroelectric Project.**

| Reservoir | Watershed Assessment Unit | Fish Bearing Stream Length (mi)[1] | Adfluvial Habitat[2] | |
|---|---|---|---|---|
| | | | Length (mi) | Spawning area (sq ft) |
| Gorge Lake | Gorge Lake | 27.7 | 1.5 | 1,832 |
| Diablo Lake | Thunder Creek | 63.4 | 11.2 | 24,119 |
| | Arctic Creek | 17.2 | 0 | 0 |
| Ross Lake | Big Beaver Creek | 48.2 | 8.6 | 36,622 |
| | Devils Creek | 15.0 | 0 | |
| | Granite Creek/Swamp Creek | 31.8 | 6.6 | 0 |
| | Hozomeen Creek | 6.0 | <0.1 | 74 |
| | Lightning Creek | 21.5 | 0.3 | 2,240 |
| | Little Beaver Creek | 30.0 | <0.1 | 0 |
| | Ruby Creek/Panther Creek | 26.2 | 4.1 | 31,709 |
| | Silver Creek | 8.2 | 0.5 | 400 |
| | Slate Creek | 38.4 | 6.4 | 30,268 |
| | Three Fools Creek | 33.4 | 0 | 0 |
| | Total | 242.5 | 39.4 | 127,264 |

1. WADNR (2006)
2. SCL (1989)

Ross Reservoir drains rugged mountain terrain, with deep canyons, and its average width at full pool is about one mile (Looff 1995). There are 33 tributaries entering the U.S. portion of the upper Skagit basin above Ross Dam that provide about 950 linear miles of stream drainage (Williams et al. 1975) of which about 243 miles are fish bearing (Table 6-5) and 39 miles are accessible to adfluvial fish.

Approximately 400 square miles of the Skagit River drainage is in British Columbia (USFWS 2004) that include 1,894 miles of stream (Triton Environmental 2008). Approximately 137 miles of stream have been confirmed as fish bearing and approximately 163 miles were inferred to be fish bearing (Triton Environmental 2008). Triton Environmental (2008) reported a bedrock-controlled falls is present on the Skagit River just upstream of Snass Creek that likely restricts char to areas downstream. Bull trout surveys have primarily been limited to the portion of the mainstem Skagit River downstream of the Sumallo River (Murray and Gaboury 2005), located approximately 146 miles upstream of the US-Canada border, but have also included a portion of the Sumallo River (Triton Environmental 2008). Half of the sites visited by Triton Environmental (2008) were considered high quality rearing habitat for trout and char that are widely distributed in the Skagit River watershed upstream of the U.S.-Canada border. Another 32 percent of the 60 sites visited were considered moderate quality. A helicopter survey during November 2001 identified over 50 bull trout redds in the upper Skagit River from river kilometer (RK) 1.0 to RK 31.0 with additional redds observed in the middle and upper Sumallo River (Nelson et al. 2002). Most redds (31) were found in the reach from RK 10 to RK 18 (26-mile Bridge). Other surveys have also identified the reach downstream of 26-mile Bridge as important for bull trout spawning (Nelson et al. 2004; Nelson et al. 2003; McPhail and Taylor 1995). Most overwintering habitat is located in the mainstem of the river (Triton Environmental 2008).

Gorge Dam is located at RM 97 while the Gorge Powerhouse is at RM 94.3. There are no minimum flow requirements within the 2.7-mile long Gorge bypass reach and flows are generally low except during spill events. In the 1991 Skagit FSA, intervenors (National Park Service; Fish and Wildlife Service; Bureau of Indian Affairs; U.S. Forest Service; National Marine Fisheries Service; Upper Skagit Tribe, Sank-Suiattle Tribe, and Swinomish Indian Tribal Community; Washington Department of Fisheries; Washington Department of Wildlife; and the North Cascades Conservation Council) agreed that flows in the bypass reach were not needed as long as SCL complied with the provisions of the Skagit FSA. Flow in the reach primarily derives from groundwater seepage and four small non-fish bearing tributaries that drain into the bypass reach. Intervenors in the Skagit FSA also agreed they would not object if the bypass reach were reclassified, such that less restrictive water quality standards would apply. The bypass reach has a special condition status granted by the State designating that water temperatures should not exceed 21°C. Monitoring by SCL documents compliance with this status (Envirosphere 1988).

#### 6.1.2.2.6. Downstream of Gorge Powerhouse

Downstream of the Gorge Powerhouse, the Skagit Hydroelectric Project primarily affects habitat conditions in the 27-mile reach extending to the Sauk River (Connor and Pflug 2004; Graybill et al. 1979). Mean annual flow in the Skagit River increases 36 percent (4,480 cfs to 6,110 cfs) between Newhalem and Marblemount (above the Cascade River confluence) and 147 percent (to 15,090 cfs) below the Baker River. The average annual flow of the Sauk River near Sauk is 4,342 cfs (1929 to 2009).

The Skagit Hydroelectric Project has the potential to primarily affect the following habitat components:

- Coarse sediment supply
- LWD supply
- Instream flows

- Riparian vegetation
- Ecosystem function
- Floodplain connectivity
- Aquatic productivity
- Trophic interactions

Each of these components will be discussed in the following subsections.

## Coarse Sediment Supply

The nature and quality of salmonid habitat in rivers is determined, in part, by the transport and instream storage of sediments recruited from upland areas (Spence et al. 1996). In free-flowing river channels, coarse, gravel-sized sediment is primarily transported downstream during moderate to high flows and is stored within the channel bed and banks during intervening low-flow periods. Suitably-sized gravel to cobble substrate is important for Chinook salmon, steelhead, bull trout, and other salmonid spawning habitat. Sediment transport and deposition are also important for shaping the morphology of the river and consequently the quality and quantity of rearing or overwintering habitat for ESA-listed fish species.

The Skagit River character has been greatly influenced by historic glacial advances and recessions. As the continental ice that covered the action area melted northward, widespread deposition of glacial sediments occurred throughout the basin. The melting ice also may have modified the flow direction for portions of the river upstream of the Skagit Gorge from a historic northern path to the Fraser River to the present westward direction (Riedel et al. 2007). Ross, Diablo, and Gorge dams retain bedload material derived from the upper Skagit River and its tributaries. Although the dams clearly disrupt bedload transport, adverse effects to spawning habitat appears to be minimal in the reach between Gorge Powerhouse and the Sauk River because spawning gravel is abundant in the river below the project, and large amounts of gravel move into the river each year from glacial fed tributaries. For example, sufficient bedload sediment is recruited from Ladder Creek and other tributaries in the Gorge bypass to provide spawning habitat immediately downstream of the Gorge Powerhouse (Figure 6-4). Although the dams reduce gravel recruitment into the reach below Gorge Powerhouse, flow management may partially offset the reduction by reducing the frequency and magnitude of peak flow events and reducing downstream transport of spawning gravels.

As part of a screening process for identifying potential restoration and protection projects, Beamer et al. (2000, 2005b) utilized a GIS model to rate the condition of WAUs in the basin relative to sediment supply. The model used basin geology to estimate natural sediment supply rates and land cover levels as a multiplicative factor that ranged from 1 to 6 depending upon the geologic class. When estimated supply levels were more than 1.5 times the natural levels and greater than 100 $m^3/km^2/yr$, the WAU was considered impaired. Several WAUs draining to the reach between Gorge Dam and the Sauk River were considered impaired (Figure 6-5) including Corkindale Creek, Damfino (Damnation Creek, Thorton Creek, Alma Creek), Diobsud Creek, and Jordan-Boulder, (the lower Cascade River downstream of Marble Creek). Compared to the lower Skagit River that included many impaired WAUs, incubation habitat upstream of the Sauk River was considered relatively good (SRSC and WDFW 2005).


**Figure 6-4. Chinook salmon and steelhead spawning habitat located immediately below the Gorge Powerhouse.**

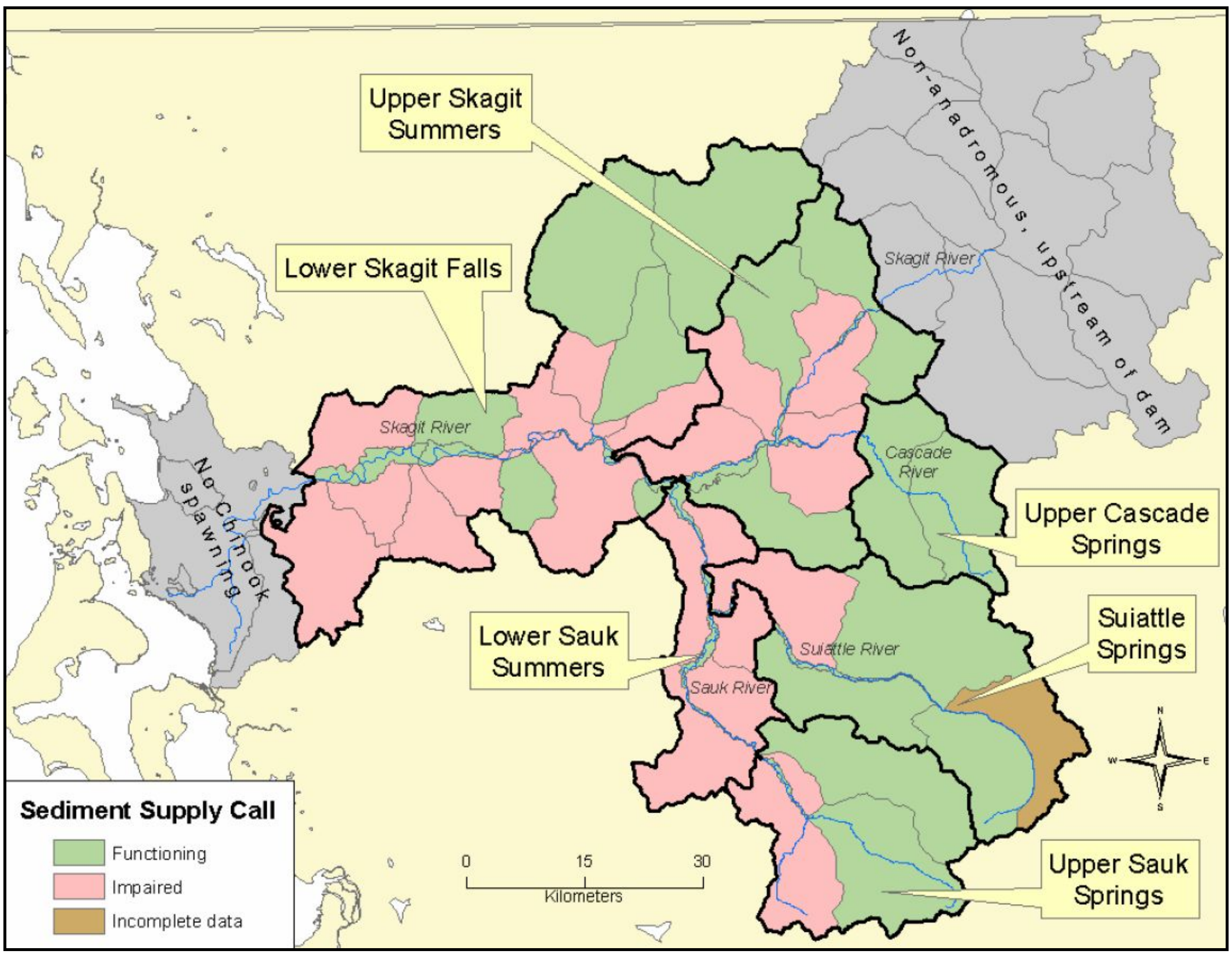



**Figure 6-5. Watershed sediment impairment ratings from Beamer et al. (2005b).**

Empirical information that maps the quantity and quality of spawning habitat in the Skagit River mainstem between the Sauk River and Gorge Powerhouse is not available, and the degree to which bedload recruitment and transport are balanced is unknown, but annual spawner and redd surveys suggest appropriate-sized substrate is widely distributed. The Skagit Chinook Recovery Plan (SRSC and WDFW 2005) does not consider the Upper Skagit Summer Chinook salmon population to be limited by spawning gravel availability, but are concerned about relatively high sediment loads from some tributary streams, the potential effects of fine materials that could reduce the quality of spawning habitat, and the potential effects of scour in places where bedload aggradation occurs.

## LWD supply and Riparian Conditions

LWD is an important component to freshwater habitat providing cover, complexity, substrate, and nutrients. In riverine systems, wood remaining on the floodplain reduces water velocity, allowing suspended sediments to be deposited adjacent to the anchored wood. These sediments provide ideal conditions for the establishment of new riparian vegetation (Maser and Sedell 1994). LWD is also important for creating and maintaining stream channel form. Wood recruitment mechanisms into streams are primarily from channel migration, windthrow, senescence, or mass wasting events (Spence et al. 1996). Loss of wood in a reach comes from breakage, decomposition, and downstream transport of LWD pieces during high flow periods (Naiman et al. 2002; Maser et al. 1988).

Ross, Diablo, and Gorge dams block the transport of LWD from upstream locations. Most LWD collected at Ross Dam is burned while some of the larger pieces are used by SCL and the NPS for restoration and bank stabilization projects along the Ross Lake shoreline (Connor 2010b, pers. comm.). Large pieces of LWD are collected from Diablo and Gorge reservoirs, stored downstream of Newhalem and released to the Skagit River during high flow events. No information is currently available on the quantity of LWD in the mainstem Skagit River between Gorge Powerhouse and the Sauk River confluence, but a study is being conducted by the Skagit River System Cooperative.

As a screening tool, Beamer et al. (2000) conducted a GIS-based assessment of riparian conditions that utilized the intersection of land cover (forest seral stage) and anadromous fish bearing streams that was cross-checked with field surveys. Beamer et al. (2000) recognized there were limitations to the tool, primarily as a result of the resolution of the land cover data. Nevertheless, SRSC and WDFW (2005) concluded that anadromous fish bearing streams upstream of the Sauk River had significantly degraded riparian areas (Figure 6-6).

Fox and Bolton (2007) reported median density of LWD pieces exceeding 10 cm in diameter and 2 m in length for streams 30 to 100 m wide was 106 pieces per 100 m of channel with an inter-quartile range of 22 to 63 pieces per 100 m. Furthermore, the minimum size recommended for a key piece in a stream 50 to 100 m wide was 10.75 $m^3$ with a root-wad attached. Although there is no LWD inventory information available, the loss of LWD natural transport from areas upstream of Ross, Diablo, and Gorge dams plus low riparian function screening indices from Beamer et al. (2000) suggests instream LWD levels downstream of Gorge Dam are likely near

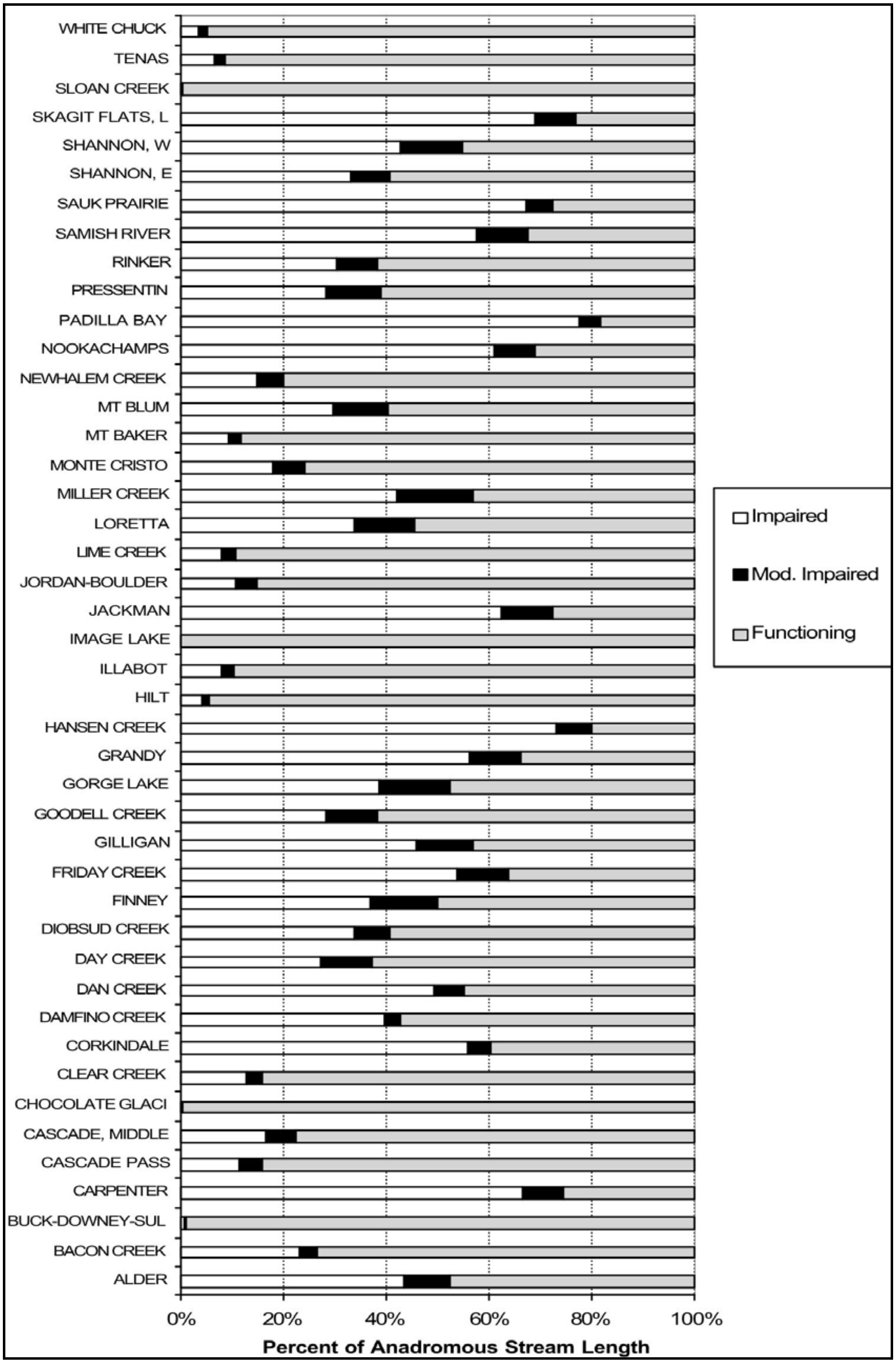



**Figure 6-6. Watershed riparian impairment ratings from Beamer et al. (2000).**

the low end of the range observed by Fox and Bolton (2007) within western Washington streams and unlikely to exceed levels considered adequate for proper function by the NMFS (1996) and USFWS (1998), which have a criterion of more than 80 pieces per mile greater than 24 inches in diameter (61 cm) and 50 feet in length (15.2 m). Ongoing field studies should help to reduce the uncertainty regarding this conclusion.

