United States Department of the Interior

FISH AND WILDLIFE SERVICE

Western Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

In Reply Refer To:
1-3-02-F-0393

Colonel Michael McCormick
Attn: Mark Ziminske
Corps of Engineers, Seattle District
Environmental Resources Section CENWS-PM-PL-ER
Post Office Box 3755
Seattle, Washington 98124-3755

Dear Colonel McCormick:

Subject: Endangered Species Act Section 7 Formal Consultation for the Operation and Maintenance of the Lake Washington Ship Canal located in the City of Seattle, King County, Washington. 5th Field HUC 171100120301 - Lower Sammamish River, 171100120302 - Cedar River, and 171100190401 - Shell Creek

This transmits the Biological Opinion (Opinion) prepared by the U.S. Fish and Wildlife Service (Service) pursuant to section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.) (Act), on the effects of the operation and maintenance of the Lake Washington Ship Canal, located in the City of Seattle, King County, Washington. In this Opinion, the Service concludes that the proposed action is not likely to jeopardize the continued existence of the bull trout (*Salvelinus confluentus*) or adversely modify bull trout critical habitat.

As required by section 7 of the Act, an incidental take statement prepared by the Service is provided with the Opinion. The incidental take statement describes reasonable and prudent measures the Service considers necessary or appropriate to minimize incidental take associated with this action. It also sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal agency and applicant, if any, must comply with to carry out the reasonable and prudent measures. Incidental take from actions by the action agency and applicant that meet these terms and conditions will be exempt from the Act take prohibition.

Your December 10, 2001, request for formal consultation was received by the Service on December 12, 2001. The U.S. Army Corps of Engineers determined that the proposed project “may effect, and is likely to adversely affect” bull trout. Your letter also requested our concurrence with the determination of “may affect, but is not likely to adversely affect” for the bald eagle (*Haliaeetus leucocephalus*). The Service expects the effects of the project to bald eagles to be discountable because 1) the closest bald eagle nest is located approximately 2,600 ft (800 meters) from the project area (the Locks) and is screened from all activities that may occur, and 2) conservation measures have been incorporated into the project.

Your July 18, 2006, letter containing the supplement to the biological assessment to the aforementioned consultation for bull trout critical habitat was received in this office on July 20, 2006. Your letter determined that the proposed project is likely to adversely affect bull trout primary constituent elements numbers 1, 2, and 4.

The Service believes that sufficient information has been provided on project effects to the bald eagle to concur with these determinations. The Service believes that sufficient information was provided to determine the effects of the proposed project to federally listed species and to conclude whether this project is likely to adversely affect those species. We, therefore, concur with your "may affect, not likely to adverse affect" determinations.

A number of terms and conditions are presented in this Opinion. Because the National Marine Fisheries Service has not yet completed consultation required to address consistencies between the terms and conditions, modifications will be completed through an amendment to the Opinion.

This Opinion is based on the information provided in the August 2001 Biological Assessment and numerous meetings, and various phone calls, emails and letters on the project. A complete administrative record of this consultation is on file at Service's Western Washington Fish and Wildlife Office in Lacey, Washington.

If you have questions, please contact Jim Muck of the Service's Western Washington Fish and Wildlife Office at (206) 526-4740 (email: jim.muck@noaa.gov) and Andrea LaTier at (360) 753-9593 (email: andrea_latier@fws.gov).

Sincerely,

Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

cc:
COE (K. Brunner)

bc:
FWS
NOAA

Endangered Species Act - Section 7 Consultation
Biological Opinion

U.S. Fish and Wildlife Service # 1-3-02-F-0393

Operation and Maintenance of the Lake Washington Ship Canal, Lower Sammamish River 171100120301, Cedar River 171100120302, and Shell Creek 171100190401
King County, Washington

Lead Action Agency:
United States Army Corps of Engineers

Consultation Conducted By:
U.S. Fish and Wildlife Service
Western Washington Fish and Wildlife Office

April 2007

Ken S. Berg

TABLE OF CONTENTS

INTRODUCTION

This Biological Opinion (Opinion) and incidental take statement was prepared by the U.S. Fish and Wildlife Service (Service) in accordance with Section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act), and implementing regulations at 50 CFR 402.

The U.S. Army Corps of Engineers (COE) has determined that the action associated with the proposed operation and maintenance (O&M) of the Lake Washington Ship Canal (LWSC) and Hiram M. Chittenden Locks (the Locks) "may affect, and is likely to adversely affect" the Coastal-Puget Sound bull trout (bull trout). This Opinion will address adverse effects to the bull trout that are associated with the O&M of the LWSC.

The COE also requests informal consultation on the bald eagle (*Haliaeetus leucocephalus*) in accordance with section 7(a)(2) of the Act (16 U.S.C. 1531 *et seq.*). In their December 10, 2001, letter, the COE requested the Service's concurrence with the determination of "may affect, but is not likely to adversely affect" for this species. The Service believes that sufficient information has been provided on project effects to the bald eagle for the COE to make these effect determinations; our concurrence is provided in the attached cover letter.

Background and Consultation History

The Opinion contained in this document is based on the Service's review of O&M actions of the LWSC by the COE Seattle District Office, Seattle, Washington. The actions are carried out under the Rivers and Harbors Act (RHA) of 1899, Section 1135 of the Water Resources Development Act (WRDA), and the Sundry Civil Act.

The following provides a partial list of significant correspondences and meetings.

1. December 2001 through December 2003, multiple letters between the COE and NOAA Fisheries transmitting the BA and requesting and responding to requests for additional information.

2. January 23, 2004 – NOAA sent a letter to the COE initiating formal consultation.

3. June 3, 2004 – NOAA sent a letter to the COE requesting a 90-day extension.

4. Numerous additional telephone conversations and e-mail correspondence between the Service and the COE.

5. March 3, 2004 through April 4, 2004 - e-mail correspondence requesting additional information and discussing reasonable and prudent measures and terms and conditions of the biological opinion between the Service and the COE.

A complete administrative record for this consultation is on file at the Service's Western Washington Fish and Wildlife Office in Lacey, Washington.

Tribal Consultation

The Muckleshoot Indian Tribe (MIT) and Suquamish Tribes are co-managers of fishery resources with the Washington Department of Fish and Wildlife (WDFW) within the boundaries of their accustomed fishing areas the Lake Washington (lake) watershed. Specific fishing areas for the Suquamish Tribe include Shilshole Bay below the Locks, Elliott Bay, and the Duwamish River estuary upstream to the Spokane Street Bridge. Specific fishing areas for the MIT include Shilshole and Elliott Bays; Management Area 10 of Puget Sound; Lake Washington; Lake Sammamish; and the Cedar, Green, and Puyallup/White Rivers. The MIT has been a leading proponent of salmon protection and recovery efforts within the Lake Washington basin (COE 1999a).

The MIT was the initial local sponsor for the Section 1135 project and provided direct funding for the Waterways Experimental Station evaluation of the slow fill procedures (Waller et al. 1998) that were shown to be beneficial to juvenile salmon and were thus instituted.

BIOLOGICAL OPINION

Description of the Proposed Action

The COE proposes the continuing O&M of the LWSC. The LWSC is a human constructed waterway connecting Lake Washington to Puget Sound. The LWSC consists of the Locks and associated facilities, the 5,800 ft (1,768 meters) Fremont Cut between Salmon Bay and Lake Union, and the 2,500 ft (762 meters) Montlake Cut between Lake Union and Lake Washington.

The following description of the Locks begins on the north side and proceeds to the southern side on the southern shore of the LWSC. Lake level elevations are maintained through conjunctive operation of the large and small locks, spillway gates, smolt passage flumes, and saltwater drain system. On the north side of the Locks facility are the Carl S. English, Jr. Garden, visitor center, administration building, and most of the support facilities. The various components of the Locks, from north to south, are the large lock chamber followed by the small lock chamber, the spillway, and the fish ladder (located at the southern end of the spillway on the south side of the LWSC). The large lock chamber has an intermediate miter gate that allows the Locks operators to fill only one-half of the chamber if vessel passage demand is low, thus conserving water. Also within or associated with the large lock are outer miter gates, intake culverts and filling culverts. The filling and intake culverts are used to fill and drain the lock chamber(s). At the eastern end of the large lock is the entrance to the saltwater drain located at the bottom of the LWSC. Saltwater that enters the saltwater drain goes directly into the LWSC below the Locks and into the fish ladder.

The small lock does not have an intermediate miter gate given its small size and is the preferred lock for most pleasure craft. Also associated with the small lock are intake culverts, filling culverts, and outer miter gates. The small lock does not have a saltwater drain associated with it because the bottom of the lock chamber is located at a higher elevation than the large lock chamber and does not provide passage for saltwater to penetrate into the freshwater portion of the LWSC.

The spillway is composed of six gates that regulate the water level during high flows. The forebays are located on the east side of the spillway with the stilling basin located to the west. Each year in summer through early fall, smolt flumes are attached near the top of one or more of the gates. A smolt flume spans the gate, funnels water into a smaller opening, and reduces the amount of water necessary to pass smolts. Compared with many other possible routes, the smolt flumes provide a less dangerous way for smolts to move through the facility on their way to Puget Sound. Some of the smolt flumes are equipped with PIT tag readers that provide data for smolt migration studies.