## Instream Flows

Dams and reservoirs are often constructed and operated to manipulate instream flows for flood control and shaping hydroelectric production. SCL's three facilities on the Skagit River are operated as a single project. The objective of flow manipulation is to store water on a seasonal or daily basis and then release it later for a variety of beneficial uses that could also include flood control, irrigation, fish protection, and recreation. However, instream flow manipulations can have adverse, and in some circumstances beneficial, effects on fish and other aquatic fauna. The types of adverse effects to fish from fluctuating flows downstream of dams are similar to many of the effects of fluctuating reservoir levels described above. These include (Hunter 1992):

- Changes in the amount of habitat
- Stranding, especially fry and juveniles
- Increased juvenile emigration
- Increased predation
- Desiccation of eggs
- Decreased abundance and diversity of macroinvertebrates
- Interruption of spawning

The effects of power generation and flood control operations at the Skagit and Baker Projects have potential cumulative, additive and synergistic effects on bull trout, steelhead, and Chinook salmon in the lower mainstem Skagit River. The effects of flow fluctuations at the Skagit Project continue downstream but dampen in magnitude and are typically observed as river level changes at the USGS gage near Concrete (RM 54.1) about 6 to 8 hours after the Skagit Project flow change depending on the background flow level. Due to the 40-mile travel distance between the Skagit Project and the Skagit River near Concrete gage, the wave exhibited by load-following operations at the Skagit Project attenuates, or flattens as the wave travels downstream. The combination of wave attenuation and operational restrictions associated with the Skagit FSA tends to reduce the amplitude of the Skagit Project load-following wave and broadens or increases the width of the wave trough as it passes downstream. By the time Skagit Project flow reductions reach the Baker River confluence, these reductions typically do not coincide with flow reductions caused by the Baker Project.

Studies conducted during the 1970s and 1980s (Graybill et al. 1979; Stober et al. 1982; Pflug and Mobrand 1989; Monk 1989; Thompson 1970; Woodin 1984) documented flow fluctuations from the Project adversely affected egg, embryo, and fry survival and affected the abundance of aquatic insects (Gislason 1985). Stranding of salmon and steelhead fry occurs in potholes and on gravel bars, particularly for salmon fry when downramping occurred during daylight hours (Pflug and Mobrand 1989).

Resource agency recommendations for flows were made for the Skagit Project as a whole, rather than separate requirements for each of the three facilities, to provide maximum benefit for fish. The Skagit FSA resulted in a number of major changes to Project operations under the original license that were intended to reduce or eliminate the negative impacts of flows on salmon and steelhead in the upper Skagit River by implementing the flow measures agreed to in the FSA and additional voluntary measures described in Section 3.3.1 These operational changes, which occurred in two phases, resulted in the current operations that mitigate the potential effects of flow manipulation.

- FSA Measures
  - Salmon spawning and redd protection from dewatering (Section 2.3.1)
  - Salmon fry protection from trapping and stranding (Section 2.3.2)
  - Steelhead spawning and redd protection from dewatering (Section 2.3.3)
  - Steelhead fry protection from trapping and stranding (Section 2.3.4)
- Voluntary Measures
  - Variable seasonal measures implemented as part of Adaptive Management (Section 2.3.5)
  - Steelhead and Chinook salmon yearling protection from trapping and stranding (Section 3.3.1)
  - Salmon fry protection start date (Section 3.3.1)
  - Chum salmon spawning start date (Section 3.3.1)

Based upon the results of hydrological, instream flow, redd protection, and fry stranding models, SCL implemented flow management measures met or exceeded the conditions specified by the Skagit FSA. These flow measures protect the eggs and embryos of steelhead, Chinook salmon, pink salmon, and chum salmon from dewatering during their incubation period, and minimize the stranding of salmon and steelhead fry on gravel bars in the river.

According to the Skagit FSA, implementation of the flow and non-flow mitigation measures "resolves all issues related to the effects on fisheries resources of the Project, as currently constructed, for the period May 12, 1981 through the duration of this Agreement." In addition "The Parties stipulate that this Agreement constitutes adequate fish protection and compensation for fishery losses caused by the Project, as currently constructed, for the period May 12, 1981 through the duration of this Agreement." (Skagit FSA, page 2). Agencies and Tribes were signatories to this settlement agreement.

Analysis of the abundance and distribution of Chinook salmon, pink salmon, and chum salmon in the reach between the Sauk River and Gorge Powerhouse demonstrates the flow measures being implemented have had the intended beneficial effects on the salmon population spawning in the reach (Connor and Pflug 2004). Spawner abundance of all three species progressively increased in an upstream direction following implementation of flow measures and increases were greatest in the reach immediately downstream of the Gorge Powerhouse, suggesting the effects of flow manipulation diminished because of unregulated flow inputs from the Cascade

River and Sauk River. Pink and chum species commonly spawn along the shallow channel margins of the Skagit River (Stober et al. 1982). Increases in pink and chum spawner abundance were linked to the reduced risk of redd dewatering and protection of this shallow margin areas (Connor and Pflug 2004). Reduction in stranding rates was also important to increased abundance of pink and chum.

In contrast to pink and chum salmon, Chinook salmon spawner abundance was only observed to increase within the upstream-most of the three reaches examined. Because Chinook salmon generally spawn in relatively fast and deep water (Stober et al. 1982), it was concluded that Chinook salmon have a substantially lower risk of redd dewatering compared to pink and chum salmon. Instead, it was suggested flood protection measures, which reduces the risk of scour, also protected incubating eggs. In addition, reductions in the magnitude and rate of downramping reduced the risk of Chinook salmon fry stranding. Together these factors both contributed to the observed increase in Chinook salmon spawner abundance in the upper reach (Connor and Pflug 2004).

Notably, steelhead spawner abundance between the Gorge Powerhouse and Sauk River has not responded to the implementation of the Skagit FSA and voluntary flow measures in a manner analogous to pink, chum, and Chinook salmon. In part, this may be the result of trophic interactions between steelhead and bull trout. As indicated previously, Lowery (2009a) estimated a population size of 1,602 bull trout greater than 300 mm in the mainstem reach between Newhalem and Rockport during 2008. Furthermore, Lowery (2009a, 2009b) documented bull trout foraging on a wide variety of food items including a significant amount of salmonid eggs and fry. Based upon bioenergetic modeling, Lowery (2009a) estimated bull trout consumed up to 87 percent of age 0 steelhead fry and up to 74 percent of age 1 parr during 2007 and up to 3 percent of age 0 fry and up to 67 percent of age 1 parr during 2008. Lowery (2009a) concluded that bull trout were having a “highly negative effect” on steelhead yearlings that contributed to low adult returns. In contrast, Lowery (2009a) concluded the effects of bull trout predation on Chinook salmon fry and yearling abundance was minor.

## Floodplain Connectivity

Instream flow is also important to the maintenance of channel morphology and riparian conditions. Rivers construct and maintain channels such that small and moderate-sized discharges (less than or equal to flows with a 2-year recurrence interval) are contained within the channel, while larger discharges that occur less frequently exceed the channel capacity and overflow onto the floodplain. During floods, water is stored in sloughs and side channels, or seeps into floodplain soils recharging groundwater storage. This stored groundwater slowly drains back to the channel, providing a source of cool inflow during the summer (Naiman et al. 1992).

Low-gradient, unconfined channels, such as found in the mainstem Skagit River downstream of Gorge Powerhouse and portions of the Sauk, Cascade, and Suiattle Rivers, migrate back and forth across their floodplains in sinuous patterns in response to differential patterns of bank erosion and sediment deposition. Channel migration may occur as a result of slow, steady erosion of the outside of a meander bend, or it may occur as a sudden shift into an old channel during flood events. As a result of these processes, natural low gradient, alluvial channels typically develop a network of low-flow channels containing numerous gravel bars, side channels, abandoned oxbow lakes, sloughs and wetlands. Such off-channel and mainstem margin habitats are an important component of juvenile salmonid rearing habitat within the Skagit River providing rearing habitat and refuge from high flows. The formation, availability and quality of off-channel habitat are currently limited due to flood control operations and land-use changes. Channelization and construction of county flood-control levees, revetments and roads has disconnected many formerly accessible side channels. Flood storage operations at the Baker and Skagit projects has reduced some of the large channel-altering flows that historically threatened people and property but were also responsible for creating new side channels.

Under existing conditions, Corps' flood control operations can affect the formation and quality of off-channel and side-channel habitats within the floodplain. The Skagit River upstream of the Sauk River has historically provided a wealth of off-channel spawning and rearing habitat for significant populations of wild-spawning chum and coho salmon in addition to rearing habitat for all salmon species and bull trout. Prior to the construction and operation of the Skagit Project, the unregulated flows allowed for natural channel forming processes responsible for the creation of off-channel habitat during flooding events.

SRSC and WDFW (2005) estimated approximately 31 percent of floodplain areas upstream of tidal influence are impaired as a result of hydromodification and other floodplain structures that constrain the lateral movement of the river (Table 6-6). The highest proportion of impairment (48%) in the mainstem reach was between the Sauk River and Cascade River and the highest amount of floodplain area impaired in the lower Skagit River (2,391 hectares). The mainstem Skagit River upstream of the confluence with the Cascade River had the lowest ratio of off-channel to mainstem channel length. The strategy for restoration of freshwater rearing habitat in the Skagit River basin is focused upon reconnecting isolated floodplain areas and restoring mainstem edge habitat by removing, relocating, or improving hydromodifications and floodplains structures.

Based upon floodplain road density and the percent and amount of channel length modified, Smith (2003) assigned ratings of good, fair or poor to Skagit River subbasins. The lower Skagit River subbasin floodplain condition was rated poor due to the presence of an extensive network of dikes and loss of wetlands, the upper Skagit River and Sauk River subbasins floodplain conditions upstream of the Sauk River were rated fair due to moderate levels of hydromodification and the presence of roads within the floodplain, and the Baker River subbasin floodplain condition was rated poor because of the inundation of the lower Baker River floodplain by Shannon and Baker lakes.

Many of the habitat measures being implemented by SCL in the lower river are targeted for floodplain zones (Section 2.4.1.1) designed for the protection of existing (functioning) off-channel habitat through acquisition, restoration of existing off-channel habitat, or construction of new off-channel habitat. To date nearly 3 miles of off-channel habitat has been acquired, restored or built. Smith (2003) concluded the creation of off-channel habitat and improvements to existing off-channel habitat from enhancement projects implemented by SCL and other entities upstream of the Sauk River has resulted in current amounts of floodplain and off-channel habitats being equivalent or higher than historical levels. He also concluded that additional floodplain enhancement in the future would not be needed.

**Table 6-6. Floodplain impairment affecting Chinook salmon rearing habitat in the Skagit River basin.**

| Chinook Population(s) Affected | Rearing Range | Channel Length (m) | Percent Floodplain Area Impaired | Ratio off-channel to channel length |
|---|---|---|---|---|
| Lower Skagit | All Stocks | 118,521 | 37 | 1.73 |
| Upper Skagit Summer | Upper Skagit Summer and Upper Cascade Spring | 43,822 | 48 | 1.42 |
| Upper Skagit Summer | Upper Skagit Summer | 10,561 | 28 | 0.65 |
| Upper Cascade Spring | Upper Cascade spring | NA | 4 | NA |
| Lower Sauk Summer | All Sauk and Suiattle | 53,150 | 27 | 2.60 |
| Lower Sauk Summer | Lower Sauk Summer and Upper Sauk Spring | 67,324 | 16 | 2.22 |
| Upper Sauk Spring | Upper Sauk Spring | 25,368 | 6 | 1.97 |
| Suiattle Spring | Suiattle Spring | 52,343 | 6 | 1.29 |
| **Total** | | 371,089 | 31 | 1.69 |

Source: SRSC and WDFW (2005).

## Aquatic Productivity

Relatively little information is available regarding the production of periphyton and benthic macroinvertebrates (BMI) in the Skagit River basin. The NPS and Skagit Valley College have conducted some BMI sampling in the Skagit River basin, but results from these assessments are not currently available. Ecology (Undated) has collected BMI samples in 6 tributary streams in WRIA 4: Bacon Creek, Diobsud Creek, Finney Creek, Illabot Creek, Jackman Creek, and Pressentin Creek and one stream in WRIA 3: O’Toole Creek (Table 6-7). The analysis included calculation of the River Invertebrate Prediction and Classification System (RIVPACS) score. A RIVPACS score of 1.0 means that all expected taxa are present in the sample while a score of less than 0.86 indicates a degraded condition relative to a reference condition. All but three of the 10 samples for which there are RIVPACS scores had values that would be considered representative of degraded conditions. The multiple years of sampling within Diobsud Creek and O’Toole Creek suggests substantial annual or site variability may occur in the BMI community. For example, the RIVPACS score for O’Toole Creek was 1.05 in 1998 and 0.85 in 1999 suggesting substantial degradation occurred over the year. Information collected on substrate type suggested materials were substantially finer during 1999, with larger proportions of fine gravel and sand.

Wiseman (2003) identified three clusters of BMI similarity within Washington State based upon collections at 45 sites (27 Puget lowland sites, 14 Cascade sites, and 4 coastal sites). The two sites from the Skagit River Basin upstream of the Cascade River (Diobsud Creek and Bacon Creek) were in a cluster of 11 sites that consisted of 9 sites from the Cascades (both east and west of divide) and 2 coastal sites. Notably, none of the Puget lowlands sites fell within the cluster, suggesting there may be at least two relatively distinct BMI communities in the Skagit River, one in the upper basin represented by the Cascade cluster and one in the lower basin represented by the Puget lowlands cluster.

The sampling by Ecology provides some understanding of the BMI community and conditions within tributaries, but conditions within the mainstem river are uncertain. SCL is considering implementation of a biodiversity assessment of the Skagit River mainstem using tributary streams considered to be in good condition as references points (Section 3.4.2.2). The upper Skagit River Biodiversity Assessment study should provide a better understanding of the extent of the Project effects on the BMI community. The following provides a literature review of potential effects.

**Table 6-7. Benthic Macroinvertebrate sampling in the Skagit River basin by Ecology (Undated).**

| Sample Location | Year Sampled | No. Samples | RIVPACS Score |
|---|---|---|---|
| Bacon Creek | 2000 | 4 | 0.98 |
| Diobsud Creek | 2004 | 4 | 0.72 |
| | 2003 | 4 | NA |
| | 2002 | 4 | NA |
| | 2000 | 4 | 0.93 |
| | 1995 | 4 | 0.81 |
| Finney Creek | 1995 | 4 | 0.56 |
| Illabot Creek | 1995 | 1 | 0.56 |
| Jackman Creek | 1995 | 1 | 0.56 |
| Pressentin Creek | 1998 | 4 | 0.81 |
| O'Toole Creek | 1999 | 4 | 0.85 |
| | 1998 | 4 | 1.05 |

Rapid short-term flow fluctuations have a pronounced, adverse effect upon the benthic macroinvertebrate community (Gersich and Brusven 1981; Armitage 1984; Saltveit et al. 1987; Cushman 1985; Moog 1993). Essentially, such fluctuations impose the effects of both reduced and increased flows on a reach of river, inflicting a difficult set of conditions upon benthic fauna residing within the affected area. Therefore, those BMI that remain in a river reach subject to short-term fluctuations must be adapted to withstand the rapid changes in discharge (Munn and Brusven 1991). Those taxa feeding under constant flows or in a narrow range of current velocity would be eliminated or competitively disadvantaged (Ward and Stanford 1979).

Areas with repeated dewatering and re-inundation of shoreline areas and fluctuating current velocities over submerged substrates were commonly called the varial zone, and were characterized by reduced invertebrate density and diversity (Fisher and LaVoy 1972; Hauer et al.

1989; DosSantos et al. 1988). The varial zone is often visually distinctive in streams subjected to frequent flow fluctuations as an area of the streambed that is lighter colored than adjoining substrates that is a result of the lack of algae and periphytic growth on permanently wetted substrates. Several studies below dams with pulse-type flow releases have reported a presence of a varial zone (Gislason 1985; Perry and Perry 1986; Troelstrup and Hergenrader 1990; Blinn et al. 1995; DeVries et al. 2001; Grzybkowska and Dukowska 2002).

Potential effects of pulse-type flow operations on the BMI communities generally relate to 1) loss of productive habitat within the varial zone of the littoral stream margins that are periodically exposed during the increase (up-ramp) and decrease (down-ramp) flow cycle (Brusven et al. 1974; Gislason 1985), 2) cycles of increased – decreased drift during the upramp and downramp cycle (Brusven and MacPhee 1976; White and Wade 1980; DeVries et al. 2001) potentially resulting in a reduction in invertebrate standing crop in permanently wetted areas; and 3) stranding of aquatic invertebrates (Brusven et al. 1974; Corrarino and Brusven 1983) within the varial zone during the downramp period.

Under flow conditions of the original Project license, Gislason (1985) concluded that the effects of power peaking adversely influenced insect density along the margins of the Skagit River, Washington. Under fluctuating flows, insect density increased in the direction from shallow to deep water, and density decreased with increasing number of hours of dewatering prior to sampling. Diversity appeared to increase with water depth, and decrease with increased duration of dewatering. Gislason (1985) determined that the density of chironomid larvae was greatest in shallow water, suggesting that they are more tolerant of stream margin dewatering.