A fish ladder, located at the southern edge of the LWSC, was designed to let adult salmonids move from saltwater to freshwater so they could continue their spawning migration. Six of the lower 11 ladder chambers have grating in the bottom where saltwater from the saltwater drain mixes with freshwater flowing down the fish ladder. The resulting brackish water acts as an attractant for adult salmonids. Also, some of the fish ladder chambers have windows that allow the public to view salmonids as they traverse the ladder.

Adult salmonids migrate into the LWSC using the fish ladder, locks, and some may enter the saltwater drain and get shunted into the diffuser wells beneath the fish ladder. Juvenile salmonids migrating out of the LWSC can pass through the Locks many different ways including the culverts used to divert freshwater into the Locks, the smolt passage flumes (when operating), locks, spillway gates, or the fish ladder.

<u>Seasonal Operations</u>

There are four periods of seasonal operation:

- The spring refill period from February 15 until May 1, when the lake level is allowed to rise to 22 ft (6.7 meters) (COE datum).
- The summer conservation period, when the lake level is maintained at the May 1 level as long as possible, and involuntary draw-down commences usually in late June or early July.
- The fall drawdown period beginning at the onset of the fall rains and continuing until December 1.
- The winter holding period, from December 1 through February 15, when the lake level is maintained at 20 ft (6.1 meters) (COE datum).

Large and Small Locks

The large lock spans 825 ft (251.5 meters) between the upper and lower service gates, is 80 ft (24.4 meters) wide, and is divided into two chambers by an intermediate gate. The downstream and upstream chambers are 375 ft (114.3 meters) and 450 ft (137.2 meters) long, respectively. The intermediate gate can serve as either an upper or lower gate when the entire lock is not required for ship transit. The large lock operates 24 hours per day, 7 days per week. Operations entail the filling and emptying of the locks by gravity flow to allow vessel traffic to move from Salmon Bay to Puget Sound and vice versa. Vessel traffic is greatest during summer months.

The small lock is 150 ft (45.7 meters) long by 30 ft (9.1 meters) wide, and is a single chamber without an intermediate gate. It is suited for smaller vessels with drafts up to 16 ft (4.9 meters), lengths less than 123 ft (37.5 meters), and widths less than 28 ft (8.5 meters). The small lock operates 24 hours per day, 7 days per week. Operations entail the filling and emptying of the lock by gravity flow to allow vessel traffic to move from Puget Sound to Salmon Bay and vice versa. As with the large lock, vessel traffic is greatest during summer months.

Both locks are dewatered annually for approximately 14 days in late November to early December (large lock) and the end of March (small lock) for maintenance. Pumps located in the pump-well beneath the administration building are used to drain the lock chambers. During maintenance, barnacles are removed by scraping and using high-pressure water. No chemicals are used. Only high-pressure water is used for cleaning the small lock.

Saltwater Barrier and Drain

During upstream lockages, Puget Sound to Salmon Bay, saltwater flows into the bottom depths of the large lock. When the upper gate is opened to allow vessels into Salmon Bay, saltwater flows out of the Lock into Salmon Bay. In 1966, the COE constructed a saltwater barrier in the large lock, and a saltwater basin with a drain upstream of the large lock to minimize saltwater movement into the LWSC.

The saltwater barrier, located in the large lock chamber, is a hinged hollow steel box structure that is erected by filling it with air. When erected it blocks saltwater intrusion. As the chambers fill, the barrier becomes buoyant, rotating upward 70 degrees, stopping as it makes contact with bumpers embedded in the large lock walls. The saltwater barrier is used to minimize the amount of saltwater intrusion from Puget Sound into the LWSC. Much of the saltwater that does get by the saltwater barrier settles in the saltwater basin, and is drained via gravity through a return system to Puget Sound or diverted to the fish ladder. A barrier/drain system is not required for the small lock since the elevation of the bottom of the small lock is high enough to preventing significant saltwater intrusion.

The saltwater return system consists of the saltwater basin, a drain-intake in the saltwater basin, and concrete pipes that direct the saltwater to the spillway side of the dam (Puget Sound) and to diffusers in the fish ladder to help attract returning adult salmon. Up to 140 cubic feet per second (4.0 cubic meters per second) is returned directly into Puget Sound. About 160 cubic feet per second (4.5 cubic meters per second) is gravity feed into the fish ladder to aid in attracting adult salmon to the fish ladder. The salinity of the saltwater drain water is approximately 3 to 16 parts per thousand.

The saltwater drain consists of a 192 ft^2 (17.8 m^2) opening upstream and slightly south of the freshwater opening to the large lock. Periodically, the saltwater drain requires maintenance due to cracks or holes in the concrete structure. Typically, divers inspect the drain every 5 years to evaluate structural integrity and determine locations where repair may be necessary. Repair of the pipes and openings occurs approximately every 15 years by installing forms that act as a coffer dam and dewater the work area, thereby isolating newly poured cement and rebar in areas where repairs are necessary. On-going maintenance includes removal of detritus and sediment upstream of the intake.

With every eastbound (upstream) large lockage, saltwater enters the large lock chamber. Most of this saltwater is either blocked by the saltwater barrier from moving any farther upstream, or it enters the saltwater drain and is conveyed back to Puget Sound. However, during the summer period of heavy boating activity, less freshwater is available for saltwater control and a saltwater layer can intrude into Lake Union and beyond. The Washington Department of Ecology (Ecology) has imposed a special condition that salinity shall not exceed one part per thousand at any point or depth along a line that transects the canal at the University Bridge (WAC 173-210A-130(58)). The University Bridge is located approximately 4 miles east of the Locks. The criterion was one of the motivating factors for construction of the saltwater barrier in the large lock.

Emergency Operations

In the event of an emergency (i.e., gate malfunction), an emergency closure system is implemented to contain the flow through the locks. The emergency closure system consists of the installation of stoplogs in the large lock and/or small lock, which provide a physical barrier to block freshwater from exiting to Puget Sound.

Spillway

The water level in the LWSC and in Lake Washington typically fluctuates 2 ft each year, from a low of 20 ft in December to a high of 22 ft (COE datum) in May. The six gates of the spillway are used by the COE to regulate water level during high flows. The amount of water released through the gates depends on environmental conditions and the discharge of water from the Cedar River and other tributaries of Lake Washington (COE 1998). Winter discharges typically range from 1,948 to 3,054 cubic feet per second at each gate, with a maximum spillway discharge capacity totaling 18,324 cubic feet per second for all gates. In general, the gates are usually closed or minimally open (0.5 to 1.0 ft) from April to October. During this time period, discharges may range from 200 to 465 cubic feet per second at each gate when the gates are open.

Fish Passage

The dam at the Locks includes a fish ladder to allow upstream migration of anadromous fishes. The ladder is located on the south side of the spillway, and was designed to operate within the Services' 1976 fish passage criteria at Lake Washington elevations of 18.5 ft to 22 ft (COE datum), and Puget Sound tidal elevations of 0.5 ft to 12 ft (Mean Lower Low Water). The fish ladder is 8 ft wide, with three adjustable weirs at the upper end fish exit, 18 fixed weirs with submerged orifices, one adjustable and one fixed slot in the entrance, and the lower six weirs are provided with diffusers that provide transportation and attraction water (COE 1992). Water is released through the fish ladder year-round, except during ladder maintenance periods (typically 1 week in late May or early June). Flow through the fish ladder includes 23 cubic feet per second freshwater from the surface of the LWSC, as well as 160 cubic feet per second attraction water from the saltwater drain.

Juvenile Chinook salmon and bull trout move through the Locks, the saltwater drain, the spillway gates, the fish ladder, and the smolt passage flumes (when operational). To improve survival of smolts passing the Locks, the COE implemented a smolt passage restoration project into its standard O&M program. This program, authorized under Section 1135 of the WRDA, includes several elements:

- Reducing the flow velocity at the filling culvert intakes and within the conduits to minimize smolt entrainment and injury.

- Annually removing abrasive materials (barnacles) from within the culverts.

- Annually installing (during out-migration periods) four low-flow surface water collectors (smolt passage flumes) in two of the spillway gates (total discharge 405 cubic feet per second).

- Installing 36 strobe lights at the entrance to the large lock-filling culverts (18 lights per culvert intake) to deter smolts from gathering near and being drawn (entrained) into the culvert intakes when the large lock is filled.

Fremont and Montlake Cuts

Concrete sills, bolstered by riprap, line both sides of the Fremont Cut. The banks on each side of the cut are lined with a single row of Lombardy poplars (*Populus nigra)*. The poplars form a nearly uninterrupted "colonnade" from the Fremont Drawbridge to Seattle Pacific University. These trees have historic status and appear on historic photographs as early as 1931. The ground cover along the Fremont Cut consists primarily of cultivated grass, with understory vegetation of woody ornamental and native shrubs, some of which overhang the bank. Vegetation on both sides of the canal consists of a mixture of native and non-native trees, shrubs, ground cover, and grasses. Tree species include European birch (*Betula pendula)*, big-leaf maple (*Acer macrophyllum*), flowering cherry (*Prunus serrulata*), blieriana plum (*Prunus Blieriana*), and European mountain ash (*Sorbus aucuparia)*.