Many studies have observed and reported on the drift response of macroinvertebrates to flow regulation (Brusven et al. 1974; Cereghino and Lavandier 1998a; Cereghino and Lavandier 1998b; Moog 1993; Perry and Perry 1986; White and Wade 1980). Catastrophic drift is usually associated with flow-related disturbances, but can also be due to disturbances involving pollution or changes in temperature regime (Brittain and Eikeland 1988). Catastrophic drift can be due to both flow increases and decreases, either due to natural occurrences such as floods or spates and droughts, or due to river regulation, as caused by various pulse-type flows.

Stranding of macroinvertebrates occurs mostly due to rapid flow reductions along gently sloping shorelines. Depending on the season, time of day, and the length of period that the shoreline remains exposed, stranded organisms can dry out and die. During a series of experimental flow reductions in the Snake River, Brusven et al. (1974) determined the fate of stranded organisms. An initial flow reduction from 27,000 to 18,000 cfs resulted in the stranding of chironomids, the principal inhabitants of the shoreline at that level. Greatest stranding occurred during the reduction from 12,000 to 7,700 cfs. The mayflies *Baetis* and *Ephemerella*, and chironomids were most readily observed as stranded and substantial numbers of *Hydropsyche* sp. were found seeking shelter under rocks and in algal mats.

Application of minimum flow programs to reduce the extremes of flow fluctuations have demonstrated increases in macroinvertebrates (Weisberg et al. 1990). The Susquehanna River below Conowingo Dam, Maryland experienced daily flow fluctuations from 106 cfs to over 35,000 cfs (Weisberg et al. 1990). In 1982, the minimum flow requirements were raised from

April to September to protect fish and invertebrates. Weisberg et al. (1990) compared macroinvertebrate abundance in 1980 to that in 1982, when minimum flow was increased. Total density was greater in 1982 than in 1980, due to an increase in chironomids and caddisflies. Caddisfly larvae were not common in 1980, increasing from 17.3 to 922.3 individuals/sampling basket in 1982. After minimum flow requirements were discontinued, declines of more than three orders in magnitude were seen in chironomid and caddisfly densities. By establishing a higher minimum flow, benthic macroinvertebrates were provided with extra protection from stresses of exposure and desiccation, and a continuous food supply by the current (Weisberg et al. 1990).

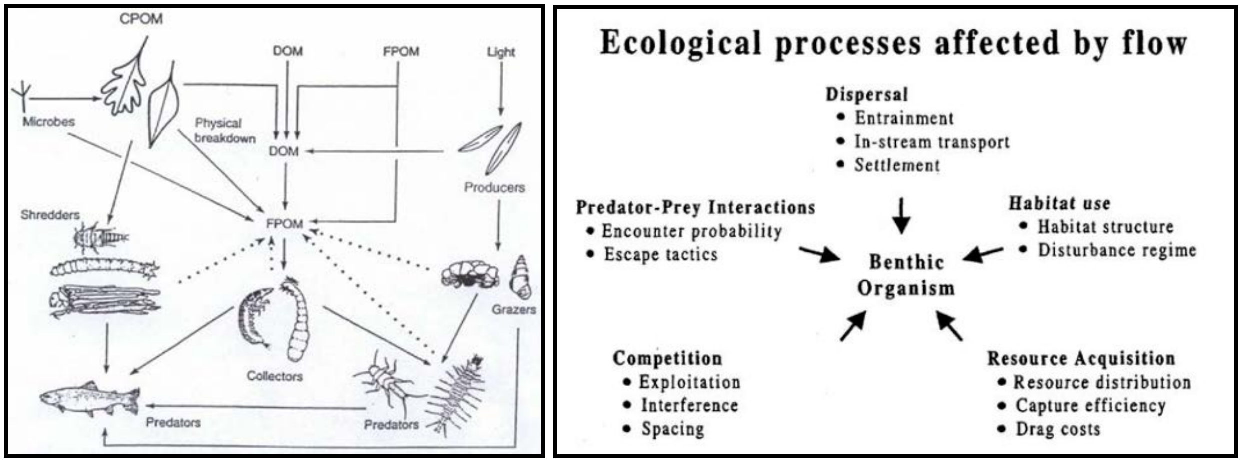
There have not been any analyses in the reach downstream of Gorge Powerhouse to determine the effects of changes in Project operations implemented as part of the FSA to BMI. Presumably the changes implemented to reduce stranding and trapping of Chinook salmon and steelhead fry and to reduce the risk of dewatering redds also had a positive effect on benthic macroinvertebrates, but the magnitude of the effect is unclear. The relatively strong production of anadromous salmon in the reach and relatively high abundance of bull trout, all of which use BMI as part of their diet, supports a conclusion that the BMI community in the reach is healthy.

## Trophic Interactions

Food webs, ecological processes, and energy pathways are complex. For example, Hart and Finelli (1999) identified flow as being an important factor in five ecological processes affecting BMI (Figure 6-7). BMI include multiple trophic levels (herbivores, carnivores, and detritivores) and BMI were only one of variety food items used by bull trout (Lowery 2009b). Based upon analysis of stable carbon and nitrogen isotopes, Lowery (2009a) concluded bull trout in the Skagit Basin were in the top trophic level of a three-tiered system and a substantial portion of their energy was marine-derived (e.g., anadromous fish eggs, fry, and carcasses). Complexity suggests the food web and potential interactions between trophic levels beneath a top predator such as bull trout can be convoluted. The available information is limited in its ability to identify specific Project effects on the interactions among different trophic levels except on a theoretical basis.

Many of the previous subsections suggest Project operations may affect multiple trophic levels and it is likely that interactions among these trophic levels do occur, but the importance of these interactions on ESA-listed fish species in the basin are difficult to discern. Interruption of LWD and gravel transport can affect the size and type of woody and hard substrate available to periphyton and BMI. LWD, as it decomposes, also provides organic material important as a food source to some BMI. Dampening of peak flows for flood control can reduce the level of disturbance to stream substrate and development of side-channels that can provide greater diversity in habitat types and increased wetted area available to BMI and fish. Fluctuating flows can affect the behavior, diversity, and abundance of BMI and the survival of fish eggs, fry, and yearlings. Top-level predators, such as bull trout, can potentially affect the abundance of other fish species, and are also potentially affected by the diversity and abundance of forage species available to them.

Several investigators (Petts 1984; Kinsolving and Bain 1993; Power and Dietrich 2002) have suggested that disturbances can influence food-web dynamics; thus it is reasonable to conclude




Sources: Hershey and Lamberti 2001, Hart and Finelli 1999.

**Figure 6-7. Simplified food web for North American forested stream (left) and alternative causal pathways by which flow can affect benthic macroinvertebrates (right). Major energy inputs include fine-particulate organic matter (FPOM), coarse particulate organic matter (CPOM), and dissolved organic matter (DOM). Key components of each ecological process can be modified by flow, thereby affecting the performance, distribution, and abundance of benthic macroinvertebrates.**

that fluctuating flows may similarly affect food-chain linkages that lead to fish community structure and abundance. Power et al. (1996) noted that functionally important food chains in rivers typically increase with flow regimes that experience flow variation, including drought (low flows) and bed-scouring floods (high flows), i.e., large magnitude, low frequency, short duration pulse flows. Power and Dietrich (2002) suggested there could be a shortening in food chain length in regulated systems where high flows that result in gravel scour are eliminated. In that case, invulnerable invertebrate (more fish predation resistant) taxa would tend to proliferate more than more vulnerable soft-bodied organisms, which could have implications relative to fish food availability and energy transfer.

Wootton et al. (1996) used a multi-trophic model to develop predictions of the ecological interactions among a large predatory case-building caddisfly species, sessile BMI grazers (midges and mayflies), and steelhead trout with and without substrate-disturbing flood flows. They concluded that patterns of algae and BMI grazer abundance observed in fabricated instream channels with experimentally manipulating caddisfly and steelhead abundance could only be explained if substrate-disturbing (i.e., flood flow) effects were incorporated in the model. Wootton et al. (1996) argued that broader community or food web perspectives are needed when developing resource management strategies.

Project effects and trophic interactions are confounded by the large number of anadromous fish including Chinook, pink, chum, and coho salmon, and steelhead that spawn in the action area. Marine-derived nutrients are likely the most important sources to the river and the basis for a highly productive and energetic ecosystem. Bull trout, in particular, appear to benefit from marine-derived energy sources (Lowery 2009a). Bisson and Bilby (1998) identified the presence of carcasses from anadromous salmonids as an important component to maintaining stream productivity. They suggested that managing populations for maximum harvest rates (i.e., MSY) and use of hatchery production likely yield insufficient numbers of carcasses in a system and could result in a downward trend in overall productivity. Gresh et al. (2000) compared historic and current levels of marine derived nutrients and estimated Puget Sound levels have declined approximately 75 percent for nitrogen and phosphorus because of reduced numbers of anadromous carcasses. Relative to other streams and rivers in the Puget Sound region, the Skagit River may have maintained a higher proportion of its historic marine-derived nutrient levels because anadromous populations are relatively abundant and the diversity of anadromous species is relatively high, which can increase both the temporal and spatial availability of marine derived nutrients. While the Skagit Project likely reduces the level of nutrients transported from the basin upstream of the Project, this amount is anticipated to be very small compared to the marine-derived component. Furthermore, flow control by the Project, decreases peak flows and helps to retain marine-derived energy for a longer period.

As described in the subsection on instream flows, there is some evidence for trophic interactions between bull trout and steelhead in the Lower Skagit River Core Area. Steelhead spawner abundance downstream of Gorge Powerhouse have not responded as expected from flow measures designed to reduce the risk of redd dewatering and steelhead fry trapping and stranding. The current working hypothesis is that flow measures have had the desired effect, but the steelhead spawning population abundance has not responded due in part to predation by bull trout on steelhead fry and yearlings. In other words, flow measures designed for steelhead have resulted in an indirect and unexpected benefit for bull trout.

### 6.1.3. Puget Sound Chinook Salmon

#### 6.1.3.1. Spawning habitat

Spawning habitat conditions for Puget Sound Chinook salmon in the Skagit River basin ranges from poor to good depending upon location. None of the Chinook salmon populations are considered to be lacking sufficient quantities of appropriately-sized substrate, but the quality in some areas is poor as a result of fine sediment resulting from natural glacial sources and increased sediment load from land use practices. With the exception of the upper Skagit River upstream of the Sauk River, spawning habitat for Chinook salmon is impaired to some extent by fine sediment (Figure 6-5). The most severely degraded reach that results primarily from land use activities is the lower Sauk River that is used by summer Chinook salmon and affected by a combination of natural sediment loading from glacial sources and land use practices (SRSC and WDFW 2005). In order from most to least impaired spawning habitat from sediment by Chinook salmon population are Lower Sauk River Summer, Lower Skagit Fall, Lower Suiattle Spring, Upper Sauk Spring, Cascade River Spring, and Upper Skagit Summer Chinook salmon populations.

Spawning habitat can also be at risk of scour from peak flow events that can be exacerbated by substrate aggradation, roads, and stream bank modifications (primarily riprap and dikes). Based upon SRSC and WDFW (2005), the Lower Sauk River Summer and Lower Skagit Fall Chinook salmon populations are at high risk of adverse effects from floods, the Lower Suiattle Spring Chinook salmon is at low to moderate risk, and the Upper Sauk Spring Chinook salmon, Cascade River Spring population, and Upper Skagit Summer Chinook salmon populations are at low risk, particularly for spawning habitat in the mainstem river upstream of the Sauk River, which is protected from all but the highest flood events as a result of flood control at Ross Dam.

#### 6.1.3.2. Rearing Habitat

SRSC and WDFW (2005) identified a number of limiting factors within the river basin that could affect the quality and quantity of fry and juvenile rearing habitat: degraded riparian zones, dam operations, sedimentation and mass wasting, high water temperature, hydromodification, water withdrawal, and loss and reduced connectivity of delta habitat. As a general trend, degradation and loss of rearing habitat is highest in the delta region and gradually improves in an upstream direction as the number and severity of the limiting factors decline. The quantity and condition of rearing habitat for fry and parr Chinook salmon in the Skagit River delta is considered the greatest bottle-neck for all six of the Skagit River Chinook salmon populations, but particularly for the Lower Skagit Fall Chinook salmon, Upper Skagit Summer Chinook salmon, and lower Sauk Summer Chinook salmon populations that have relatively high proportions that use the delta or fry life history strategies.

#### 6.1.3.3. Migration Corridors

With the exception of about 20 miles of spawning habitat inundated by the Baker River Hydroelectric Project, Chinook salmon have access to nearly all of the historic spawning areas available. However, similar to the juvenile rearing habitat described above, the condition of migration corridors for Chinook salmon are likely impaired in some areas from loss of off-channel habitat, hydromodification, reduced riparian function and LWD recruitment, and high sediment loads. Large pools greater than 3.3 feet deep are considered an important habitat type for holding by upstream migrating adult salmon (Washington Forest Practices Board 1997). While the Skagit Chinook Recovery Plan (SRCS and WDFW 2005) does not mention the availability of holding pools as a critical impairment anywhere in the system, it does mention restoration activities designed to increase pool depth and volume, and that reduce the amount of plane-bed channel types and increases the amount of pool-riffle channel types. Smith (2005) noted the lack of pool habitat data for the Skagit River Basin. Although there appears to be a lack of specific information regarding migration corridors for Chinook salmon, this biological evaluation assumes that migration corridors are generally functioning properly because of the overall lack of concern within the Chinook Recovery Plan.

### 6.1.4. Puget Sound Steelhead

#### 6.1.4.1. Spawning Habitat

Winter and summer-run steelhead in the Skagit Basin substantially overlaps that of the Chinook salmon populations, but includes more extensive use of tributary habitat such as Nookachamps Creek, Diobsud Creek, Finney Creek, Jackman Creek, and Illabot Creek. Spawning habitat conditions for steelhead are likely to be similar to that of Chinook salmon with adequate quantities of suitably-sized substrate where access is available, but with conditions impaired in some mainstem areas and tributary reaches from high sediment loads. The NMFS consider the Skagit Gorge reach upstream of Gorge Powerhouse to be within the historic spawning range for steelhead, albeit with suboptimal conditions due to gradient. Project operations are considered to have an adverse effect on the limited spawning habitat present in the reach.

### 6.1.4.2. Rearing Habitat

The limiting factors identified by the SRSC and WDFW (2005) for Skagit River Chinook salmon rearing habitat, namely: degraded riparian zones, dam operations, sedimentation and mass wasting, high water temperature, hydromodification, water withdrawal, and loss and reduced connectivity of delta habitat, would similarly affect steelhead rearing habitat. Similarly, degradation and loss of rearing habitat is highest in the delta region and gradually improves in an upstream direction as the number and severity of the limiting factors decline.

The amount of specific habitat survey information in the basin is sparse and primarily from smaller tributary streams; however, it is likely to be representative of steelhead rearing habitat conditions elsewhere in the basin where similar land use practices (primarily forestry, but some livestock production as well) have historically occurred. Smith (2003) summarized the results of watershed analyses conducted by the Washington Department of Natural Resources (WDNR) in the Hansen (lower Skagit subbasin) and Jordan-Boulder (upper Skagit subbasin) WAUs and the USFS in the Sauk River and Finney Creek/Lower Skagit River. With few exceptions tributary streams in the lower Skagit subbasin and Jordan-Boulder WAU were considered to have poor rearing conditions because of high sediment loads, low levels of instream LWD, and poor riparian conditions. High sediment loads and low levels of LWD were implicated in reduced pool habitat. In contrast, conditions were mixed in the Sauk River subbasin with some WAUs in poor condition, while others were in fair to good condition. Pool habitat in the mainstem Sauk River was rated poor from RM 31.9 to 39.7, poor to fair in the South Fork Sauk River with one short good section, and poor in most tributary streams. A decline in pool habitat from surveys conducted 1984 to the early 1990s was cited as a concern.

### 6.1.4.3. Migration Corridors

Smith (2005) reports the results of a barrier screening procedure using GIS-based information. The results suggested access to habitat in some tributary streams may be limited by barriers, primarily culverts at road crossings. The analysis identified 122 high priority barriers (>1000 $m^2$ of weighted habitat area present upstream), 197 medium priority barriers (100 – 1000 $m^2$), and 253 low priority barriers (0 to 100 $m^2$). Most high priority barriers were located in tributaries to the lower Skagit sub-basin. The Carpenter, Nookachamps and Hanson Creek watersheds were rated "poor" because of the large number of high and medium priority barriers. Less severe barrier problems were also reported for the Jones, Mannser, Red Cabin, Gilligan, Morgan, Careys, Alder, and Grandy Creek watersheds. Watersheds considered to have good access included Sorenson, Loretta, Cumberland, Pressentin, and Jackman creeks. Access into tributaries in the Upper Skagit and Sauk sub-basins was generally good. Exceptions with a few high or medium priority barriers included Jordan and Shoemaker Creeks (lower Cascade River), Barnaby Slough and Babcock Creek. Prairie Creek and Everett Creek in the Sauk sub-basin were identified as having several high and medium priority barriers and considered to have poor access. For fish trapped at the lower Baker River and released, Smith (2005) also considered access into tributaries above upper Baker Dam was generally good with additional field analysis needed to access the impact of potential barriers in Little Sandy and Channel creeks. However, steelhead are currently not released above upper Baker Dam and the importance of access to these creeks is minor unless a program for reintroducing steelhead to the upper Baker system is re-initiated.

### 6.1.5. Bull Trout

#### 6.1.5.1. Spawning Habitat

Spawning habitat surveys are generally lacking for bull trout populations in the basin. Downen (2006a) has described the SF Sauk River spawning reaches as "high quality." Based primarily upon GIS-based analyses (Beamer et al. 2000), spawning habitat for some bull trout local populations could have suboptimal spawning conditions as a result of fine sediment inputs resulting from poor land use practices. Areas of particular concern include the Forks of the Sauk River, SF Sauk River, Tenas Creek, and other lower tributaries to the Sauk River. None of these areas are affected by Project operations. Spawning habitat in the Baker subbasin is considered to be generally in good condition (Smith 2003), except tributaries along the west side of Lake Shannon which have been affected by road-related landslides. Spawning habitat in the Upper Skagit Core Area is generally in excellent condition because of the protection provided by the National Park status. Access to spawning areas is potentially in conflict with water management in Ross Lake. However, the seasonal drawdown for flood control generally begins after most bull trout spawning is completed.