Concrete revetments line both sides of the Montlake Cut. The tops of the concrete revetments are used as waterside walks. On the south shore, a recreational trail connects to the Washington Park Arboretum trail. The Montlake Cut is characterized by steep side slopes, planted with a combination of ornamental English ivy (*Hedera helix*), deciduous and evergreen trees, and native shrubs and grasses. Trees primarily consist of native conifers. In addition, a row of approximately 12 Lombardy poplars lines the west end along the north shore.

Along both shores of the Fremont and Montlake Cuts the Project Master Plan calls for protection and maintenance of the concrete embankments, including retention and preservation of the terrain and significant landscape features, which are considered historic resources. Several sections of the Fremont and Montlake Cuts have required repair due to erosion (COE 1999b). The COE does necessary maintenance to the Fremont and Montlake Cuts to maintain existing conditions. This may include replacement of concrete bulkheads, concrete sills, riprap, etc.

<u>Lake Washington Water Management</u>

The COE is mandated to maintain the level of Lake Washington between 20 ft and 22 ft (COE datum) as measured at the Locks. The COE regulates the lake level based on lake level forecasts, lake level measurement, and projected demand for smolt passage flumes, saltwater drain, and lock operation.

The spillway is operated as needed to maintain the minimum level of Lake Washington at 20 ft from December 1 until the refill starts. The spillway gates are opened in a specific order to minimize scouring below the Locks and to maximize attraction of anadromous fish toward the fish ladder during periods of upstream migration.

<u>Dolphin Replacement</u>

The dolphins, located downstream of the rail bridge and at the end of the east large lock waiting pier, consist of approximately 20 to 30 creosote pilings that will need replacement with ammoniacal copper zinc arsenate (ACZA) pilings as needed within the next 5 years.

<u>Annual Maintenance After the Large and/or Small Locks are Dewatered</u>

Timbers that need to be replaced within the large lock are removed and replaced by timbers treated with ACZA. The wooden sills at the bottom of the lock gates need periodic replacement where the gates meet each gate clappersill. Currently, the sill consists of creosote-treated timber. The worn sills will be replaced with ACZA-treated wood. The sills generally need replacement every 7 years on the saltwater side and every 20 years on the freshwater side of the locks. The decks and walls of each lock chamber are washed as needed with high-pressure tap water. Barnacles are removed from the large lock chamber and the filling culverts. No chemicals are used. This work is done when the lock (large and/or small) is dewatered.

Special Operations

Occasionally, project operations are modified to facilitate adult salmon fish harvest. The locks or spillway gates may be closed for short periods at the request of various resource agencies or the MIT. At times, these agencies and MIT may need to examine the saltwater layer, conduct salmon studies, or observe salmon behavior, all of which may require changes in flows in the locks or at the spillway.

Pier Maintenance

Pier pilings along the western guide pier at the north and south lock walls and the center guide pier between the large and small locks are replaced as needed with ACZA-treated pilings. Pilings need to be replaced approximately every 7 to 15 years. Such work occurs when there is minimal or no fish present.

Facilities Maintenance

Buoy maintenance, including battery replacement, is done by Locks personnel using small boats. The gates and gate rams are lubricated daily with a lithium/graphite-based grease. This grease is not sprayed over the water. Another type of grease (Chevron Black Pearl™) is applied directly to the gate knuckles. However, food-grade grease (vegetable oil) is being considered to replace these petroleum-based lubricants and may be used if it allows the gates to function properly and perform to required specifications. Divers periodically inspect all underwater areas in the immediate vicinity of the Locks to document any areas in need of repair and to assist in the placement of the fish monitoring equipment.

Considerable amounts of driftwood, and miscellaneous flotsam accumulates at the east (freshwater) approach of the Locks, fish ladder, and spillway due to the water current moving through the LWSC. Some of the debris passes through the Locks during operation. The remainder is collected and stored on barges that are moored along the north side of the upstream guide pier of the large lock. The debris is then transported upland and disposed of through environmentally sensitive means.

Maintenance of the Carl S. English garden, located along the north side of the Locks, includes mowing, weeding, edging, pruning, plant replacement, watering, and fertilizing plants. The addition of fertilizer is minimal (about six pounds of nitrogen per year). Weeding is accomplished by hand or spot treatment with a biodegradable herbicide (i.e., Rodeo). The Environmental Review Guide for Operations (ERGO) describes regulations relevant to herbicide usage and is consulted if herbicides are needed. No chemicals are sprayed in winds greater than 5 miles per hour or during heavier rains than a mist. No pre-emergent herbicides or insecticides are used. In the botanical garden greenhouse, biological control of pest species is the primary method employed. Elsewhere, for larger pests such as rats, live trapping is used to confirm that only the targeted species is removed.

Pest control for the LWSC is achieved through an integrated pest management program. As such, no large-scale applications of herbicides or pesticides occur. One exception would be the community-wide spraying for Asian gypsy moths, conducted by the Washington State Department of Agriculture. ERGO describes regulations relevant to pesticide usage and is utilized if pesticides are needed. No chemicals are sprayed in winds greater than five miles per hour or during heavy rains.

Painting is required periodically on facilities of the LWSC. This maintenance activity is ongoing as needed and standard methods are used to contain paint and avoid spillage. When painting occurs, all areas to be painted are roped off to minimize disruption of the painting process by unauthorized personnel. When not in use, all paints are stored in storage lockers located in the paint storage room in a warehouse (Warehouse 3).

The Programmatic Agreement developed for compliance with the National Historic Preservation Act requires the in-kind repair or replacement of the existing concrete walls along the Fremont and Montlake Cuts. Walkways along the LWSC require periodic repair or partial replacement. Best management practices are used to ensure that repair activities do not affect water quality or other sensitive habitats.

Gallery Drains

Because the Locks are a concrete structure, water leaks into lock galleries where some of the machinery is housed. A series of drains in the Lock galleries allows water to drain the water from the galleries to Puget Sound. The water does not contact any of the machinery in the galleries.

Channel Tidelands

Two parcels of channel tidelands, totaling 12.6 acres (5.1 hectares), are owned by the COE as part of the LWSC. The tidelands are located west of the Locks and were acquired along with other lands to guarantee navigation. Both parcels are considered environmentally sensitive areas in the LWSC Master Plan, and the objective of management is to preserve the parcels in a natural state. Any activities that potentially degrade fish and wildlife habitat qualities are prohibited.

Guide Pier

The large lock guide and small lock waiting piers (western end) are rehabilitated by replacing several of the creosote-treated timbers with ACZA-treated timber. The rehabilitation of the guide piers is interrelated to the continued O&M of the LWSC.

Spill Response Plan

In the event any potentially hazardous or toxic material is spilled in or above the Locks, the COE ceases operation of the Locks and keeps the Locks (and if necessary the spillway) closed until the spill has been contained. This action is intended to prevent transportation of any contamination downstream to Puget Sound. An Environmental Compliance Coordinator is employed and is responsible for monitoring and controlling wastes, such as oils, lubricants, solvents, paints, and asbestos. All hazardous wastes are kept covered, labeled, and locked away in appropriate storage sheds. Three spill kits are located near the storage areas in case of an accidental spill.

Fire Suppressants

In the past, "light water," a fire suppressant, was kept on the premises of the LWSC in case of fire. The "light water" units have been removed and a newer, fire department approved, system will be installed. This will most likely take the form of backpack-style foam packs as used and recommended by the fire department. The Materials Safety Data Sheet will be made available when these units are installed.

Lake Washington General Investigation Study

The Lake Washington General Investigation (GI) study requires annual funding from congress, the City of Seattle, and King County. The study is designed to evaluate various projects that may contribute to the restoration of ecological processes or functions within the Lake Washington Basin. The primary objective of the GI study is to provide fish passage and survival at the Locks or find new sources of water to provide more flow for juvenile and adult fish passage; the study also includes restoration of habitats in the basin and environmental monitoring. The study is being conducted in two phases. Phase 1, sponsored by King County, covers Lake Washington and its tributaries. Phase 2, sponsored by Seattle Public Utilities, focuses on the Ship Canal, locks, and estuary. Phase 1 of the study (depending on funding availability) is scheduled for completion in 2009, with construction beginning in 2011. Phase 2 is scheduled (again, depending on availability of funds) for completion in 2010, with construction beginning in 2012. The GI study complements post-smolt passage flume construction monitoring that has been performed as part of the LWSC Smolt Passage, Section 1135 Restoration Project. Monitoring activities in the GI study include:

- Passive Integrated Transponder (PIT) tagging and detection at various locations in the LWSC.
- Beach seining in Lake Washington and in the saltwater environments of the Locks.
- A study of food habits of juvenile Chinook salmon in Lake Washington and of piscine predators below the Locks.
- Water velocity studies associated with fish attraction to the flumes.
- Water quality studies upstream and downstream of the Locks to evaluate effects of dissolved oxygen (DO), temperature, and salinity on both juvenile and adult salmonids.
- Monitoring of fish entrainment into the large lock culverts and subsequent injury and survival.
- Monitoring of fish entrainment into the saltwater drain.