#### 6.1.5.2. Rearing Habitat

The limiting factors identified by the SRSC and WDFW (2005) for Skagit River Chinook salmon rearing habitat, namely: degraded riparian zones, dam operations, sedimentation and mass wasting, high water temperature, hydromodification, water withdrawal, and loss and reduced connectivity of delta habitat, would similarly affect bull trout rearing habitat in the lower Skagit Core Area, particularly for larger bull trout that have migrated out of headwater streams and use the larger mainstem rivers that have been more affected by structures placed within floodplains. Similar to spawning habitat, rearing habitat in the Upper Skagit Core Area is considered excellent because of protection within the National Park System.

#### 6.1.5.3. Migration Corridors

Reduced connectivity between local populations is identified as one of the important threats to bull trout in the Puget Sound DPS (64 FR 58910). In the Skagit River Basin, reduced connectivity is one of the effects of the Baker and Skagit hydroelectric projects. Both of the projects pass some bull trout downstream that can potentially spawn with downstream local populations. The Baker Project also collects bull trout at a trap in the lower Baker River and releases them upstream if they carry a PIT tag identifying them as part of the Baker River population. Bull trout without a PIT tag are returned to the Skagit River. In the mainstem Skagit River, movement of bull trout upstream from the lower river was historically unlikely because conditions in Diablo Canyon naturally created a barrier. Consequently, historical movement of genetic material by bull trout in the mainstem Skagit River was unidirectional from upstream to downstream. Recent genetic analysis supports this conclusion by identifying bull trout collected from Stetattle Creek as part of a unique population having more genetic similarities to bull trout collected from the Upper Skagit Core Area than from the Lower Skagit Core Area (Smith and Naish 2010).

Bull trout entrained at Ross, Diablo, or Gorge dams move downstream either by passing over the spillways or passing through the turbines. It is currently unknown how many bull trout are entrained at the dams and by which pathway. Some level of injury or mortality is likely through both pathways. Factors that could affect the magnitude of downstream entrainment and mortality include the size of spill, the size of fish, and other turbine specific and operational factors. Bull trout that are entrained and survive passage are lost to the local populations of the Upper Skagit River Core area, but may contribute to local populations in the Lower Skagit River Core Area.

The Diablo Reservoir and Gorge Reservoir local populations may be most at risk from lost connectivity and the loss of genetic diversity because of their relatively small watershed areas. However, these local populations, if historically present, were probably relatively isolated before construction of the Project because of natural barriers. Genetic analysis by Smith and Naish (2010) suggests Stetattle Creek local population has been isolated sufficiently long to diverge from Big Beaver Creek and Ruby Creek local populations. Although data on these populations are scarce, available information suggests that opportunities for dispersal are quite limited. In turn, the effective population size for these local populations may be quite small. Although the minimum amount of genetic diversity that must be maintained to ensure the persistence of bull trout populations is not yet known, Rieman and McIntyre (1993) have suggested that large numbers are required. Rainbow trout tagged in Ross Reservoir have passed over the spillway and been caught in Diablo and Gorge reservoirs (Johnston 1989), which identifies a potential mechanism for downstream gene flow in bull trout. However, prolonged periods of concurrent spill at the three dams have occurred only three times since 1972, and do not represent a reliable mechanism for gene dispersal. While the Diablo and Gorge Reservoir local populations may be at relatively high risk, the overall risk of lost genetic diversity to the Lower Skagit Core Area or Upper Skagit Core Areas are relatively low because of the overall diversity of the core areas and the large number of local populations present. Furthermore, the relatively high level of risk to the Diablo Reservoir and Gorge Reservoir local populations was likely present prior to Project construction because of isolation by natural barriers.

The construction of Ross Dam may have actually increased the level of connectivity in the Upper Skagit Core Area. The upper Skagit populations may have been "superconnected" rather than isolated by the dams according to McPhail and Taylor (1995). The evidence for this is provided by the presence of Dolly Varden trout genetic markers in the majority of Ross Lake bull trout. Many of the Ross Lake streams, including Lightning Creek, Little Beaver Creek, and Big Beaver Creek were formerly hanging glacial valleys, and were isolated from one another by falls prior to the filling of Ross Lake. McPhail and Taylor (1995) stated that Ross Lake may have provided a connection between once isolated populations, which would explain the unusual genetic composition of upper Skagit char. Further complicating the lineage of Dolly Varden and bull trout in the upper Skagit River is that portions of the upper basin drained towards the Fraser River and Okanogan Rivers prior to breaching of a local divide by overflow drainage of proglacial lakes at the location of the Skagit Gorge during retreat of the Fraser glaciation, which was an arm of the Cordilleran ice sheet, less than 3 million years ago (Riedel et al. 2007). Baxter et al. (1997) suggested that in areas of sympatry between Dolly Varden and bull trout from recent glacial activity, relatively high levels of hybridization may occur until sufficient time has allowed for reproductive isolation.

Perhaps more significant than the genetic effects of isolation is the increased risk of environmental and demographic stochasticity on small isolated populations (Rieman and

McIntyre 1993). This risk is relatively low for the Upper and Lower Skagit Core areas, which overall have relatively high abundance and many diverse local populations, but may be relatively high for the Diablo Reservoir and Gorge Reservoir local populations. A single mass wasting or other stochastic event could potentially eliminate an entire brood year. Population specific data to determine risk of extinction for the Diablo Reservoir and Gorge Reservoir subpopulations is limited. Downen (2006b) found that native char (bull trout or Dolly Varden trout) accounted for nearly 18 percent of the gill net catch in Gorge Reservoir during August 2006 and included fish age 2 to age 5+, which suggests the native char population in Gorge Reservoir is likely in at least fair condition. Offsetting the risk of adverse stochastic events is the fact that bull trout spawn in a variety of habitats, and exhibit iteroparity and considerable variability in age at maturity, making the risk of such an event eliminating the entire local population unlikely. Nevertheless, such an event would likely put the local populations at a high risk of extinction if other factors came into play, such as a prolonged drought. Close monitoring would be needed in order to evaluate whether the local population was recovering following the event and to determine if additional management actions are needed.

### 6.1.6. Cumulative Effects

Cumulative effects are those effects of future State or private activities, not involving Federal activities, which are reasonably certain to occur within the action area of the Federal actions subject to consultation. These include the following:

- Baker Hydroelectric Project Activities
- WDFW/SRSC Skagit Chinook Recovery Plan
- Puget Sound Partnership Salmon Recovery Plan
- Skagit County Strategic Plan for Wild Salmonids
- Skagit Watershed Council Strategic Plan
- WDFW/Tribal Hatchery and Harvest Programs

The Baker Hydroelectric Project obtained a new 50-year FERC license in October 2008. License articles related to fish were primarily derived from a comprehensive settlement agreement (Baker CSA) between Puget Sound Energy and 24 stakeholders. Implementation of the Baker CSA and requirements of the FERC license have the potential to affect ESA-listed species within the action area, primarily fish residing downstream of the confluence with the Baker River. Actions likely to affect ESA-listed species in the action area include:

- Flow regime
- Gravel augmentation
- Large Woody Debris Management Plan
- Water quality
- Operation of the Lower Baker Fish Trap

The Baker River Project and Skagit River Project both affect flow levels in the Skagit River downstream of Baker River. Similar to the Skagit Project, the Baker Project operates primarily as a load following generation facility that results in fluctuating flows. As described previously, fluctuating flows from the Skagit Project propagate downstream as a wave that dampens in magnitude as it moves downstream. By the time it reaches the Baker River confluence, the waves from the Baker Project and Skagit Project usually do not coincide. Consequently the physical characteristics of the flow wave downstream of the Baker River are complex. Based upon average annual flow, the Baker River provides approximately 16.7 percent of the Skagit River flow downstream of its confluence while Skagit River flow at Newhalem, downstream of the Skagit Project provides approximately 29.7 percent of the flow. The remainder of the flow derives from tributaries, such as the Sauk River and Cascade River that have no flow regulation.

Prior to the current Baker FERC license, flows in the lower Baker River were usually greater than 80 cfs to allow operation of the trap and haul facility and flows in the middle Skagit River (RM 24.5 to RM 56.5) and the lower Skagit River (downstream of RM 24.5) in combination with flows from the upper river affected by Skagit River Project flows could fluctuate up to 6,000 to 8,000 cfs (PSE 2005). Under the new license the Baker Project would have minimum flows downstream of lower Baker Dam that would range from 1,000 cfs in the late summer to 1,200 cfs during the remainder of the year. In addition, ramping rate restrictions of less than 0, 1, or 2 inches per hour would apply depending upon the time of day and year when Skagit River flows upstream of the Baker River near Concrete are less than or equal to 26,000 cfs. The minimum flows and ramping rate restrictions are designed to stabilize flows in the Skagit River downstream of Baker River in order to improve fish habitat, reduce stranding of fry and other aquatic fauna, and reduce redd dewatering (PSE 2005). A change to Baker River Project flow regime may also reduce the magnitude of peak flow events and consequently reduce the risk of scour to salmonid redds.

The Baker Project includes both upstream and downstream passage facilities. At upper Baker Dam, the downstream facility includes a barrier net that guides fish to a trap located on an attraction barge (known as the “Gulper”) mounted with pumps that provide attraction flow. Lower Baker Dam has a similar facility, but it is smaller than the gulper at Upper Baker Dam. Under the Baker River Settlement Agreement an improved downstream passage facility is being designed for Lower Baker Dam and construction should be completed over the next several years. Captured fish are sampled for biological information, marked or tagged, if required for monitoring or research needs, then transferred to a transport truck and released at the mouth of the Baker River.

The upstream trap and haul facility located in the lower Baker River has a complicated handling protocol for Chinook, coho, sockeye, pink, and chum salmon, steelhead, native char, sea-run cutthroat, and Atlantic salmon (PSE 2009). How a fish is handled depends on the species, time of year, and the number of previously captured fish. Unmarked (presumably wild) spring Chinook salmon without a coded wire tag (CWT) captured between June 1 and August 15 are transported to Baker Lake and released while wild summer/fall Chinook salmon capture between August 16 and September 1 are returned to the Skagit River near Hamilton and given an operculum clip. Unmarked Chinook salmon with a CWT are sacrificed to obtain the CWT data. Adipose clipped Chinook salmon (presumably hatchery fish) are returned to the Skagit River. Chinook salmon with an adipose clip and CWT captured between June 1 and September 15 are sacrificed to recover the tag, but after that period only one in four Chinook salmon are sacrificed and the remainder are return to the river with an operculum punch. All natural run steelhead are returned to the river while all hatchery-run steelhead are removed from the system. All PIT-tagged native char are transported to Baker Lake or Lake Shannon, depending upon the PIT code while fish without PIT tags are returned to the river. The first 5,000 pink salmon captured at the trap are transported to Baker Lake while the remainder are returned to the river. All chum salmon are returned to the river. All Atlantic salmon are sacrificed. Sockeye salmon are distributed to spawning beaches in Baker Lake or distributed to the tribes.

PSE has agreed to augment gravel downstream of the project by an amount not to exceed 12,500 tons annually (PSE 2005). The amount and location of gravel augmentation are to be determined according to a gravel management plan currently under preparation. PSE (2005) concluded the project disrupted sediment transport processes, but aerial photo interpretation and a Corps study suggested the Skagit River downstream of the project is aggrading, likely as a result of a combination of high sediment loads from tributaries affected by land use practices and a reduction of sediment transport due to flood control. Because there was uncertainty about the need for gravel augmentation it was agreed that monitoring and development of a gravel management plan would be used to determine if augmentation would be beneficial.

PSE has agreed to the development of a LWD management plan (PSE 2005). Under the plan, LWD greater than 12 inches in diameter and more than 8 feet in length would be collected from the Lake Shannon and Baker Lake log booms upstream of their forebays and transported to stockpiles. Targets over a 20-year period are 2,960 pieces 1 to 2 feet in diameter, 540 pieces 2 to 3 feet in diameter, and 160 pieces greater than 3 feet in diameter. PSE commitment is only to collect, transport, and stockpile the LWD. Stockpiled wood is intended for use in habitat restoration or protection projects by PSE and members of the Aquatic Resources Group and Terrestrial Resources Implementation Group. Although it is uncertain precisely how the wood will be used in the basin, it is likely that at least some of the stockpiled LWD will be used in projects within the action area.

Baker River operations were considered to affect two water quality parameters: turbidity and total dissolved gas (PSE 2005). Turbidity occasionally increased when pool elevation reductions resulted in resuspension of fine sediments deposited in the reservoirs. The new license set minimum pool level targets and development of a water quality monitoring plan to address the risk of increased turbidity. Pre-licensing studies found the Baker Project could have TDG levels that exceed the state maximum criteria of 110 percent during extremely low or extremely high flows. Under the new license, minimum flow criteria of 1,000 cfs or 1,200 cfs plus the addition of two new 750-cfs turbines are anticipated to decrease the risk of TDG exceedances downstream of the project.

The SRSC and WDFW (2005) Skagit Chinook Recovery Plan identified limiting factors to the six Chinook salmon populations and proposed actions for improving population viability and salmonid habitat. The Skagit Chinook Recovery Plan concluded that three primary habitat types were currently limiting Chinook salmon populations: tidal freshwater and estuary habitats in the delta, shallow nearshore habitats such as pocket estuaries, and floodplains. In addition, it identified tributary watershed processes that affect sediment supply, flow regime, and riparian functions also affect habitat loss. The plan includes a comprehensive set of actions designed to recover Chinook salmon populations in the Skagit Basin, including:

- harvest management
- habitat protection
- habitat restoration
  - spawning
  - freshwater rearing
  - tidal delta rearing
  - nearshore rearing
- artificial production
- research
- monitoring

Because of the type and spatial extent of the actions required to implement the plan, the authors recognized that effort and sacrifice would be needed by multiple governmental jurisdictions, stakeholders, and land uses in order to achieve recovery goals.

The Puget Sound Salmon Recovery Plan (PSSRP) (Shared Strategy for Puget Sound 2007) summarized individual watershed recovery plans (e.g., SRSC and WDFW 2005) and outlined the over-arching goals, strategies, and actions that would be taken in the Puget Sound region to recover ESA-listed salmon. Two important components to the PSSRP included a timeframe for success and identification of a strategy for funding implementation of the plan. The PSSRP recognized that recovery would take many decades (perhaps 50 to 100 years, NMFS 2006) and there is substantial uncertainty regarding implementation over such a long period. Consequently, the plan focused on strategies and activities that would be implemented over the next 10 years. The plan estimated a substantial increase in funding from current levels of about $60 million on an annual basis to future levels of about $120 million per year would be needed to make significant progress towards implementing the plan. The financing plan included existing salmon recovery funding plus other existing funding that had not traditionally been used for salmon recovery.

The Skagit Chinook Recovery Plan and PSSRP do not prescribe specific constraints or activities to entities for implementation. Instead, the plans provide strategic guidance for achieving recovery of ESA-listed species. Implementation of the strategies is voluntary by the various entities that wish to contribute to the recovery process.

The Skagit Watershed Council (SWC) is the lead entity for salmon recovery in the Skagit and Samish basins. The SWC recently distributed the draft 2010 update to their Strategic Approach (SWC 2010) for meeting the goals of the Skagit Chinook Recovery Plan. Seattle City Light is an active participant on the SWC and considers the Strategic Approach when selecting protection, restoration, monitoring, and research activities for implementation. The Strategic Approach has three guiding principles: 1) Restore processes that form and sustain salmon habitats; 2) Protect functioning habitats from degradation; and 3) Focus restoration on the most biologically important areas. The Strategic Approach identifies three tiers of target areas of action (Figure 6-8). Tier 1 target areas receive the primary focus and include the Skagit estuary, riverine tidal