- Monitoring of adult Chinook salmon upstream migration movements.

Conservation Measures

Conservation measures described here as part of the proposed action are intended to reduce adverse effects on listed species and their habitats. The Service regards these conservation measures as integral components of the proposed action, expect that all proposed project activities will be completed consistent with these measures, and we have completed our effects analysis accordingly. Any project activity that deviates from these conservation measures will be beyond the scope of this consultation, will not be exempted from the prohibition against take as described in the attached incidental take statement, and will require further consultation to determine what effect the modified action may have on listed species.
The following conservation measures are and will be implemented by the COE to improve conditions for migrating salmonids.

a. During non-drought years, the COE reduces water use for salinity control and increases flow through the fish passage flumes.

b. During drought years, the COE begins the annual refill of Lake Washington at an earlier date to assure the likelihood of attaining a lake elevation of 22 ft. By beginning the filling process earlier, most of the inflow to the lake can be devoted to the fish passage flumes in May and June.

c. Slow valve operation: Currently the east end and center Stony gate valves have been mechanically modified to slow the opening time (increased from 2 minutes 20 seconds to 4 minutes 40 seconds). This modification to the operation has decreased the rate of fill of the Lock chambers, effectively minimizing injury to juvenile salmonids. The lower injury rates result from the fact that water flows through the filling culverts at a lower velocity and entrains fewer salmonids; additionally, the lower velocities result in less severe injury to those fish that are entrained. Additional testing indicates that even slower opening speeds could further reduce injury to juvenile salmonids. The COE is currently developing plans and specifications for a new operating system that will include variable speed motors, providing a broad range of opening rates to further enhance the ability to reduce entrainment. The COE is seeking funding to construct this new operating system and will do so should funding become available.

d. Strobe lights have been installed in the large lock to reduce entrainment of juvenile salmon in the filling culverts.

e. Barnacles in the filling culverts to the large lock are removed annually to reduce physical injury to Chinook salmon and bull trout.

f. Wires (bird netting) were strung over the stilling basin to deter avian predation of smolts.

g. All in-water work will occur during appropriate work windows in consultation with the Service and MIT.

h. Replacement of treated wood structures, or parts of structures, is and will be done with best management practices as recommended by the Western Wood Preservers Institute (1996) to minimize impacts to sensitive species.

Action Area

'Action area' means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 C.F.R. 402.02). For purposes of this consultation, the action area is the LWSC (within the City of Seattle, King County, Washington), which includes the Locks and all its components (the saltwater drain, the fish ladder, the smolt passage flumes, and the spillway), the Fremont and Montlake Cuts, and associated structures, the water and land areas immediately adjacent to these facilities that are regulated by the COE, all water encompassed by Shilshole Bay, Salmon Bay, Lake Union, Portage Bay, Union Bay, and Lake Washington, as well as tributary and upland areas immediately adjacent to these waters potentially affected by the Locks operation (Figure 1).

The action area includes the area to which the extent of the physical, chemical, and biotic effects of the action may extend. The action area is located in the Coastal-Puget Sound Critical Habitat Unit. In the final listing rule, the Service determined that the Coastal Puget Sound Management Unit of bull trout occurs in a unique ecological setting because it supports the only known anadromous forms of bull trout in the coterminous United States. In addition, it was determined that the loss of this population segment would significantly reduce the overall range of the taxon (64 FR 58910). The action area encompasses the aquatic environment from Shilshole Bay to Lake Washington, its water and tributaries affected by Lock operations (Figure 1).

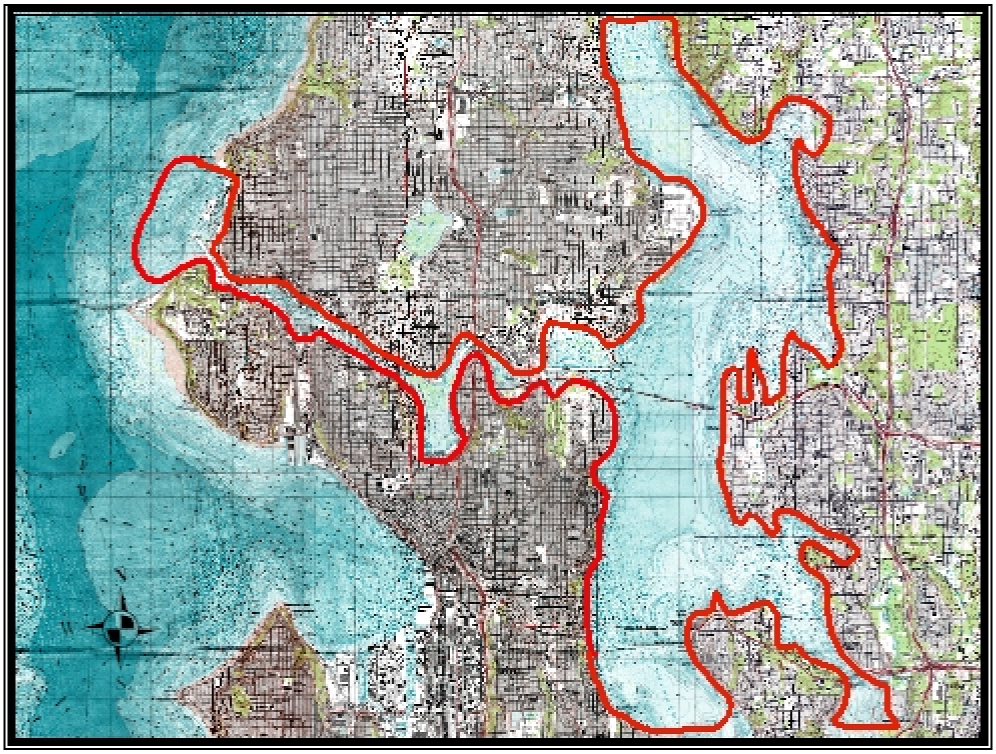


Figure 1. Lake Washington Ship Canal Action Area

The action area is used by bull trout. Out-migrating juvenile (smolt), returning adult Chinook salmon, and bull trout subadult and adult life stages use the area.

ENDANGERED SPECIES ACT

The Act establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the Act requires Federal agencies to consult with the Service, as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats. Section 7(b)(4) requires the provision of an incidental take statement specifying the impact of any incidental taking and specifying reasonable and prudent measures to minimize such impacts.

BIOLOGICAL OPINION

This Opinion presents the Service's review of the status of each listed species considered in this consultation, the environmental baseline for the action area, all the effects of the action as proposed, and cumulative effects. See, 50 C.F.R. 402.14(g). For the jeopardy analysis, the Service analyzes those combined factors to conclude whether the proposed action is likely to appreciably reduce the likelihood of both the survival and recovery of the affected listed species.

If the action under consultation is likely to jeopardize the continued existence of a listed species, or destroy or adversely modify critical habitat, the Service must identify any reasonable and prudent alternatives for the action that avoid jeopardy or destruction or adverse modification of critical habitat and meet other regulatory requirements (50 C.F.R. 402.02).

STATUS OF THE SPECIES (Bull Trout)

Listing Status

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Cavender 1978; Bond 1992; Brewin and Brewin 1997; Leary and Allendorf 1997).

Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 58910). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (63 FR 31647; 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the Act relative to this species (64 FR 58910):

> Although this rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as interim recovery units with respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process.

Current Status and Conservation Needs

In recognition of available scientific information relating to their uniqueness and significance, five segments of the coterminous United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as interim recovery units:

1) Jarbidge River, 2) Klamath River, 3) Columbia River, 4) Coastal-Puget Sound, and 5) St. Mary-Belly River (USFWS 2002; 2004a, b). Each of these interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

A summary of the current status and conservation needs of the bull trout within these interim recovery units is provided below and a comprehensive discussion is found in the Service draft recovery plans for the bull trout (USFWS 2002; 2004a,b).

The conservation needs of bull trout are often generally expressed as the four "Cs": cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout at multiple scales ranging from the coterminous to local populations (a local population is a group of bull trout that spawn within a particular stream or portion of a stream system). The recovery planning process for bull trout (USFWS 2002; 2004a,b) has also identified the following conservation needs: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each interim recovery unit, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each interim recovery unit, and 4) establishment of a positive population trend. Recently, it has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit (Rieman et al. 2003).

Central to the survival and recovery of bull trout is the maintenance of viable core areas (USFWS 2002; 2004a,b). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat. Each of the interim recovery units listed above consists of one or more core areas. There are 121 core areas recognized across the coterminous range of the bull trout (USFWS 2002; 2004a,b).

<u>Jarbidge River Interim Recovery Unit</u>

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historic angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004a). The draft bull trout recovery plan (USFWS 2004a) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout within the core area, 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area, 3) restore and maintain suitable habitat conditions for all life history stages and forms, and 4) conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning bull trout per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004a).

Klamath River Interim Recovery Unit

This interim recovery unit currently contains 3 core areas and 7 local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002). Bull trout populations in this interim recovery unit face a high risk of extirpation (USFWS 2002). The draft Klamath River bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the 3 core areas (USFWS 2002).