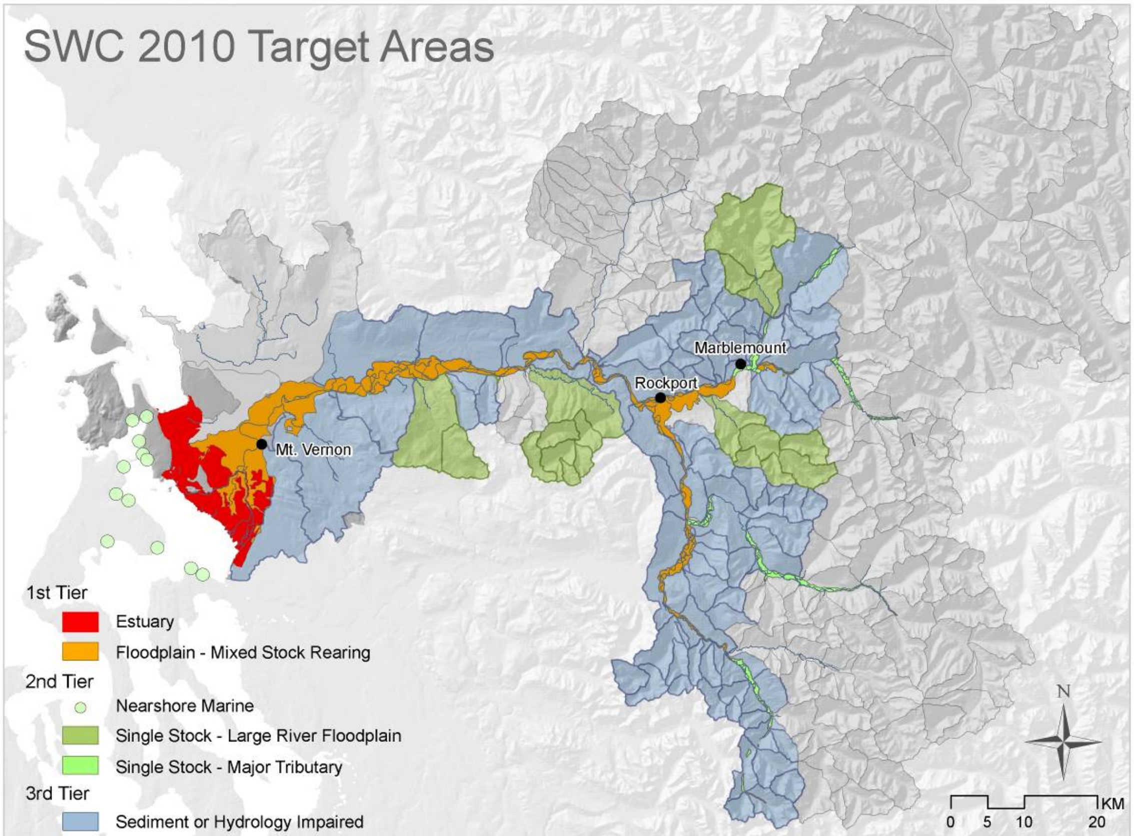
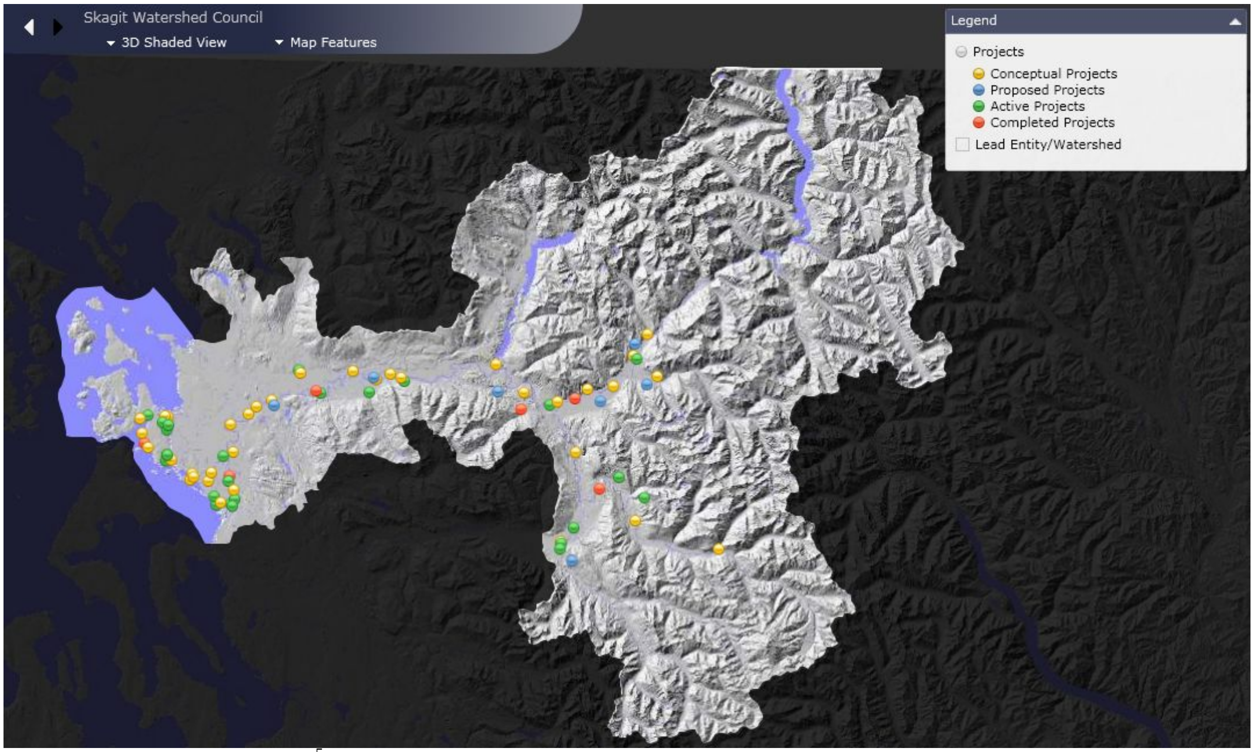



**Figure 6-8. Skagit Watershed Council (SWC 2010) target areas.**

delta, and river floodplains that are important for multiple populations. Tier 2 target areas are those where habitat losses have significantly impeded Chinook salmon recovery. These areas include pocket estuaries and floodplain areas that affect single populations. Tier 3 target areas are watersheds that have elevated sediment loads or peak flows.

The SWC is the primary coordinating entity in the watershed. It convenes and facilitates workgroups as needed, tracks the basin's Habitat Work Schedule, identifies specific projects, and recruits sponsors for implementing the projects. The SWC currently tracks and assists in obtaining grants for 97 projects in the WRIA 3 and WRIA 4 Habitat Work Schedule. Only a small proportion of the projects are completed, but about a third are active, and about half are in conceptual phases(Figure 6-9). Overall, the SWC appears to be making substantial progress towards their ESA recovery objectives.

The Puget Sound Indian Tribes (PSIT) and WDFW as co-managers of salmon harvest in Washington State developed a draft Harvest Management Plan to guide salmon fisheries between 2010 and 2014 (PSIT and WDFW 2009). Harvest can significantly affect the number of returning Chinook salmon to the basin, and consequently the number of fish potentially affected




Source: http://hws.ekosystem.us[5]

**Figure 6-9. Skagit Watershed Council Habitat Work Schedule.**

by Project activities. The plan developed exploitation rate ceilings for each of the harvest units, however it anticipated that annual targets would generally be lower than the ceilings. Annual exploitation rates are determined as part of pre-season planning. Notably, PSIT and WDFW (2009) state that: "Recovery to substantially higher abundance is primarily dependent on restoration of habitat function." The Harvest Management Plan is designed "such that harvest will not significantly reduce the likelihood of survival and recovery of the ESU."

Terminal area harvest is an important objective for Skagit Tribes, and other commercial and recreational fishing interests. Terminal area harvest objectives for summer/ fall Chinook salmon are 20,000 fish in the near-term and 30,000 fish in the long-term (SRSC and WDFW 2005) Historical total life-cycle average exploitation rates based upon the Chinook Fisheries Regulation Analysis Model declined substantially between 1983 and 2006 (Figure 6-10) (PSIT and WDFW 2009). Recent total life cycle exploitation rates calculated by the JCTC (2008) from 2002 to 006 have averaged 32.1 percent[6]. Average harvest distribution for Skagit River summer/fall Chinook Salmon from 2002 to 2006 was 26.4 percent Alaska, 63.4 percent British Columbia, 1.2 percent Washington ocean troll fishery, 6.4 percent Puget Sound net fishery, and 2.6 percent Washington

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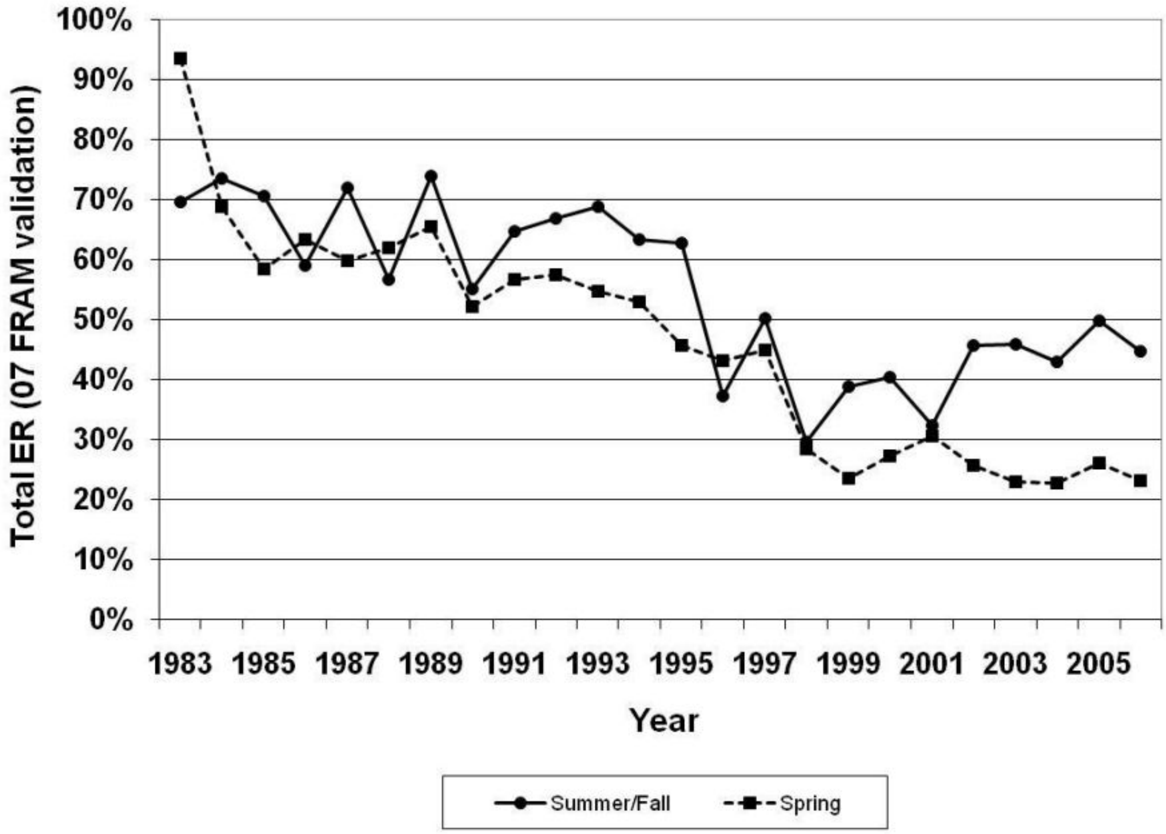
[5] Complete URL is: /Map.aspx?mmap=wa2&mz=6&mlon=-121.709531267602&mlat=48.4789472385856&mlayer=Projects&mlayerid=WALEADENT&mobjectid=280&mtitle=Skagit Watershed Council &sids=280&pstat=any

[6] PSIT and WDFW (2009) and JCTC (2008) utilize different models to estimate exploitation rates and results are slightly different. For comparable years 1998 to 2001 PSIT and WDFW mean estimated exploitation rate was 41.3 percent (range 34 to 49%) while JCTC mean was 37.8 percent (range 15.1 to 43.5%).




Source: (PSIT and WDFW 2009).

**Figure 6-10. Exploitation rate for the Skagit River summer/fall and spring Chinook salmon management units.**

sport fishery (JCTC 2008). Notably, during no year was terminal harvest (i.e., Puget Sound net and Washington sport) more than 17 percent of the total harvest and most were less than 10 percent, which suggests the importance the non-terminal fisheries contribute to the overall exploitation rate on the management unit. In-river sport harvest of wild Chinook salmon occurred for the first time in 16 years during 2009, but will not be allowed during 2010.

Terminal area harvest objectives for Skagit River spring Chinook salmon are 500 fish in the near-term and 1,000 fish in the long-term (SRSC and WDFW 2005). Similar to summer/fall Chinook salmon, historical total life-cycle average exploitation rates for spring Chinook salmon based upon FRAM analysis declined substantially between 1983 and 2006 (Figure 6-10) (PSIT and WDFW 2009). Recent total life cycle exploitation rates from 2002 to 2006 have averaged 46.6 percent for yearlings and 34.4 percent for fingerlings (JCTC 2008). Harvest distribution for yearling releases of Skagit River spring Chinook Salmon (Marblemount hatchery Indicator stock) from 2002 to 2006 were 1.3 percent Alaska, 63.1 percent British Columbia, 0.8 percent Washington ocean troll fishery, 2.5 percent Puget Sound net fishery, and 32.3 percent Washington sport fishery (JCTC 2008). In contrast, fingerling releases for the same period were 5.6 percent Alaska, 69.8 percent British Columbia, 2.7 percent Washington ocean troll fishery, 2.7 percent Puget Sound net fishery, and 19.2 percent Washington sport fishery (JCTC 2008).

The differences in the two harvest distributions suggest that fingerling releases may have a tendency to migrate farther north than yearling releases.

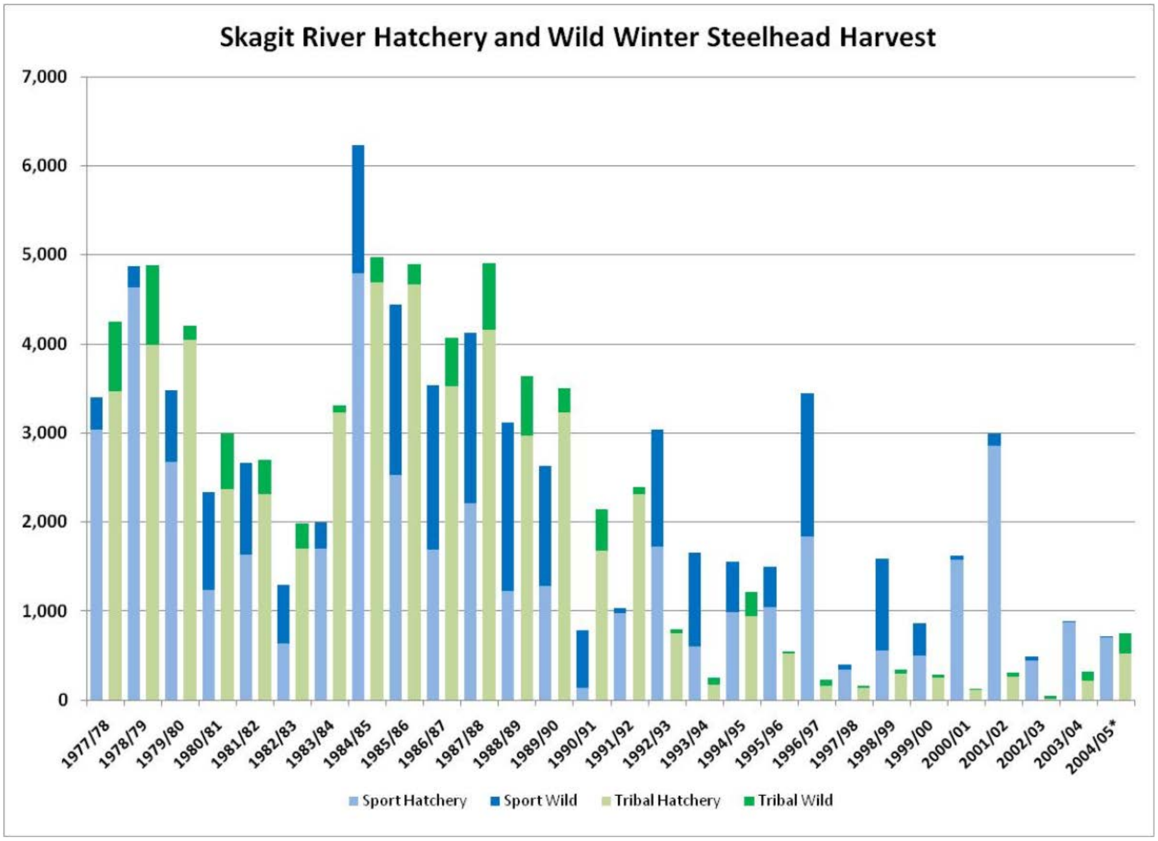
The PSIT and WDFW (2009) Harvest Management Plan includes several thresholds for application of different exploitation rates. When low abundance thresholds are exceeded[7], terminal exploitation rate ceilings of 50 percent for Skagit River summer/fall Chinook salmon and 38 percent for spring Chinook salmon applies. When returns are less than the low abundance thresholds then harvest is limited to the critical exploitation rate ceilings of 15 percent on even years and 17 percent on odd years for summer- and fall-run fish and 18 percent for spring-run fish. Upper management thresholds have been define as 14,500 fish for the combined summer- and fall-run populations and 2,000 fish for combined spring-run populations, which are the levels at maximum sustainable harvest and optimal productivity. If, after consideration of Alaskan, Canadian, incidental, test fishery, tribal ceremonial, and tribal subsistence catch, runs are anticipated to exceed the upper management threshold, then a harvestable surplus is available and exploitation rates may be higher than the ceilings.

Harvest of Skagit River steelhead is co-managed by WDFW, Upper Skagit Indian Tribe and the Skagit River System Cooperative, which represents two of the three affected treaty tribes. The Skagit River recreational fishery is managed for catch-and-release of unmarked wild steelhead while up to two marked hatchery steelhead may be retained (WDFW 2010). During 2009 the open season varied depending upon location in the basin. Harvest of winter steelhead in the Skagit River has declined substantially in recent years and after 2004 retention of wild steelhead was not allowed (Figure 6-11). In addition, the fishing season for hatchery steelhead has been closed early in recent years (2008, 2010) to reduce the risk to weak wild steelhead returns from hooking mortality during incidental catch and release. Average annual harvest of hatchery fish for the years 2000/01 to 2004/05 has been 1,517 fish and 133 fish for wild fish (Data from Scott and Gill 2008).

WDFW manages freshwater fisheries not included under Indian treaty rights. The Skagit River system is one of the basins of the United States where harvest of bull trout is allowed in some areas as part of the trout daily limit (2 fish in streams or rivers, 5 fish in lakes or reservoirs). Specific rules vary depending upon the time of year and location. In areas and periods where harvest is allowed, the minimum size is 20 inches. In areas where harvest is not allowed, catch and release can occur using selective gear.

There are 11 artificial propagation programs in the Skagit River Basin (HSRG 2003; PSE 2005) (Table 6-8). Under PSE's new FERC license, production of spring Chinook salmon or steelhead may occur in the future at the Sulphur Creek Hatchery as determined by the Baker Hydroelectric Project Aquatic Resource Group. All of the hatchery programs except the rainbow trout

[7] Upper Skagit summer – 2,200 fish; Sauk summer – 400 fish; Lower Skagit fall – 900 fish; combined summer/fall run – 4,800 fish; upper Sauk spring – 130 fish; Upper Cascade spring – 170 fish; Suiattle spring – 170 fish; combined spring run – 576 fish.




Data Source: Scott and Gill (2008).

**Figure 6-11. Winter-run steelhead harvest 1977/78 to 2004/05.**

production have the potential to affect ESA-listed species by one or more of the following ecological pathways: 1) By acting as forage for bull trout; 2) Competition with natural origin fish for food and space; 3) vectors for disease (e.g., infectious haematopoetic necrosis); 4) genetic introgression; and 5) incidental mortality during fisheries directed at hatchery fish. The rainbow trout program is for a put-and-take fishery at Depression Lake and is unlikely to have any effect on ESA-listed species. The Hatchery Scientific Review Group (HSRG 2003) reviewed the existing hatchery programs and provided recommendations for minimizing the adverse affects of the programs on native stocks. In addition, for application of ESA 4(d) rules that limit the prohibition of a take, each non-tribal hatchery is required to periodically prepare a hatchery genetic management plan that documents program objectives, recent production levels, mitigation measures implemented to reduce adverse affects to ESA-listed species, and associated take levels (65 FR 43422). Under the 4(d) rules, Tribes prepare a tribal resource management plan that would address artificial propagation activities (65 FR 42481).

The Marblemount Hatchery, located on the Cascade River, produces fall, summer, and spring Chinook salmon as indicator stocks for the summer/fall and spring Chinook salmon stocks (Table 6-8, Table 6-9) in order to estimate demographic, harvest rate, and distribution information about these stocks. Returning hatchery adults from these programs are a very low proportion of the spawning escapement and contributions to harvest are minor. Fingerlings are adipose fin-clipped, tagged (coded wire tag, CWT) and acclimated at their release site for at least 3 days prior to release. The hatchery formerly produced summer Chinook salmon and spring Chinook salmon targeted for harvest by the commercial and recreational fisheries. Suiattle Spring Chinook salmon were the original source of wild fish for the Skagit River spring Chinook salmon hatchery program at the Marblemount Hatchery. However, during the late 1970s and early 1980s a number of unmarked spring Chinook salmon were included as a small proportion of the broodstock for the Skagit River spring Chinook salmon hatchery program and it is considered likely these unmarked fish were primarily wild Cascade River fish. The summer Chinook salmon production-for-harvest program was halted in 1992 because of significant introgression by Green River fall Chinook salmon into the stock (Salmon Hatchery Assessment Group 2003).

**Table 6-8. Artificial propagation programs in the Skagit River basin.**

| Program | Species | Purpose | Type | Note |
|---|---|---|---|---|
| Marblemount (WDFW) | Summer Chinook Salmon | Indicator/Harvest/ Conservation | Integrated | |
| | Fall Chinook Salmon | Indicator/Harvest/ Conservation | Integrated | |
| | Spring Chinook Salmon | Indicator/Cultural/ Conservation | Segregated | |
| | Baker Spring Chinook Salmon | Conservation | Integrated | |
| | Coho | Indicator/Harvest | Segregated | |
| | Winter steelhead | Harvest | Segregated | |
| Baker Artificial Spawning Beaches (PSE) | Sockeye | Harvest/Conservation | Integrated | |
| Sulphur Creek (PSE) | Coho | Harvest/Conservation | Integrated | |
| | Rainbow trout | Harvest | Segregated | Released in Depression Lake |
| Red Creek (Upper Skagit Tribe) | Chum | Education/Cultural | Integrated | Released in mainstem Skagit R. near Hamilton |
| Lake Whatcom (WDFW) | Kokanee | Harvest | Segregated | Released in Lake Shannon |

Source: (HSRG 2003; PSE 2005).

The HSRG (2003) indicated the Skagit Chinook salmon hatchery programs presented relatively low risk to the wild populations but expressed specific concerns about the ability of the respective programs to meet their goals. The HSRG was concerned the fall Chinook salmon program would fail to achieve its goals because of the location and imprinting period for release of the fingerlings and the potential difficulties of retrieving sufficient numbers of tagged adults on the spawning grounds. A similar concern was expressed about the summer Chinook salmon program retrieving sufficient numbers of tagged adults on the spawning grounds. The HSRG was concerned about the spring Chinook salmon program because broodstock collection and spawning were not consistent with conservation goals, the HSRG recommended the conservation goal of the population be dropped and a new plan developed for conserving spring Chinook salmon from the Sauk and Suiattle Rivers in case wild population number decline significantly. The HSRG suggested the spring Chinook salmon hatchery population be evaluated to determine if it was still representative of Skagit River wild spring Chinook salmon and to discontinue the program if it was not. They suggested there was a risk that released yearling hatchery Chinook salmon could forage on wild subyearling Chinook salmon. In recent years there have been concerns about high straying rates by Skagit River hatchery spring Chinook salmon. For the summer and fall Chinook salmon programs, the HSRG suggested that brood stock collection could have an adverse effect on the population if program productivity rates were lower than natural origin spawners and thus resulting in "broodstock mining." Risks to other stocks were considered negligible.

**Table 6-9. Chinook salmon and steelhead artificial propagation programs at the Marblemount Hatchery.**

| Program | Juvenile Production | | Broodstock | |
|---|---|---|---|---|
| | Numbers Produced (Year Program Started) | Release Site | Number | Source |
| Fall Chinook Salmon | 222,000 fingerlings (1998) | Baker Trap | 80 | Gillnet in lower Skagit (RM 32-40) |
| Summer Chinook Salmon | 200,000 fingerlings (1995) | County Line Ponds | 150 | Gillnet in upper Skagit (RM 80-84) |
| Spring Chinook Salmon | 250,000 fingerlings (1978)<br>150,000 yearlings (1989) | Clark Creek | 200 | Hatchery trap |
| Winter Steelhead | 250,000 yearlings (mid-1960s) | 50% at hatchery<br>50% near Baker R | 400 | Baker trap and hatchery trap |

Source: (HSRG 2003, WDFW 2002b, WDFW 2002c, WDFW 2002d, WDFW 2003).

Skagit River winter steelhead are produced at the Marblemount Hatchery to provide sport and tribal harvest opportunities (WDFW 2003). Harvest goals are 5,000 adults for the tribal fishery and 5,000 fish for the sport fishery (HSRG 2003). Approximately 200 adult fish of hatchery origin are collected annually as broodstock. Production goals are to release 250,000 yearling juveniles. About half are released from the hatchery and remaining at one off-site location at the mouth of the Baker River. The original source of the broodstock was Chambers Creek stock (South Tacoma Hatchery), which are genetically distinct from the wild winter steelhead population. Primarily because the hatchery stock spawns early compared to the wild population, the HSRG considered the risk to wild fish from the hatchery population was low. However, recent findings indicate genetic introgression rates by Chambers stock fish exceed 10 percent, which is above the "low" threshold level of 5 percent and is a cause for concern by the fishery co-managers.

## 6.2. Status of Wildlife Habitat Features within the Terrestrial Action Area

The terrestrial action area is part of the Northern Cascades Ecoregion (Washington DNR 2007), a landscape characterized by deeply dissected topography and extremely variable geology and precipitation (Franklin and Dyrness 1988). The area is within the North Pacific Maritime Dry-

Mesic Douglas-fir Western Hemlock Ecological System, as defined by the Washington Natural Heritage Program (WNHP) (Rocchio and Crawford 2009). This ecological system is typical of interior western Washington lowlands (<2,000 foot elevation) and has a mild, moist maritime climate, with more precipitation as rain than snow; fire is a major natural disturbance. Vegetation is dominated by Douglas-fir (*Pseudotsuga menziesii*) with western hemlock (*Tsuga heterophylla*) co-dominant or occasional in the canopy; sword fern (*Polystichum munitum*) is usually a major component of the understory (Rocchio and Crawford 2009). Because of the regular occurrence of stand-replacement fires (mean return interval=200-500 years) most existing old-growth is considered "young old-growth," ranging from 200 to 500 years in age. Natural-origin stands less than 200 years old are also common in this ecological system (Rocchio and Crawford 2009).

All the land within the terrestrial action area is within federal or SCL ownership; compared to other locales in Washington State most of this area is relatively undisturbed. Developments, roads, and utility infrastructure in the action area are concentrated in a narrow corridor along the Skagit River between Newhalem and Bacon Creek, and along portions of Diablo and Gorge reservoirs. The riparian zone along the Skagit River from Newhalem to Bacon Creek is characterized by stands of older conifer trees, primarily western red cedar (*Thuja plicata*)and Douglas-fir, intermixed with patches of big-leaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), and cottonwood (*Populus balsamifera ssp. trichocarpa*). Outside of the riparian zone, the terrain is very steep and supports mostly closed canopy stands of forests dominated by Douglas-fir.

Much of the action area around the Project reservoirs is accessible only by boat and has never been logged. However, fires have occurred and old growth forest stands are not common. Mapping done in 1987 documented 305 acres of old growth forest (200-500 years) and 1,696 acres of closed canopy forest (30-200 years) on the land within 125 feet of Ross, Diablo, and Gorge reservoirs (Envirosphere 1988). These two forest types covered about 60 percent of the 3,332 acres of land within 125 feet of the reservoirs; other forested types represent another 21 percent.

Many of the WHL parcels also have limited vehicle access but most of these lands have been logged in the past. Over 70 percent of the WHL acreage supports upland conifer and mixed conifer-hardwood forests, mostly mid-seral stands. The remaining acreage consists of upland deciduous forests dominated by red-alder and big-leaf maple, as well as wetlands, riparian forests. There are a few patches of mature forest on WHL along the Skagit and Sauk rivers; the greatest amount of old growth occurs on the Nooksack WHLs (SCL 2006).

### 6.2.1. Marbled Murrelet

Marbled murrelets may use portions of the terrestrial action area between Newhalem and Bacon Creek, as well as some of the WHLs. The Gorge 2nd Tunnel portal area is 54 miles straight-line distance from Puget Sound, which is just beyond the 50-mile zone generally considered to be the primary marbled murrelet nesting region in Washington. No nesting activity has been documented in the action area. Nonetheless, the action area does have some stands with large trees that could possibly be used by marbled murrelets for nesting. The tunnel portal site, and SR 20 to Gorge Dam do not represent suitable nesting habitat for marbled murrelets; suitable habitat does occur to the east of these areas and in the upper Newhalem Creek drainage. Older forested stands east and west of SR 20 between Newhalem and Bacon Creek may also provide some potential habitat for this species.

The steep forested mountains in the Bacon Creek drainage, which is located approximately 50 miles from marine waters, have some patches of large trees that could provide suitable habitat for marbled murrelets. However, the SCL property that encompasses the disposal site near Bacon Creek supports mid-seral conifer stands (41 acres) that have only a few large-diameter trees. There are approximately 40 acres of old-growth on USFS lands within 1 mile of the Bacon Creek WHL (SCL 2006).

In May and June 2008, radar surveys conducted downriver from Newhalem recorded detections of possible marbled murrelets flying along the Skagit River near the mouths of Bacon, Thornton, and Damnation creeks (Hamer Environmental 2008). The Thornton Creek survey site is approximately 2 miles from the Gorge 2nd Tunnel portal location. Eleven of the flight path detections were located very close to the Bacon Creek spoils deposition site, but all were high-speed flights indicative of birds passing through as opposed to flights near nest sites. Follow-up ground-based surveys in 2009 detected marbled murrelet-like audio-visual observations 1.5 miles up the Thornton Creek drainage but failed to detect any possible murrelet activity at survey stations 4.6 miles up the Bacon Creek drainage (Hamer Environmental 2009). Further survey effort would be necessary to verify actual marbled murrelet use in these drainages.

There is mapped critical habitat for the marbled murrelet approximately 1 mile south of the Bacon Creek confluence with the Skagit River and near Illabot Creek, approximately 8 miles from the portal area (http://criticalhabitat.fws.gov/flex/crithabMapper.jsp [accessed March 9, 2010]). SCL's WHLs along the south side of the Skagit River include about 67 acres of late serial conifer forest; about 619 acres of this habitat occur on WHLs in the Nooksack drainage, which is considerable further to the west (SCL 2006). While not mapped as critical habitat, these late serial stands, particularly those in the Nooksack WHLs, could potentially support nesting marbled murrelets.

### 6.2.2. Northern Spotted Owl

The terrestrial action area includes some late serial forest stands that represent suitable habitat for spotted owls. However, this species is considered an uncommon resident in the North Cascades National Park Complex (NOCA), which includes the entire action area except the WHLs. Surveys of suitable habitat in 1990-1994 recorded 11 spotted owl activity sites. Pair occupancy was documented at six activity sites, all east of the Cascade crest in the Lake Chelan-Stehekin River watershed (Kuntz and Christopherson 1996). Surveys in this watershed in 2007-2008 documented only four pairs (Siegel et al. 2009). It is thought that competition with barred owls for suitable habitat may be influencing spotted owl distribution and abundance in the NOCA (Kuntz and Christopherson 1996).

There are no known spotted owl activity centers in proximity to the terrestrial action area within the NOCA. Surveys conducted by the NPS in 2009 and 2010 detected only barred owls in the Ross Lake National Recreation Area, which overlaps the action area (Kuntz 2010, pers. comm.). The nearest known active spotted owl nest in 2009 was located in the Newhalem Creek drainage on NPS-managed land, more than 3.5 miles from the Gorge 2nd Tunnel portal site. There were no spotted owls detected at this site in 2010 (Kuntz 2010, pers. comm.). SCL's WHLs have not been surveyed for spotted owls, so use is unknown. The 619 acres of late seral conifer forests on SCL WHLs in the Nooksack drainage probably represent the most suitable habitat for this species on WHLs.

Despite the lack of documented spotted owl activity centers in the action area, it is possible that that some of the conifer stands with large trees, particularly those to the east and west of Newhalem and further up the Bacon Creek drainage, are used by spotted owls for as foraging and dispersal habitat. However, the very low numbers of spotted owls in the North Cascades suggests that this is unlikely.

### 6.2.3. Grizzly Bear

The terrestrial action area along Ross reservoir and Thunder Creek Arm on Diablo Lake contain habitats that could provide suitable spring forage and cover for grizzly bears. These areas are both densely forested with significant amounts of down wood, habitat considered to be important for grizzly bear cover. Suitable spring forage areas including marshes, riparian areas, and low elevation shrubfields, also occur along Ross Lake and Diablo Lake's Thunder Creek Arm. However, these areas lack the upper elevation shrubfields and grass sidehill parks and alpine ridges that represent suitable summer foraging habitat and, similarly, are too low in elevation to provide denning habitat. The level of human activity from Diablo Dam downstream to Bacon Creek probably precludes use of these portions of the action area by grizzly bears.

It is very unlikely that grizzly bears use any of the action area. There have been no documented recent observations of this species in or near the action area. Between 1959 and 1991, there were 21 confirmed grizzly bear observations in the Washington North Cascades; additional sightings are considered highly probable (Almack et al. 1993). The only evidence of grizzly bears near the action area is a photograph of a grizzly bear track taken in 1991 in the Thunder Creek drainage, which is a tributary to Diablo Lake (North Cascades Grizzly Bear Outreach Project, accessed June 17, 2008; www.bearinfo.org).

### 6.2.4. Gray Wolf

Gray wolves are habitat generalists and virtually the entire terrestrial action area, with the exception of developed sites, could potentially be used by wolves. Wolves have been documented in the action area, both recently and in the past. Wolves were documented in the Hozomeen area of Ross Lake every year from 1990 to 1993 (Almack and Fitkin 1998). After many years with no reported observations, one potential wolf track was found in the Ross Lake drawdown zone near Hozomeen by a NPS biologist on May 27, 2009 (Christopherson, R., 2009, pers. comm.). In late May, 2010 numerous probable wolf tracks and scat were found in the Hozomeen area during surveys by NPS and WDFW biologists (Bohannon, J., 2010, pers. comm.).

Despite these observations, the nearest known wolf pack to the action area is in western Okanogan County (WDFW 2009). The territory for this pack, known as the Lookout Pack, is thought to be east of the Cascade crest and mostly within the Lake Chelan-Sawtooth Wilderness Area. Straightline distance between Newhalem and the Cascade crest is approximately 25 miles;

it is another 30 miles to the Lookout Mountain area near Twisp, Washington, which is where the pack was first documented. There is no evidence to suggest that this pack uses habitats in or near the action area. However, gray wolves are expanding in Washington and a pack may eventually establish in the North Cascades west of the crest with a territory that includes portions of the action area near Newhalem and the Gorge 2nd Tunnel. While wolves are generalists and will use a wide variety of habitats, they also tend to avoid areas of human habitation and disturbance.

Sightings of wolves in the action area outside the general vicinity of Hozomeen are rare. There was one reliable sighting of an individual wolf near the Bacon Creek WHL parcel in 1992 (WDFW 2010 [PHS data]). In 1988, two adult wolves were reported on the Illabot South WHL parcel by a WDFW biologist (WDFW 2010 [PHS data]). However, all of the WHLs have the potential to be used by wolves if packs were to establish in the area. The Nooksack WHL parcels probably have the greatest habitat potential as they support more big game and are more isolated from major road and the development than the Skagit and Sauk river WHLs.

### 6.2.5. Canada Lynx

Critical habitat for lynx in Washington includes the North Cascades above 4,000 feet elevation and east of the crest (71 FR 53355-53361). There have been no observations of Canada lynx recorded in or near the action area, which is considerably outside of the species' range in north-central Washington.

The action area does include some nearly pure lodgepole pine stands, which is the primary habitat type for Canada lynx in many areas of North America. About 186 acres of this forest type occur within 125 feet of Diablo and Ross lakes. These stands, however, are relatively small and would not be expected to have the prey densities needed to support Canada lynx. Lynx use of the action area for dispersal is unlikely because the action area is so distant from any suitable habitat.

# 7 EFFECTS OF THE ACTION

The following describes the direct and indirect effects of the proposed action on species ESA-listed within the Skagit Project action area. The proposed action has the following components: 1) the proposed FERC non-capacity license amendment, which includes construction of a new power tunnel extending from Gorge Dam to the powerhouse, Project boundary adjustment; and 2) ongoing operation of the Project under the license as amended, which includes the addition of several flow measures into the license that currently being implemented on a voluntary basis. The qualitative assessment presented for each species is based upon the current understanding of the different activities to be undertaken to implement the proposed action, an understanding of the physical and biological processes that could be affected by these activities, and an understanding of the distribution, life history, and ecology of the ESA-listed species present in the action area. The effects of interdependent and interrelated actions that would not occur unless the proposed action was implemented are also discussed. The section is subdivided into two major subsections that discuss: 1) the effects to ESA-listed fish species and 2) effects to ESA-listed wildlife species.