Columbia River Interim Recovery Unit

The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997). This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River interim recovery unit has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. In Idaho, for example, bull trout have been extirpated from 119 reaches in 28 streams (Idaho Department of Fish and Game in litt. 1995). The draft Columbia River bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of the bull trout within core areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good. All core areas have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: dewatering; road construction and maintenance; mining; grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species. The Service completed a core area conservation assessment for the 5-year status review and determined that, of the 97 core areas in this interim recovery unit, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, 2 are at low risk, and 2 are at unknown risk (USFWS 2005).

Coastal-Puget Sound Interim Recovery Unit

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this interim recovery unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004b). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this interim recovery unit. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this interim recovery unit. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the interim recovery unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River Interim Recovery Unit

This interim recovery unit currently contains six core areas and nine local populations (USFWS 2002). Currently, bull trout are widely distributed in the St. Mary River drainage and occur in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002). The draft St Mary Belly bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and forms, 4) conserve genetic diversity and provide the opportunity for genetic exchange, and 5) establish good working relations with Canadian interests because local bull trout populations in this interim recovery unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

Life History

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Fraley and Shepard 1989; Goetz 1989). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989; Goetz 1989), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978; McPhail and Baxter 1996; WDFW et al. 1997). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Leathe and Graham 1982; Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1996).

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Pratt 1985; Goetz 1989). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993, 1995; Rich 1996; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), bull trout should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997).

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; Gilpin, *in litt.* 1997; Rieman et al. 1997). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Spruell et al. 1999; Rieman and McIntyre 1993). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat, as these fish are primarily found in colder streams (below 15° C or 59° F), and spawning habitats are generally characterized by temperatures that drop below 9° C (48° F) in the fall (Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1993).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992; Rieman and McIntyre 1993; Baxter et al. 1997; Rieman et al. 1997). Optimum incubation temperatures for bull trout eggs range from 2° C to 6° C (35° F to 39° F) whereas optimum water temperatures for rearing range from about 6° C to 10° C (46° F to 50° F) (McPhail and Murray 1979; Goetz 1989; Buchanan and Gregory 1997). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8° C to 9° C (46° F to 48° F), within a temperature gradient of 8° C to 15° C (4° F to 60° F). In a landscape study relating bull trout distribution to maximum water temperatures, (Dunham et al. 2003) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11° C to 12° C (52° F to 54° F).

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Fraley and Shepard 1989; Rieman and McIntyre 1993, 1995; Buchanan and Gregory 1997; Rieman et al. 1997). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 8° C to 20° C (46° F to 68° F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Bart Gamett, U.S. Forest Service, pers. comm. 2002).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Thomas 1992; Rich 1996; Sexauer and James 1997; Watson and Hillman 1997). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989; Pratt 1992; Pratt and Huston 1993). Pratt (1992) indicated that increases in fine sediment reduce egg survival and emergence.

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes or nearshore marine habitat where foraging opportunities may be enhanced (Frissell 1993; Goetz et al. 2004; Brenkman and Corbett 2005). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Rieman and McIntyre 1993; MBTSG 1998; Frissell 1999). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993).

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, because this strategy can change as the fish progresses from one life stage to another (i.e., juvenile to subadult). Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994), and as fish grow, their foraging strategy changes as their food changes, in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987; Goetz 1989; Donald and Alger 1993). Subadult and adult migratory bull trout feed on various fish species (Leathe and Graham 1982; Fraley and Shepard 1989; Brown 1994; Donald and Alger 1993). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and

Van Tassell 2001). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (WDFW et al. 1997; Goetz and Jeanes 2004).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one source of food over another. For example, prey often occur in concentrated patches of abundance ("patch model;" Gerking 1994). As the predator feeds in one patch, the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005; Goetz and Jeanes 2004).

<u>Changes in Status of the Coastal-Puget Sound Interim Recovery Unit</u>

Although the status of bull trout in Coastal-Puget Sound interim recovery unit has been improved by certain actions, it continues to be degraded by other actions, and it is likely that the overall status of the bull trout in this population segment has not improved since its listing on November 1, 1999. Improvement has occurred largely through changes in fishing regulations and habitat-restoration projects. Fishing regulations enacted in 1994 either eliminated harvest of bull trout or restricted the amount of harvest allowed, and this likely has had a positive influence on the abundance of bull trout. Improvement in habitat has occurred following restoration projects intended to benefit either bull trout or salmon, although monitoring the effectiveness of these projects seldom occurs. On the other hand, the status of this population segment has been adversely affected by a number of Federal and non-Federal actions, some of which were addressed under section 7 of the Act. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the Act permitted the incidental take of bull trout.

Section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans (HCPs) completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP, 2) Simpson Timber HCP, 3) Tacoma Public Utilities Green River HCP, 4) Plum Creek Cascades HCP, 5) Washington State Department of Natural Resources HCP, 6) West Fork Timber HCP (Nisqually River), and 7) Forest Practices HCP. These HCPs provide landscape-scale conservation for fish, including bull trout. Many of the covered activities associated with these HCPs will contribute to conserving bull trout over the long-term; however, some covered activities will result in short-term degradation of the baseline. All HCPs permit the incidental take of bull trout.

Changes in Status of the Columbia River Interim Recovery Unit

The overall status of the Columbia River interim recovery unit has not changed appreciably since its listing on June 10, 1998. Populations of bull trout and their habitat in this area have been affected by a number of actions addressed under section 7 of the Act. Most of these actions resulted in degradation of the environmental baseline of bull trout habitat, and all permitted or analyzed the potential for incidental take of bull trout. The Plum Creek Cascades HCP, Plum Creek Native Fish HCP, and Forest Practices HCP addressed portions of the Columbia River population segment of bull trout.

Changes in Status of the Klamath River Interim Recovery Unit

Improvements in the Threemile, Sun, and Long Creek local populations have occurred through efforts to remove or reduce competition and hybridization with non-native salmonids, changes in fishing regulations, and habitat-restoration projects. Population status in the remaining local populations (Boulder-dixon, Deming, Brownsworth, and Leonard Creeks) remains relatively unchanged. Grazing within bull trout watersheds throughout the recovery unit has been curtailed. Efforts at removal of non-native species of salmonids appear to have stabilized the Threemile and positively influenced the Sun Creek local populations. The results of similar efforts in Long Creek are inconclusive. Mark and recapture studies of bull trout in Long Creek indicate a larger migratory component than previously expected.

Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of listing – habitat loss and degradation caused by reduced water quality, past and present land use management practices, water diversions, roads, and non-native fishes – continue to be threats today.

Changes in Status of the Saint Mary-Belly River Interim Recovery Unit

The overall status of bull trout in the Saint Mary-Belly River interim recovery unit has not changed appreciably since its listing on November 1, 1999. Extensive research efforts have been conducted since listing, to better quantify populations of bull trout and their movement patterns. Limited efforts in the way of active recovery actions have occurred. Habitat occurs mostly on Federal and Tribal lands (Glacier National Park and the Blackfeet Nation). Known problems due to instream flow depletion, entrainment, and fish passage barriers resulting from operations of the U.S. Bureau of Reclamation's Milk River Irrigation Project (which transfers Saint Mary River water to the Missouri River Basin) and similar projects downstream in Canada constitute the primary threats to bull trout and to date they have not been adequately addressed under section 7 of the Act. Plans to upgrade the aging irrigation delivery system are being pursued, which has potential to mitigate some of these concerns but also the potential to intensify dewatering. A major fire in August, 2006 severely burned the forested habitat in Red Eagle and Divide Creeks, potentially affecting three of nine local populations and degrading the baseline.

Status of the Species Within the Action Area: Coastal - Puget Sound Bull Trout. The draft Bull Trout Recovery Plan has identified the Lake Washington system as important foraging, migration, and overwintering (FMO) habitat (USFWS 2004b). FMO habitats are believed to be critical to the persistence of the anadromous bull trout life history form. Anadromous adult and subadult bull trout from nearby core areas may migrate through the marine environment into the Lake Washington FMO habitat. The Lake Washington FMO habitat is located within foraging and migratory distances of the following core populations: Stillaguamish, Snohomish-Skykomish, and the Puyallup Rivers. Their use of the Lake Washington FMO habitat is presumed to be related to the abundance of these core populations as well as the distance from the core area to the action area. More robust core populations such as the Snohomish-Skykomish are expected to utilize the marine environment in greater proportion than core populations that are extremely low in number (Chan, pers. comm. 2004). The status of the Lake Washington FMO habitat and the three core populations are addressed below.

Lake Washington Forage, Migration, and Overwintering Habitat. The Lake Washington FMO habitat consists of the lower Cedar River below Cedar Falls; Sammamish River; Washington, Sammamish and Union Lakes; the LWSC and all accessible tributaries. Population status information and extent of use of this area is currently unknown. Adult and subadult size individuals have been observed infrequently in the lower Cedar River (below Cedar Falls), Carey Creek (a tributary to Upper Issaquah Creek), Lake Washington, and at the Locks. No spawning activity or juvenile rearing has been observed and no distinct spawning populations are known to exist in Lake Washington outside of the upper Cedar River above Lake Chester Morse (not accessible to bull trout within Lake Washington).