## 7.1. Fish

### 7.1.1. Skagit Project Facilities as Amended

#### 7.1.1.1. Direct Effects

##### 7.1.1.1.1. Chinook Salmon

As described in Section 3.1, the Gorge 2nd Tunnel will be constructed with a tunnel boring machine. No in-water work is anticipated. However, the construction activities will result in the production of substantial coarse sediment and some associated fine sediment that will need to be transported over the Skagit River and delivered to a disposal area. Other effects are related to the need to spill water during the period when the new tunnel is connected to the existing tunnel, and hydroelectric production is halted at the Gorge Powerhouse.

There are two options for transporting boring spoils across the Skagit River, either by enclosed conveyor belt or haul trucks. If the conveyor belt option is used a temporary spoils storage area on the west side of the river will be needed, but larger trucks, and thus fewer truck loads will be needed to dispose of the spoils. If spoils are transported directly from the portal, then smaller haul trucks must be used, resulting in more truck loads (approximately 197 per day). As part of the drilling, process water will also need to be treated and disposed.

Seven potential adverse effects could occur to Chinook salmon from the construction activities and spill:

- Coarse and fine sediment delivery to Skagit River
- Risk of fuel spill
- Tunnel drilling process water spill

- Naturally contaminated spoils or process water
- Attraction to the Gorge bypass reach during the June 1 to August 15 period of spill
- Stranding of fish following spill reduction and cessation
- Dewatering of eggs of fish spawning in the bypass reach following spill reduction and cessation

Coarse sediment of the proper size added to the Skagit River just below the Gorge Powerhouse could potentially be beneficial as spawning habitat because the Project's dams block bedload transport. However, there are no indications that the river is currently starved of spawning gravel and the opposite is likely true farther downstream because of inputs from tributaries that are considered to be impaired. Large inputs of coarse materials, which is unlikely to occur from the proposed action, could adversely affect channel morphology and increase the risk of scour. It is assumed that the worst mishap that could occur is the overturning and delivery of one truck-load of materials to the river. This amount (approximately 20 cubic yards) would be relatively small. Because the amount of coarse material delivered to the river from the proposed action is likely to be very low, neither beneficial nor detrimental effects from coarse material are anticipated.

Fine sediment loading to streams affects the quality and quantity of spawning and rearing habitat by filling in the spaces between gravels and cobbles and by filling pools (Hicks et al. 1991; Everest et al. 1987; Cederholm and Reid 1987). High levels of fine sediment in streams can be detrimental to the survival of eggs and fry incubating in redds (Iwamoto et al. 1978; Chapman 1988; Chapman and McLeod 1987; Gregory and Bisson 1997).

The effects of suspended sediment and turbidity on fishes are reported in the literature as ranging from beneficial to detrimental. Elevated total suspended solids (TSS) conditions have been reported to enhance cover conditions, reduce predation by piscivorous fishes and birds, and improve survival (Gregory and Levings 1998; Gregory 1993). Elevated TSS conditions have also been reported to cause physiological stress, reduce growth, and adversely affect survival (MacDonald and Newcombe 1993). Of key importance in considering the detrimental effects of TSS on fishes are the season, frequency, and duration of the exposure, not only the TSS concentration.

Behavioral avoidance of turbid waters may be one of the most important effects of suspended sediments (DeVore et al. 1980; Birtwell et al. 1984; Scannell 1988). Salmonids have been observed to move laterally and downstream to avoid turbid plumes (McLeay et al. 1984; MecLeay et al. 1987; Sigler et al. 1984; Lloyd 1987; Scannell 1988; Servizi and Martens 1991).

At moderate levels, turbidity has the potential to adversely affect primary and secondary productivity, and at high levels it has the potential to injure and kill adult and juvenile fishes. Turbidity might also interfere with feeding (Spence et al. 1996). Newly emerged salmonid fry may be vulnerable to even moderate amounts of turbidity (Bjornn and Reiser 1991). Other behavioral effects on fishes, such as gill flaring and feeding changes, have been observed in response to pulses of suspended sediment (Berg and Northcote 1985). Deposition of fine sediments also have the potential to adversely affect primary and secondary productivity (Spence et al. 1996), to reduce incubation success (Bell 1991), and to reduce cover for juvenile salmonids (Bjornn and Reiser 1991).

Increases in stormwater runoff from the staging area, parking area, and other construction facilities is expected to be minimal and undetectable in the Skagit River because of its relatively small size compared to the Skagit River. Standard erosion control measures will be implemented to minimize levels of fine sediment that might be transported with stormwater runoff.

Accidental spills of fuel that reach the Skagit River could have sub-lethal and lethal effects to fishes residing in the river depending on the magnitude and duration of a spill. However, the risk of this occurring is considered low because of standard operating procedures that will be in place in the fueling area and a spill-response plan will be developed prior to implementing construction activities.

Risk of raw process water entering the Skagit River is low because it will be piped to the treatment facility. Accidental delivery of treatment water to the river could only occur as a result of a catastrophic failure of the pipe system. To minimize the risk of delivering untreated process water to the river, the pipe system will include alarms as needed to alert operators to a pipe failure, and regular inspections of the pipe will occur according to a Process Water Management Plan that will include actions to contain and clean-up process water in the event of a pipe failure.

Tunnel spoils and process water could become contaminated if sulfide minerals are encountered during tunnel boring operations, which could resulted in acidic process water or the presence of heavy metals. Test boring conducted as part of the design process did not encounter any significant levels of sulfide minerals, but there is the potential that these could be present along the tunnel route. A monitoring and procedures plan will be developed prior to construction that will identify monitoring procedures for spoils and process water, and procedures for containment, treatment, and disposal of hazardous materials, if they are encountered.

During the period that the new tunnel and existing tunnel are connected, the project will need to drain the existing Gorge power tunnel and halt hydroelectric production at the Gorge Powerhouse. To provide downstream flows, water will be spilled through Gorge Dam into the bypass reach. The June 1 to August 15 time period was explicitly selected for connecting the tunnels to reduce the potential for adverse effects on listed fish species such as Chinook salmon. The work to connect the tunnels may not take the entire designated work window, in which case the spill would be shorter than 2½ months. The specific timing and duration is dependent upon the need to address unforeseeable construction or tunneling delays or scheduling issues.

Upper Skagit Summer Chinook salmon enter the river from mid-May through August and spawning occurs from September through early October (D. Pflug pers. comm. 2011, WDFW and WWTIT 1994). During the upstream migration period spill passing through the bypass reach may attract Summer Chinook salmon to pass the Gorge Powerhouse up to the series of chutes and falls located approximately 0.5 miles upstream in the bypass reach that were historically a natural barrier to anadromous fish (Smith and Anderson 1921). It is unlikely that Chinook could pass the lowermost obstacle, but empirical evidence is lacking to verify that assumption. No spawning habitat is present above the lowermost obstacle and the second obstacle is a complete barrier (D. Pflug pers. comm. 2011). The 0.5 miles of river that could be accessed by Summer Chinook salmon is low gradient, but is considered to be poor habitat at the flows anticipated during spill (1,500 to 2,000 cfs) because water velocities would be high and there is little in-stream structure (D. Pflug pers. comm. 2011).

Following completion of the tunnel connection construction, the Project is expected to be put back on-line with cessation of spill and a return to normal operations. Summer Chinook salmon that move into the bypass reach during spill are unlikely to be stranded because there are no large holding pools in the reach. Nevertheless, additional mitigation measures will be implemented to minimize these potential effects including: 1) a spill cessation flow reduction plan, and 2) a monitoring and fish salvage plan. Both of these plans will be developed in collaboration with the Flow Coordinating Committee.

The spill cessation flow reduction plan will specify the ramping rates that will be utilized as spill levels are reduced and the Project is put back on-line. The monitoring and fish salvage plan will specify the procedures to be followed for monitoring the presence of listed species in the bypass reach before, during, and after the spill period and methods for locating and recovering fish trapped in the bypass reach following the cessation of spill. Despite these mitigation measures, there is a low level of risk that a few Summer Chinook salmon may remain in the bypass reach and spawn after cessation of the spill period. Redds present in the bypass reach may be at risk of dewatering because of flow fluctuation related to normal operations of the project.

The level of risk to Chinook salmon from the proposed action is considered minor or low because of the implementation of BMPs, standard operating procedures, monitoring, and other mitigation measures are expected to minimize adverse effects to this species.

#### 7.1.1.1.2. Steelhead

The potential construction-related effects of the Gorge 2$^{nd}$ Tunnel on steelhead are anticipated to be similar to those described above for Chinook salmon. However, the risk of adverse effects on steelhead from of the spill during the period (June 1 to August 15) when the new and existing tunnels are connected are anticipated to be less because the spill will occur after the peak spawning time (May) for this species. Consequently, the level of risk to steelhead from the proposed action is considered minor or low because the implementation of BMPs, standard operating procedures, monitoring, and other mitigation measures are expected to minimize adverse effects to this species.

#### 7.1.1.1.3. Bull Trout

With two exceptions, the construction-related effects of the Gorge 2$^{nd}$ Tunnel on bull trout are anticipated to be similar to those described above for Chinook salmon. One exception is that bull trout are not known to spawn in the reach downstream of the Gorge Powerhouse. Consequently, there is little to no risk of fine sediments from the proposed action adversely affecting bull trout reproduction. The other exception is that because Gorge Reservoir has little storage capacity, reservoir water will need to be spilled rather than directed through the powerhouse during the period when the new and existing tunnels are connected. During that period, bull trout entrained over the spillways may incur a level of injury or mortality that may exceed injury or mortality rates that would result from entrainment through the powerhouse and turbines. Levels of entrainment and rates of injury and mortality via the different pathways are unknown. However, a desktop analysis of entrainment at SCL's Boundary Dam, a 304-foot impoundment on the Pend Oreille River, Washington suggested larger (600 mm) fish fared better via the spillway pathway (20 to 50% mortality) compared to the turbines (23% to 65% mortality) while medium-sized fish (250 mm) fared better via the turbine pathway (11 to 33% mortality) compared to the spillway path (35 to 65% mortality) (R2 Resource Consultants 2006). There is considerable uncertainty about the actual mortality rates, but the results suggest on a qualitative basis that mortality rates for younger and smaller fish would be higher during the construction spill periods while mortality rates for the older, larger fish would be lower. Based upon monitoring during multiday spill events, gas supersaturation is not anticipated to be a problem during spill as part of the tunnel construction. Bull trout that enter the bypass reach from downstream or are entrained as a result of spill could be at risk of stranding during cessation of spill. Implementation of a spill cessation flow reduction plan and a monitoring and fish salvage plan is anticipated to reduce the level of risk to bull trout. The implementation of BMPs, standard operating procedures, monitoring, and other mitigation measures during project construction are expected to minimize adverse effects to bull trout that could be foraging downstream of the Gorge Powerhouse.

#### 7.1.1.2. Indirect Effects and Effects of Interrelated and Interdependent Actions

There are no indirect, interrelated, or interdependent effects of the amended Skagit Project facilities on Chinook salmon, steelhead, or bull trout.

### 7.1.2. Skagit Operations as Amended

Operations as amended include the effects of the Project with the new tunnel. However, other than formalizing the voluntary flow measures, there are no changes to operational flows, so the analysis will focus on the effects of existing operations.

The direct and indirect effects of the amended Skagit Project operations on ESA-listed fish species are virtually the same as those under the baseline conditions described in Section 6. By formalizing the voluntary flow measures currently being implemented by SCL, there is greater certainty that the benefits of these actions to ESA-listed fish will be recognized throughout the remainder of the current license period. Incorporation of the voluntary actions into the license means the activities are enforceable by the FERC. Without the license amendments there is a risk that SCL could decide to discontinue the voluntary actions.

#### 7.1.2.1. Direct Effects

Direct effects are those caused by the action and occur at the same time and place as the action. As described in detail above, the amended operations would have the following direct effects:

- Reservoir Habitat (Section 6.1.2.1)
    - Drawdown effects on habitat
    - Tributary barriers and migratory behavior
- Instream Flows
    - Flow effects on spawning and egg incubation

  - Ramping effects on trapping and stranding
  - Effects of instream flow agreements
- Water quality (Section 6.1.1)
- Entrainment

In summary, Project operations have two primary direct effects on reservoir habitat. The major adverse effect results from drawdowns associated with flood control required by agreement with the Corps and coordinated on an annual basis depending upon snowpack, precipitation and weather forecasts, and other factors. Drawdown occurs in the fall and winter and refilling occurs in the spring. At maximum drawdown (127.5 feet), the reservoir surface area declines by over 60 percent. During typical years drawdowns are about 74.5 feet. Drawdowns result in significant portions of the reservoir edge being exposed for long periods and where tributaries and the Skagit River enter the reservoir, lacustrine habitat is transformed into riverine habitat that is generally in poor condition compared to stream reaches upstream of the reservoir full pool level. BMI and other benthic fauna that can be important food sources to bull trout and forage fish can be adversely affected within the exposed littoral habitat area by decreasing the diversity and abundance of the benthic community and by the gradual movement of organic and fine materials into deeper waters. Although the benthic community may be adversely affected by drawdowns, bull trout and forage fish populations in Ross Lake such as redside shiner appear to be robust.

The filling of Ross Lake submerged barriers in the lower reaches of some tributary streams that provided connectivity between isolated populations of bull and opened-up habitat previously unavailable. On the other hand, low water velocity areas were created where coarse sediment aggradation could occur, as well as the build-up of LWD that could result in fish barriers. Drawdowns can expose these barriers and disrupt upstream migrations. SCL mitigates these potential effects by conducting inspections and removing potential barriers at the mouths of tributary streams. In addition, drawdowns are typically scheduled to occur after bull trout spawning is completed.

The direct effects of Project operations downstream of Gorge Powerhouse are related to fluctuating flows that can dewater salmon redds; trap and strand fry and juvenile fish; and reduce benthic community diversity and abundance within the varial zone. SCL has largely mitigated for these effects through the implementation of minimum instream flow levels and maximum ramping rate measures specifically designed and implemented during periods when at-risk life history stages of Chinook salmon, steelhead, and other salmon species are present in the river downstream of the Project. Analysis of the abundance and distribution of salmon redds have demonstrated these mitigation measures have been effective at increasing Chinook, chum, and pink salmon spawning success. SCL believes that instream flow measures have also been effective for steelhead, but anticipated increases in steelhead adult returns have not occurred because of bull trout foraging on steelhead eggs and fry. While instream flow mitigation measures have not been specifically designed to benefit benthic fauna, it is assumed the measures have had at worst a neutral effect and likely some benefits have been accrued. As part of the ESA Fish Research Program, SCL is considering implementation of a study investigation the effects of flow fluctuations on steelhead spawning and rearing habitat use and invertebrate productivity and diversity in the reach downstream of Gorge Dam. The results from these studies will help SCL better understand if the flow mitigation measures currently being implemented adequately address the potential adverse effects and minimize the take of listed species.

Water quality in Ross, Diablo, and Gorge reservoirs is excellent and meets all Washington State water quality standards. Ross Lake stratifies during the summertime and surface waters above the thermocline, which usually forms about 2 meters below the surface, are generally higher than optimal for bull trout. However, a large volume of water below the thermocline is well within the suitable range for bull trout. Water quality in the Skagit River mainstem downstream of the Project also meets all Washington State water quality standards.

Water quality is currently excellent within the Project Boundary and the reach downstream of Gorge Powerhouse to the confluence with the Sauk River. However, climate change over the next 100 years or more could potentially have a large effect on the recovery of ESA-listed species. There is some uncertainty regarding how climate change will affect local weather patterns such as snow pack and annual precipitation levels. Interactions of climate change with project operations are largely unknown. SCL is considering monitoring studies such as water temperature and limnological analysis of Project reservoirs and research studies such as modeling of climate change impacts on temperature regimes in the Project reservoirs and mainstem Skagit River downstream of the Project. Such studies may not have direct beneficial effects to listed species, but may help SCL and its partners in the basin develop appropriate management actions that reduce the adverse effects of climate change and ensures continued recovery of ESA-listed species in the basin.

Bull trout are likely entrained through the three Project Dams, but the magnitude of entrainment is unknown. Injury and mortality of bull trout is likely to occur and the magnitude is also unknown and likely dependent upon whether the entrainment pathway is via turbines or during spill, the level of flow, and which turbines are in operation. It is unlikely that mortality is 100 percent; thus entrainment results in some level of genetic dispersal from bull trout populations in an upstream to downstream direction. No mechanism for upstream dispersal of genetic material from the Lower Skagit River Core Area to the Upper Skagit River Core Area is present. However, this is believed to be similar to the historic condition where upstream migration was blocked by the physical characteristics of the Skagit River Gorge.

#### 7.1.2.2. Indirect Effects

Indirect effects are those caused by the action and are later in time but are reasonably certain to occur. As described in detail above in Section 6.1.2.2.6, the amended operations would have the following indirect effects:

- Coarse Sediment Supply
- LWD supply and Riparian Conditions
- Aquatic Productivity
- Floodplain Connectivity
- Trophic Interactions

The following summarizes these effects.

The Project disrupts the transport of coarse sediment and large woody debris to the mainstem reach downstream of the Project. However, based upon spawning surveys adequate quantities of appropriately-sized spawning substrate is present in the reach between Gorge Powerhouse and the Sauk River confluence. Export of coarse and fine sediment from many tributary streams has increased over historic levels as a result of land use activities, primarily forestry-related, and there are indications the mainstem Skagit River has aggraded substantially downstream of Sedro-Woolley. Mainstem transport of coarse sediment during peak flow events has likely declined as a result of flood control. Specific studies in the Skagit River upstream of the Sauk River have not been conducted to determine to what extent sediment supply is balanced with sediment transport. Overall, the availability of suitably-sized spawning substrate does not appear to be a limiting factor downstream of the Project.

Project dams have disrupted the transport of LWD, but it is unclear to what extent LWD that could be transported through the steep and rocky Skagit River gorge would remain intact because breakage and accelerated degradation could have occurred. The abundance of LWD in the river has also been affected by riparian conditions which is degraded in some areas from forest practices, agriculture, urban development (although the basin remains largely rural), hydromodification, and roads. SCL is currently implementing a monitoring study to determine the current quantities and distribution of LWD in the reach downstream of the Gorge Powerhouse.

Project operations can disrupt the downstream transport of nutrients. However, aquatic productivity downstream of the Project is unlikely to be substantially affected because marine-derived nutrients from anadromous salmon and char are likely a much larger component to the downstream riverine energy cycle than nutrients from upstream sources. Consequently, this effect of Project operations is viewed to be relatively minor.

Flood control can affect side-channels and other off-channel habitat by reducing the frequency and magnitude of overbank flows that are critical for the creation of these morphological features. Off-channel habitat can be important for fry and juvenile rearing habitat, over-wintering habitat, and spawning habitat for salmon, steelhead, and char. SCL has implemented a number of off-channel protection, restoration, and creation projects to mitigate for Project effects. Smith (2005) analyzed the current and historical levels of off-channel habitat in the Skagit River and concluded the amount present in the upper reaches affected the Project likely exceeds historical levels. Consequently, the available evidence suggests that SCL has fully mitigated for the Project effect.

As mentioned previously, one unanticipated trophic interaction effect has been likely benefits to bull trout from instream flow mitigation measures designed to benefit steelhead in the reach downstream of Gorge Powerhouse. An investigation of the bioenergetics of bull trout found that steelhead eggs, fry, and carcass flesh were important components their diet (Lowery 2009a). Modeling suggested bull trout predation could be important factor in the regulation of steelhead abundance. It has been hypothesized that bull trout predation is offsetting anticipated improvements in steelhead fry and egg survival from instream flow and ramping rate constraints.

#### 7.1.2.3. Effects of Interdependent/Interrelated Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no significant independent utility apart from the action under consideration. Some of the projects or studies to be implemented as conservation measures (see Section 2.7) do not directly mitigate for, monitor, or evaluate, specific Project effects. Instead, the Conservation Land Acquisition Program, Habitat Restoration Program, and parts of the ESA Fish Research Program are intended to contribute to basin-wide and region-wide efforts to recover Chinook salmon, steelhead, and bull trout. Some of the limiting factors described in Section 4.1.1.6 occur in tributary streams outside the Project Boundary or in areas relatively distant to the Project (e.g., delta rearing habitat) and Project facilities or operations have contributed little to nothing to the limiting condition. Nevertheless, improvements to these limiting factors increase the likelihood that recovery of the listed species will occur in the basin.

#### 7.1.2.4. Effects on Critical Habitat

Nearly all aquatic habitat in the Skagit River accessible to Chinook salmon or bull trout is designated as critical habitat for these species. These critical habitat designations are likely to overlap all habitat accessible to steelhead that has the potential for designation as critical habitat. Consequently, all of the effects described in Sections 6.2.1.1 to 6.2.1.3 occur within critical habitat for one or more of the listed species.

## 7.2. Wildlife

The Biological Assessment (BA) prepared by the FERC in 1994 determined that the continued operation of the Skagit Project under a new 30-year license would not adversely affect the grizzly bear, gray wolf, marbled murrelet, or spotted owl. The USFWS concurred with this determination (letter from D. Frederick, State Supervisor, USFWS, Olympia, WA, to J. Clement, Acting Director, FERC, Washington D.C., August 10, 1994). Consequently, this section of the BE addresses the effects of the amendment to the Skagit license, specifically the construction and operation of the Gorge 2nd Tunnel, on the four species covered by the 1994 BA and USFWS's letter of concurrence. For the Canada lynx, which was not listed in 1994, this section of the BE addresses effects of the entire Skagit Project, as amended.

### 7.2.1. Gorge 2nd Tunnel

The effects of constructing and operating the Gorge 2nd Tunnel on the five listed wildlife species are summarized below.

#### 7.2.1.1. Direct Construction Effects

There are two construction-related effects of the Gorge 2nd Tunnel that potentially affect wildlife—noise and the temporary loss of a small amount of upland habitat.

##### 7.2.1.1.1. Noise Impacts

Construction of the Gorge 2nd Tunnel will result in elevated noise levels relative to the measured ambient level of 46 dBA (NPS 2009) during the approximately 30-month construction period. Work during much of this period (7:30 AM – 11:30 PM, 7 days/week) may result in noise levels above ambient levels within approximately 0.84 miles of the portal and staging area. Some of the noise impact would be lessened due to existing human-caused noise and creek and river noise. Behind the Gorge Powerhouse human-caused noises were audible an average of 100 percent of the time during the NPS's acoustic monitoring (NPS 2009). The hum from the adjacent power lines and power generation equipment, the cascading water from the Skagit River and Ladder Creek, and traffic noise on SR 20 are the most consistent background noises at the staging/portal site (NPS 2009). During periods with heavy truck and motorcycle traffic, noise levels exceeded 52 dBA (6% during the day) and 60 dBA (< 1%) behind the Gorge Powerhouse.

Construction-related noise from the Gorge 2nd Tunnel would not be expected to affect grizzly bears, gray wolves, or Canada lynx because these species do not occur, nor would they be expected to use habitats, in or near the part of the action area that extends from the portal site to Bacons Creek.

Potential construction noise effects on marbled murrelets and northern spotted owls were assessed using the following thresholds from a 2004 U.S. Forest Service Biological Opinion prepared for a project located in forested habitats on the Olympic Peninsula:

- ***Detectability threshold:*** Noise is detectable, but a marbled murrelet or spotted owl does not show any reaction. 4 dB above the baseline sound level, thus 50 dBA in the Action Area.
- ***Disturbance threshold:*** Marbled murrelet or spotted owl shows avoidance of the noise by hiding, defending itself, moving the wings or body, or postponing a feeding. Subjectively estimated to be 70 dBA ($L_{max}$).
- ***Injury threshold:*** Marbled murrelet or spotted owl is actually injured (adult flushed from the nest or the young missing a feeding). Estimated as 92 dBA ($L_{max}$).

Using these thresholds, the typical construction activities (excluding blasting) would cause potential disturbance within approximately 281 ft of the staging area and portal site, although owls and marbled murrelets could detect the noise up to 0.53 miles from the staging area. This area does not include any sites where marbled murrelets have been detected (see Section 6.2.1). Although there are some forest stands within this half-mile radius that have large trees suitable for use by spotted owls, there is no evidence that this habitat is occupied as spotted owls have not been detected in or near the terrestrial action area (see Section 6.2.2).

During the short periods of time when explosives are detonated at the portal, noise may be detected by spotted owls or marbled murrelets up to 1.5 miles from the site, depending on how the mountainous terrain affects noise dispersion. However, the disturbance threshold would only be exceeded within 792 ft of the portal during blasting; the injury threshold would not be exceeded beyond the immediate staging area (Table 7-1).

Noise associated with the loading of trucks at the rock stockpile area would be detectable to murrelets and spotted owls up to 0.4 miles away, but would reach disturbance threshold only out to 199 ft, in which there is no suitable habitat. Noise levels at the Bacon Creek Quarry site where the rock is deposited would be slightly greater because of the use of additional heavy equipment to spread and contour the spoil materials (Table 7-1). Habitat within 2,500 feet of the quarry site is mostly mid-serial stage conifer forest and does not represent suitable nesting habitat for either the marbled murrelet or spotted owl. Suitable habitat for both species may exist further up the drainage and it is possible that construction noise may cause individual birds to change their flight patterns to avoid the quarry site but would not be detectable within areas likely to be used by murrelets or spotted owls.

**Table 7-1. Distances (ft) that Gorge 2nd Tunnel construction activities will affect exceed threshold levels.**

| Construction Activity | Detectability (50 dBA) | Disturbance (70 dBA) | Injury (92 dBA) |
|---|---|---|---|
| Portal Blasting Operations | 7,924 | 792 | 63 |
| Tunnel boring | 2,812 | 281 | 22 |
| Rock Disposal and Bacon Creek Quarry Restoration | 2,506 | 251 | 20 |
| Rock Stockpile | 1,991 | 199 | 16 |
| Hauling Traffic | 998 | 0 | 0 |

#### 7.2.1.1.2. Habitat Impacts

The lawn and ornamental trees in the approximately 1.5-acre staging area for the Gorge 2nd Tunnel would be removed before construction to provide space for equipment, temporary buildings, and the stormwater treatment facility. In addition, vegetation along the route of the waste water pipeline and in treatment area will be removed or disturbed. None of these areas represent suitable habitat for listed species and site restoration is planned.

The rock material from the Gorge 2nd Tunnel will be deposited in the Bacon Creek Quarry and used to restore this site. Currently, this old gravel quarry supports only sparse stands of young alders and a few scattered conifer seedlings; shrubs, grasses, and forbs are generally lacking. Restoration will involve contouring the spoil material, adding topsoil, and planting native vegetation on the site. The result will be an additional 6 acres of conifer forest that will be managed for wildlife since it is part of the Bacon Creek WHL parcel. When this area matures, it will contribute potentially suitable habitat for spotted owls, marbled murrelets, grizzlies, and wolves. However, its close proximity to SR 20 and is likely to preclude its use by wolves, grizzly bears, and other species that require isolation from human disturbance. Similarly, its use by spotted owls and marbled murrelets will depend on the condition of the surrounding landscape and the ability of these species to avoid extirpation over the next few centuries. It is too low in elevation to provide habitat for the Canada lynx.

### 7.2.1.2. Indirect Construction Effects

No indirect effects of construction have been identified for listed wildlife. The addition of 127-197 daily truck trips to SR 20 between Newhalem and Bacon Creek represents an increased risk of mortality for wildlife from collision. However, none of the three listed mammal species have been documented in this area and are unlikely to be impacted from increased traffic.

#### 7.2.1.3. Direct and Indirect Operational Effects

When complete, the Gorge 2nd Tunnel will be completely underground. There will be no operational changes as a result of the new tunnel, nor will SCL's workforce increase. No direct effects of the Gorge 2nd Tunnel on listed wildlife species have been identified.

One indirect effect related to the operation of the Gorge 2nd Tunnel Project on wildlife has been identified. The project will result in the permanent loss of a small amount (<1 acre) of conifer forest habitat at the portal site. The steep rocky slope at and adjacent to the portal site would be cleared of selected vegetation before construction, and several of the nine large Douglas-fir trees on the slope would be cut. Once construction is complete, trees, shrubs, and herbaceous vegetation will re-colonize the rocky ledges and spaces between boulders on the slope surrounding the portal. This small area that will be occupied by the portal does not represent suitable habitat for any of the five listed wildlife species. It is possible that the few large trees in this area could be used by spotted owls for roosting, but unlikely given the absence of this species from the Skagit Valley.

### 7.2.2. Skagit Project as Amended

The Gorge 2nd Tunnel will be completely underground and none of the other Skagit facilities or operations will change under the amended license. The Canada lynx has not been documented in the action area that encompasses the Skagit reservoirs and facilities and there is no suitable habitat for this species.

# 8 CONCLUSION

## 8.1. Evaluation of Diagnostics for Fish

A summary of the effects of the proposed action on physical and biological diagnostics is provided in Table 8-1. Construction of the Gorge 2nd Tunnel is anticipated to have minimal risk of adverse effects to ESA-listed fish because none of construction activities will be conducted in waterbodies associated with the Project. The need to spill water from Gorge Dam during a portion of the construction period could have a short-term adverse affect upon upper Skagit River Summer Chinook salmon, winter steelhead, and bull trout. However, mitigation measures that include scheduling the spill period between June 1 and August 15, and implementation of a spill cessation flow reduction plan and a monitoring and fish salvage plan are anticipated to minimize the potential adverse effects. Adverse effects may also result if accidents occur and mitigation measures including spill response plans fail to prevent delivery of sediment, fuel, or raw boring process water to the Skagit River.

Ongoing operations under the amended license primarily maintain the baseline conditions. The amendment ensures the continuation of improvements to three of the diagnostics in the reach from Gorge Powerhouse to the confluence: spawning and incubation, juvenile/adult rearing, instream flows, and nutrients/food web that were realized as a result of the voluntary flow measures.

## 8.2. Puget Sound Chinook Salmon

The determination for Puget Sound Chinook salmon is "*May affect, likely to adversely affect*." With implementation of appropriate BMPs, a chemical spill response plan, a spill cessation flow reduction plan, and a monitoring and fish salvage plan, the effects from the construction of the Gorge 2nd Tunnel are expected to be minimal. However, the ongoing effects of Project operations are anticipated to have some level of adverse effects to Chinook salmon because of flow fluctuations and disruption of LWD transport. Disruption of sediment transport may also be an adverse effect if transport capacity is higher than the amount of gravel delivered by tributaries downstream of the Project. While it is clear that the Project prevents LWD from contributing to salmonid habitat downstream of the Project, the magnitude of the effect is uncertain because of the lack of instream LWD information.

## 8.3. Puget Sound Steelhead

The determination for Puget Sound steelhead is "*May affect, likely to adversely affect*" because with implementation of appropriate BMPs, a chemical spill response plan, a spill cessation flow reduction plan, and a monitoring and fish salvage plan, the effects from the construction of the Gorge 2nd Tunnel are expected to be minimal. However, the ongoing effects of Project operations are anticipated to have some level of adverse effects to steelhead because of flow fluctuations and disruption of LWD transport. Disruption of sediment transport may also be an adverse effect if transport capacity is higher than the amount of gravel delivered by tributaries downstream of the Project. While it is clear that the Project prevents LWD from contributing to salmonid habitat downstream of the Project, the magnitude of the effect is uncertain because of the lack of instream LWD information.

**Table 8-1. Summary of the effects of the proposed action on physical and biological diagnostics.**

| Diagnostics | ESU or DPS Jeopardy | Effects of the Action | | | |
|---|---|---|---|---|---|
| | | Restore | Improve | Maintain | Degrade |
| **Reservoir and tributary delta conditions** | | | | | |
| Juvenile/adult rearing | No | | | X | |
| Adult upstream migration | No | | | X | |
| **Downstream riverine conditions** | | | | | |
| Spawning and incubation | No | | X | | |
| Sub-adult rearing | No | | X | | |
| Adult upstream migration | No | | | X | |
| **Habitat connectivity** | | | | | |
| Upstream passage | No | | | X | |
| Downstream passage | No | | | X | |
| **Water quality** | | | | | |
| Total dissolved gases | No | | | X | |
| Water temperature | No | | | X | |
| Turbidity | No | | | X | |
| **Ecosystem functions** | | | | | |
| Instream flows | No | | X | | |
| Nutrients/trophic interactions | No | | X | | |
| Gravel transport | No | | | X | |
| Woody debris transport | No | | | X | |
| Floodplain connectivity | No | | | X | |

## 8.4. Bull Trout

The determination for bull trout is "*May affect, likely to adversely affect*." With the exception of the effects from spill, the effects from the construction of the Gorge 2nd Tunnel are expected to be discountable. Spill during portions of the tunnel construction period may result in higher mortality rates for smaller bull trout, and lower mortality rates for larger bull trout entrained over Gorge Dam through the spillways compared with mortality rates experienced from passage through turbines. Entrainment rates by bull trout through either pathway are unknown. Consequently, the overall number of bull trout that may be injured or killed because of spill during the construction period is unknown.

The ongoing effects of Project operations are anticipated to have some level of adverse effects to bull trout because of flow fluctuations and disruption of LWD transport. Disruption of sediment transport may also be an adverse effect if transport capacity is higher than the amount of gravel delivered by tributaries downstream of the Project. While it is clear that the Project prevents LWD from contributing to salmonid habitat downstream of the Project, the magnitude of the effect is uncertain because of the lack of instream LWD information.

## 8.5. Marbled Murrelet

The determination for marbled murrelet from construction and operation of the Gorge 2nd Tunnel is "*May affect, not likely to adversely affect*." Radar detections of this species in the action area are limited to the Bacon Creek drainage and murrelets are not expected to use any of the habitats near the Gorge 2nd Tunnel portal site or immediately adjacent to SR 20. Noise from trucks and restoration activities at the Bacon Creek Quarry could potentially disturb birds flying to and from nest sites further up the drainage if they exist. However, because the nearest suitable nesting habitat is located beyond the zone affected by construction noise, impacts would be minimal.

## 8.6. Northern Spotted Owl

The determination for northern spotted owl from construction and operation of the Gorge 2nd Tunnel is "*May affect, not likely to adversely affect*." The nearest known spotted owl activity center to the action area is in the Newhalem Creek drainage, about 3.5 miles from the Gorge 2nd Tunnel portal. However, there is suitable forage and dispersal habitat for this species in the action area, particularly east and west of Newhalem and just over 0.5 mile from the Bacon Creek Quarry. It is possible that noise from constructing the Gorge 2nd Tunnel and restoring the Bacon Creek Quarry could potentially cause minor disturbance to spotted owls that use these habitats.

## 8.7. Grizzly Bear

The determination for grizzly bear from construction and operation of the Gorge 2nd Tunnel is "*No effect.*" This species occurs in very low numbers in the North Cascades and there is no recent evidence of its use of habitats in or near the action area.

## 8.8. Gray Wolf

The determination for gray wolf from construction and operation of the Gorge 2nd Tunnel is "*No effect.*" The territory for the nearest known pack is west of the Cascades crest. While wolves may eventually establish west of the Cascade crest and use habitats in and near the action area, they generally avoid areas of human habitation and would not be impacted by construction and operation of the 2nd tunnel.

## 8.9. Canada Lynx

The determination for Canada lynx from construction and operation of the Gorge 2nd Tunnel and continued operation of the Skagit Project is "*No effect.*" The high elevation habitat required by Canada lynx is not present in or near the Skagit Project.

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