The potential for spawning in the Lake Washington basin is believed to be low as a majority of accessible habitat is low elevation, below 152 meters (500 ft), and thus not expected to have proper thermal regime to sustain successful spawning. There are, however, some coldwater springs and tributaries that may come close to suitable spawning temperatures and that may provide thermal refuge for rearing or foraging during warm summer periods. These include Rock Creek (tributary to the Cedar River below Landsburg Diversion) and Coldwater Creek, a tributary to Cottage Lake Creek immediately below Cottage Lake. Coldwater Creek is a major temperature modifier for both Cottage Lake and Big Bear Creeks. Cottage Lake Creek below Coldwater Creek exhibits a much lower temperature profile than any other tributary to Big Bear Creek. High temperatures in Big Bear Creek are moderated by this flow to its confluence with the Sammamish River. Both Coldwater and Rock Creeks are relatively short, 1.6 to 3.2 kilometers (1 to 2 miles) in length, have high quality riparian forest cover and are formed by springs emanating from glacial outwash deposits.

Upper reaches of Holder and Carey Creeks, the two main branches of Issaquah Creek, have good to excellent habitat conditions and may hold potential for bull trout spawning due to their elevation and aspect. However, despite survey efforts by King County (Berge and Mavros 2001; KCDNRP 2002) no evidence of bull trout spawning or rearing has been found. Holder Creek drains the eastern slopes of Tiger Mountain, elevation of 914 meters (3,000 ft), and the southwestern slopes of South Taylor Mountain. Coho are found in Holder Creek up to an elevation of about 360 meters (1,200 ft) and cutthroat trout occur up to 427 meters (1,400 ft) in elevation.

Carey Creek originates at an elevation of roughly 700 meters (2,300 ft) in a broad saddle on the southeastern slopes of South Taylor Mountain. It is the only stream in the north Lake Washington/Sammamish drainage with a relatively recent (within past ten years) char sighting. The single observation of a pair of native char in the fall of 1993 (WDFW 1998a) was about 0.8 kilometer (0.5 mile) downstream from an impassable, approximately 12-meter (40-foot) high falls, which is at an elevation of approximately 256 meters (840 ft). Thus habitat in which the pair of char was observed was potentially too low for successful spawning.

Aside from spawning, the Lake Washington drainage has potential benefits and challenges to adult and subadult bull trout. Two large lakes with high forage fish availability are dominant parts of the lower watershed, and provide significant foraging habitat. A number of observations of subadult and adult sized bull trout have been made in Lake Washington (KDNR 2000; Shepard and Dykeman 1977); H. Berge, King County Department of Natural Resources and Parks, pers. comm. 2003). Connection with the Chester Morse Lake core area (population located in the upper Cedar River) is one-way only, and currently, the level of connectivity with other core areas is unknown. Observations of bull trout in the Locks suggest migrations from other watersheds are likely occurring.

Bull trout have been caught in Shilshole Bay and the Locks during late spring and early summer in both 2000 and 2001. In 2000, up to eight adult and subadult fish (mean size 370 millimeters; 14.5 inches) were caught in Shilshole Bay below the Locks, between May and July. These fish were found preying upon juvenile salmon (40 percent of diet) and marine forage fish (60 percent of diet) (Footen 2000; 2003). In 2001, five adult bull trout were captured in areas within the Locks and immediately below the Locks. One bull trout was captured within the large locks in June, and in May, one adult was captured while migrating upstream through the fish ladder in the adult steelhead trap at the head of the ladder. Three adult bull trout were also captured below the tailrace during the peak of juvenile salmon migration on June 18 (Goetz, pers. comm. 2003).

Snohomish River/Skykomish River Core Population. Fluvial, resident and anadromous life history forms of bull trout are all found within the Snohomish River system, which includes the Skykomish and Snoqualmie Rivers. There are no lake systems within the basin that support typical adfluvial populations; however, anadromous and fluvial forms occasionally forage in a number of lowland lakes connected to the mainstem rivers. A large portion of the migratory segment of this population is anadromous, and these forms make extensive use of the lower estuary, nearshore marine areas, and Puget Sound for extended rearing. Recent tagging information indicates that subadults observed in the mainstem may include fish from populations outside of the Snohomish River basin (Fred Goetz, COE, pers. comm. 2002).

Bull trout can be found throughout the Snohomish River system, generally downstream of anadromous barriers. Four local populations have been defined: North Fork Skykomish River (includes Goblin Creek and West Cady Creek), Troublesome Creek, Salmon Creek, and South Fork Skykomish River. Bull trout are not known to occur upstream of Snoqulmie Falls, upstream of Spada Lake on the Sultan River, in the upper forks of the Tolt River, above Deer Falls on the North Fork Skykomish River, or above Alpine Falls on the Tye River (Kraemer 1999).

A spawning index, established by WDFW, has been used to track the status of bull trout in the Snohomish-Skykomish River core area. This index reach encompasses the upper North Fork Skykomish River from river mile 15 to 18.5, including Goblin Creek up to river mile 0.5 and the lower portion of West Cady Creek. Spawner abundance (number of redds) have been tracked annually since 1988 (WDFW 1998a) (Table 1).

Table 1. Bull trout redd counts in the North Fork Skykomish River spawning index area, and bull trout adult counts at the Sunset Falls trap on the South Fork Skykomish River, 1988 to 2002.

Year	Number of Redds	Number of Adults
1988	21	--
1989	49	--
1990	67	--
1991	156	--
1992	82	--
1993	159	--
1994	*	18
1995	75	40
1996	60	45
1997	170	42
1998	177	47
1999	110	45
2000	236	51
2001	319	62
2002	538	90

*incomplete survey

Assuming an intermediate value of 2.5 spawners per redd based on sex ratios reported in other systems (Brown 1994; Goetz 1989; James and Sexauer 1997), the average number of redds counted over the last 6 years (258), when counts exceeded 100 redds annually, suggest the average annual spawner abundance in the North Fork Skykomish index reach is around 650 individuals. The average number of redds counted for the past 10 years of record is 188, which would suggest a 10-year average of 470 individuals. Population monitoring also occurs at the trap and haul facility at Sunset Falls. All adult bull trout entering the trap are counted, and released above the falls (Table 1). Numbers of adult bull trout passed into the South Fork continues to increase, and new spawning and rearing areas are being colonized. It is believed that this local population will exceed 100 adult spawners in the near future. Based on increasing abundances (approximately a three-fold increase in spawner abundance since 1990), WDFW has rated this population as healthy (USFWS 2004b). With this increase in abundance, fishing continues to be allowed in this system (two fish limit with a 508 millimeters (20 inches) minimum size limit).

Since the listing of bull trout in 1999, the Service has issued eight Opinions that exempt incidental take for the Snohomish River/Skykomish River core area (Table 2). Issuance of these Opinions resulted in the incidental take of bull trout associated with approximately 11.45 miles

(1.6 percent) of the Snohomish River/Skykomish River Basin that is accessible to bull trout. Incidental take exempted from these Opinions was in the form of harm and harassment primarily from temporary sediment increases during in-water work, loss or alteration in habitat, and/or handling of fish. None of these projects were determined to result in jeopardy to the bull trout. The combined effects of these Opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the core area.

Table 2. Prior Incidental Take Authorized within the Snohomish River/Skykomish River Bull Trout Subpopulation.

Project	Geographic Extent of Incidental Take Authorized
I – 90 Land Exchange	No take associated with project.
Stossel Creek Way -Harris Creek Culvert Replacement	Harm and harassment within 5.8 miles on Harris Creek and 2.0 miles on the Snoqualmie River.
Everett Bridges Seismic Retrofit	Harm and harassment within 0.92 mile of the Snohomish River.
SR – 2 Snohomish River Bridge	Harm and harassment within 2.5 miles of the Snohomish River.
State Route 522 Road Widening	Harassment within 50 linear feet along the south bank from construction and in-water activities, 46 linear feet from placement of riprap, 600 feet from the placement, removal, and dewatering of the coffer dam, and direct take of 1individual (killed) and 5 individuals (captured) from fish capture/salvage operations.
Anthracite Creek Bridge Scour Protection	Harassment within 600 feet from the placement, removal, and dewatering of the coffer dam, and direct take of 1individual (killed) and 2 individuals (captured) from fish capture/salvage operations.
SR - 104, Hood Canal Bridge Retrofit and East Half Replacement Project	Harassment within 5.32 acres (subpopulation will depend on final project construction) due to shading of subtidal habitats (May 2005 to June 2006).
Fish Passage Barrier Removal Programmatic	Harassment within 5 miles of stream associated with sediment and 5.4 acres for habitat alteration; harm for 35-40 individuals for capturing and handling.
Seattle Aquarium	Harm and harassment within a 0.6 mile and 2.4 mile radius, respectively, of the Seattle Aquarium associated with pile driving.

The Service has also issued take for the Coastal-Puget Sound Bull Trout DPS, including the Snohomish River/Skykomish River core population, in the WDNR HCP. The take is estimated based on the amount of habitat likely to be impacted in the 70 year HCP time frame. Take was not quantified at the subpopulation level.

Stillaguamish River Core Population. The Stillaguamish River bull trout core population supports primarily anadromous and fluvial life history forms. Four local populations have been identified: Upper Deer Creek, the North Fork Stillaguamish River (including a major tributary, the Boulder River), the South Fork Stillaguamish River (including its upper minor tributaries), and Canyon Creek (major tributary to the South Fork Stillaguamish River). These local populations are isolated from one another. The abundance of each local population is low, therefore the population status of the core area is also low.

Primary foraging, migration, and overwintering areas in this Stillaguamish River basin include the North and South Forks and the Stillaguamish River to the estuary. The anadromous forms in the Stillaguamish basin are presumed to use Puget Sound especially the nearshore marine areas in Skagit Bay, Port Susan and Possession Sound.

Since the listing of bull trout in 1999, the Service has issued four Opinions that exempt incidental take for the Stillaguamish River core area (Table 3). Incidental take exempted from these Opinions was in the form of harm and harassment primarily from temporary sediment increases during in-water work, loss or alteration in habitat, and/or handling of fish. None of these projects were determined to result in jeopardy to the bull trout. The combined effects of these Opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the core area.

Table 3. Prior Incidental Take Authorized within the Stillaguamish River Bull Trout Core Population.

Project	Geographic Extent of Incidental Take Authorized
SR-9 Stillaguamish River to Lake Creek	Harm and harassment within 3.17 miles of Harvey Creek and 2 miles of the Stillaguamish River, and 4 miles of unnamed tributary and 2 miles of Pilchuck Creek.
SR - 104, Hood Canal Bridge Retrofit and East Half Replacement Project	Harassment within 5.32 acres (subpopulation will depend on final project construction) due to shading of subtidal habitats (May 2005 to June 2006).
Haller/Nugents Bridge Demolition	Harassment within 600 feet downstream of the Haller Bridge. Harm within approximately 5,100 square feet in the Stillaguamish River. Harm of one bull trout for fish handling.
Fish Passage Barrier Removal Programmatic	Harassment within 5 miles of stream associated with sediment and 5.4 acres for habitat alteration; harm for 35-40 individuals for capturing and handling.
Seattle Aquarium	Harm and harassment within a 0.6 mile and 2.4 mile radius, respectively, of the Seattle Aquarium associated with pile driving.

Puyallup River Core Population. The Puyallup core area contains the southernmost population of bull trout in the Puget Sound Management Unit. This core area is critical to maintaining the overall distribution of migratory bull trout within the Puget Sound DPS, since it is the only anadromous bull trout population in south Puget Sound. The anadromous life history form is believed to use Commencement Bay and likely other marine nearshore habitats along Puget Sound. Both anadromous and fluvial/resident bull trout local populations have been identified in the White River and Puyallup River systems, which converge in the lower basin at river mile 10.4 of the Puyallup River. Limited information is available regarding the distribution and abundance of bull trout in this core area. Observations of bull trout have generally been incidental to other fish survey work.

Five local populations have currently been identified for this core area. These are the upper Puyallup and Mowich Rivers, Carbon River, upper White River, West Fork White River, and Greenwater River. In addition, one potential local population, Clearwater River, has also been identified. Although part of the current bull trout distribution, there is currently insufficient information to determine if reproduction is occurring here (USFWS 2004b).

The individual status of each of these local populations within the White River system is currently unknown, however, based on trap counts at the PSE dam, the number of adult migratory bull trout transferred upstream into the White River system is known. These numbers are extremely low, relative to other anadromous core populations within the Puget Sound Management Unit. It is uncertain whether these are primarily anadromous or fluvial migrants; however, a number of the bull trout scale and length samples collected at the trap (Hunter 2001) are comparable to that of anadromous forms sampled in the Lower Skagit River core area (Kraemer 2003).

Since the listing of bull trout in 1999, the Service has issued eleven Opinions that exempt incidental take in the Puyallup River core area (Table 4). Incidental take exempted from these Opinions was in the form of harm and harassment primarily occurred from temporary sediment increases during in-water work, loss or alteration in habitat, and/or handling of fish. None of these projects were determined to result in jeopardy to the bull trout. The combined effects of these Opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the core area.

Table 4. Prior Incidental Take Authorized within the Puyallup River Bull Trout Core Population.

Project	Geographic Extent of Incidental Take Authorized
White River Amphitheater	Harm and harassment within the lower 0.28 mile of Pussyfoot Creek (from the confluence of the White River).
Greenwater River Channel Relocation	Harm and harassment within approximately 2.3 miles of the Greenwater River.
Puyallup Indian Tribe-Electron Dam Fish Ladder	No more than two bull trout will be incidentally taken on river mile 41.7 of the Puyallup River.
Tacoma Public Utilities, Permit for work in the White River	Harm and harassment 750 feet upstream and 900 feet downstream of river mile 23.3 on White River.
Asarco Smelter Superfund Site Shoreline Armoring (reintiation)	Harm and harassment in marine waters within 200 feet from the shoreline (mean lower low tide), along 3,464 feet of shoreline, along 780 feet in the breakwater peninsula, 703 feet by Sag Seawall, 875 feet along the South East. For a total of 15.9 surface area acres.
SR 104, Hood Canal Bridge Retrofit	Harassment in subtidal habitat (The Opinion had a total of 5.32 acres of subtidal habitat for the Lower Puyallup, Dungeness, Skagit, Snohomish and Stillaguamish River bull trout subpopulations).
Hylebos Waterway Area 5106, Commencement Bay Superfund Site	Harassment of bull trout within 45.7 acres of the dredging/excavation activities and 8.3 acres of sediment capping activities in the Hylebos Waterway, 7.1 acres of habitat in Slip 5. Ten percent exceedance of the dredged area (4.6 acres), sediment capping area (0.8) acres, and habitat construction area (.7 acres). All bull trout in the 13.1 acre Slip 1 CDF between August 16, 2003 and February 15, 2004. Harm to one bull trout in Slip 1 CDF.
State Route 167 Sumner Interchange	Harassment will occur from the site of the interchange and its unnamed tributary, downstream to its confluence with the White River totaling 2.2 miles along Soaton Creek. Harm to one bull trout within Soaton Creek. Harassment will occur between river miles 0.7 and 4.0 totaling 3.3 miles of the White River.
COE Programmatic	Restoration activities covering a period of 5 years. The incidental take specific to the lower Puyallup River subpopulation amounts to all bull trout associated with 5 miles (1 mile/year) of river from sediment impacts; between 35-40 fish (7-8 fish/year) resulting from stranding, capture and handling activities; bull trout associated with 7,500 square feet (1,500 square feet/year) of permanent stream alteration; bull trout associated with 5,000 square feet (1,000 square feet/year) of temporary stream alteration; bull trout associated with 0.5 acre (0.1 acre/year) of marine nearshore alteration, and bull trout associated with five acres (1 acre/year) of scrub-shrub and forested riparian habitat impacts.
Forest Service Programmatic Culvert Replacement	Culvert replacement covering a period of 5 years. Harassment is for all bull trout life stages within 600 feet downstream of the construction/dewatered stream reach. An average of 24 juvenile and adult bull trout per project will be harassed. Harm is only for juvenile fish (aged 0+ and 1+). For a 5 year period the amount of harm authorized is less than 42. Take authorized is for all the identified culverts being located in one 5th field watershed. Harm is derived as follows: 25 culvert sites (maximum) over the next 5 years (5 per year) multiplied by 0.82 fish killed per culvert project, which equals 20.5 total estimated mortalities of 0+ and/or 1+ year-old fish (4.1 fish killed per year). (The author of the Opinion expected less than a 10 percent chance that all 25 culverts would be replaced).
Seattle Aquarium	Harm and harassment within a 0.6 mile and 2.4 mile radius, respectively, of the Seattle Aquarium associated with pile driving.

Summary of Coastal-Puget Sound Bull Trout in the Action Area

Anadromous adult and subadult bull trout will be found within the LWSC action area. These bull trout will utilize the action area for either foraging or will be migrating through the area to other marine foraging habitats or to the Lower Green/Duwamish FMO habitat. Bull trout are anticipated to be in the action area throughout the year. However, bull trout will most likely be found in the action area in spring and early summer during the outmigration of juvenile salmon. Bull trout have been captured in and around the Locks and LWSC from May through July. The bull trout within the action area are anticipated to be from the Snohomish/Skykomish River, Stillaguamish River, and the Puyallup River Core Areas.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

The biological requirements of bull trout in the action area vary depending on the life history stage present and the natural range of variation present within that system (Groot and Margolis 1991; NRC 1996; Spence et al. 1996). Generally, during spawning migrations, adults require water with cool temperatures and access to thermal refugia, DO near 100 percent saturation, low turbidity, adequate flows and depths to allow passage over barriers to reach spawning sites, and sufficient holding and resting sites. Anadromous fish select spawning areas based on species-specific requirements of flow, water quality, substrate size, and groundwater upwelling. Embryo survival and fry emergence depend on substrate conditions (e.g., gravel size, porosity, permeability, and oxygen concentrations), substrate stability during high flows, and, for both species, water temperatures of 13° C or less. Habitat requirements for juvenile rearing include seasonally suitable microhabitats for holding, feeding, and resting. Migration and feeding corridors for juveniles to reach rearing areas, whether the ocean, lakes, or other stream reaches, requires unobstructed access to these habitats. Physical, chemical, and thermal conditions may all impede migrations of adult or juvenile fish. The biological requirements likely to be affected by this action are those conditions necessary for the bull trout to survive and recover to naturally reproducing population levels, at which time protection under the Act would become unnecessary. Adequate population levels must safeguard the genetic diversity of the listed stocks, enhance the species' capacity to adapt to various environmental conditions, and allow them to become self-sustaining in the natural environment. The biological requirements for bull trout include adequate food (energy) sources, flow regimes, water quality, habitat structure, passage conditions (migratory access to and from potential spawning and rearing areas), and biotic interactions (Rieman and McIntyre 1993; Spence et al. 1996).

Biological requirements are generally defined as properly functioning habitats relevant to each life history stage. In addition, there must be enough of the properly functioning habitats to ensure the continued existence and recovery of the listed species.

Bull trout forage in and migrate through the action area. Thus, for this action area, the biological requirements for bull trout are the habitat characteristics that would support successful foraging in and migration through FMO habitat.

Lake Washington Hydrology

The Lake Washington Basin has been dramatically altered from its pre-settlement conditions by the LWSC and urban development, resulting in possibly the most modified estuary on the West Coast of North America. Historically, Lake Washington flowed into the Black River and the Cedar River joined the Black River approximately half a mile downstream from the Lake. The combined flow of these two Rivers joined the Duwamish River and emptied into Elliott Bay. A significant re-routing of the system occurred when the Cedar River was diverted to create a shipping channel into Lake Washington to provide a port facility on the lake. This diversion was done by a private entity just prior to the Corps' construction of LWSC. Construction of LWSC dropped the water level of Lake Washington 9 ft, which also dewatered the Black River. The Locks then became the outlet from the Lake (Warner 1996).

The Cedar River is now the major source of freshwater to the lake, providing about 50 percent (663 cubic feet per second) of the mean annual flow entering the lake. The Cedar River drainage area is approximately 184 square miles (476 square kilometers), which represents about 30 percent of the watershed area of the Lake Washington Basin. The Sammamish River provides about 25 percent (307 cubic feet per second) of the mean freshwater flow into Lake Washington. The Sammamish River has a drainage area of about 240 square miles (622 square kilometers) and represents about 40 percent of the Lake Washington Basin. Tributaries to the Sammamish River include Swamp Creek, North Creek, Bear Creek, and Little Bear Creek, as well as the surface waters of Lake Sammamish. The remainder of freshwater inflow into Lake Washington originates from a variety of small creeks located primarily along the northern and eastern shores. Other smaller tributaries and subbasins in the Lake Washington system include Thornton Creek, McAleer Creek, Forbes Creek, Juanita Creek, Kelsey Creek, Coal Creek, May Creek, and Mercer Slough.

Within Lake Washington, the natural hydrologic cycle has been temporally shifted. Historically, lake elevations peaked in winter and declined in summer. Today, lake elevation peaks in spring and begins to decline in summer during the drawdown period, reaching the lowest levels by winter when the minimum elevation of 20 ft (6.1 meters) is maintained. Changes to the Lake Washington Basin have substantially altered the frequency and magnitude of flood events in Lake Washington and its tributary rivers and streams. In the past, Lake Washington's surface elevation was nearly 9 ft (2.7 meters) higher than it is today and the seasonal fluctuations further increased that elevation by as much as 7 ft (2.1 meters) annually (Williams 2000). In 1903, the average lake elevation was recorded at approximately 32 ft (9.8 meters).

Development and urbanization have also decreased base flow in many of the tributary systems (Horner and May 1998). Increases in impervious and semi-impervious surfaces (e.g., lawns) reduce infiltration thus reduce groundwater discharge into streams and rivers. A substantial amount of surface water and groundwater also infiltrate into the City of Seattle and King County wastewater treatment systems and are eventually discharged to Puget Sound. The frequency and magnitude of flooding in tributary rivers and streams (with the exception of the dam-controlled Cedar River) have increased largely because of the extensive development that has occurred within the basin over the last several decades (Moscrip and Montgomery 1997).

Lake Washington Shoreline and Riparian Zone

The shoreline riparian and littoral zones of Lake Washington have undergone considerable change since pre-settlement times. The lowering of Lake Washington exposed 1,334 acres (540 hectares) of shallow water habitat, reducing the lake surface area by seven percent, and decreasing the shoreline by 10.5 miles (16.9 kilometers) (a 12.8 percent reduction) (Chrzastowski 1981). The most extensive changes occurred in the sloughs, delta areas, and shallows of the lake.

The area of freshwater marshes decreased from an estimated 1,136 acres (460 hectares) prior to construction of the Locks to 74 acres (30 hectares) by the early 1980s (Chrzastowski 1981). The mouths of tributaries entering the lake have moved some distance to the new lake shoreline, often across what had previously been a relatively shallow sloped alluvial delta (Warner and Fresh 1999). Historically, the mouths of the tributaries often presented fish passage problems due to depth and some of these areas (i.e., May Creek, Thornton Creek) continue to present fish passage problems today. New wetlands and riparian zones have developed in Union Bay, Portage Bay, Juanita Bay, and Mercer Slough since the LWSC was completed (Dillon et al. 2000).

Shoreline vegetation has changed dramatically from a dense undergrowth of small trees, brush, and tule grass to landscaped residential properties with bulkheads where most natural vegetation has been removed. An estimated 81 percent of the shoreline east of the Montlake Cut has bulkheads and over 2,700 residential piers exist (Warner and Fresh 1999). Vegetation in the shallow-water habitat along the shoreline is dominated by Eurasian water-milfoil (*Myriophyllum spicatum*), a non-native invasive aquatic plant introduced into the lake in the 1970s. Milfoil has replaced the native aquatic vegetation and altered the substrate characteristics of much of the littoral zone of the lake (Patmont et al. 1981).

The LWSC and Lake Union Shoreline and Riparian Zone

From the east end of the LWSC to Lake Union, there are only a limited number of short segments (most less than 100 ft (30.5 meters)) of open shoreline (City of Seattle 1999). Portage Bay and Lake Union have heavy over-water private and commercial uses while the LWSC has concrete bulkheads through the Montlake Cut and is heavily riprapped at the foot of the walls through the Fremont Cut. Areas west of the Fremont Cut have several commercial shipyards and large vessel moorage areas with heavy riprap and bulkheads for shorelines (Weitkamp and Ruggerine 2000). Areas that have some amount of undeveloped shoreline include Gasworks

Park, the area south of SR-520 (in Lake Union and Portage Bay), and a protected cove west of Navy Pier at the south end of Lake Union. Vegetation within these areas is limited, with the area south of SR-520 possessing the highest abundance of natural vegetation, consisting primarily of small trees and cattails (*Typha* spp.)(Weitkamp and Ruggerine 2000).

Downstream of the Locks (from its western end at Shilshole Bay), the canal is a saltwater channel dredged to an authorized depth of 34 ft (10.3 meters) Mean Lower Low Water. The canal is about 300 ft (91 meters) wide and 5,500 ft (1,676 meters) long. The maximum tidal range is 19.3 ft (5.8 meters). There are numerous bulkheads and ship-holding areas along this section of the canal, and the intertidal habitat has been substantially reduced and degraded. The riparian zone has largely been developed and urbanized. Minimal natural vegetation remains.

Just upstream of the Locks, the authorized depth of the canal is 30 ft (9.1 meters), with a variable width ranging from 100 ft to 200 ft (31 to 61 meters). The section of the canal closest to the Locks is Salmon Bay. Before construction of the Locks, this area was tidally influenced and navigable only by shallow-draft vessels at high tide. Historically, Salmon Bay was a saltwater inlet (at least during high tide). At low tide, it was practically dry. The water level dropped nearly 20 ft (6.1 meters) between extreme high and low tides (Williams 2000). The Locks raised and stabilized the water level and converted this section of the canal from an estuarine to freshwater/ pseudo-estuarine environment and connected Salmon Bay to Lake Union via the Locks and the Fremont Cut.

The mean water level in Lake Union was not changed by construction of the LWSC, although the range of water level has been reduced since the elevation at the Locks only ranges 2 feet (20 ft to 22 ft (6.1 meters to 6.7 meters)). Lake Union accommodates a large variety of commercial and industrial facilities along its shoreline, including ship repair and scrapping yards, marinas, and office buildings. Most (76 to 80 percent or more) of the shoreline has been developed and modified by installation of bulkheads or other types of bank stabilization materials (Toft et al. 2003). Little of the Lake Union shoreline and riparian zone retains natural vegetation (City of Seattle 2000). Eurasian water-milfoil is present in Lake Union. The species contributes a large amount of organic material to Lake Union, which can affect DO levels (Washington Department of Natural Resources 1999).

Lake Union has an arm extending eastward known as Portage Bay. Portage Bay is lined by University of Washington facilities, commercial facilities, and houseboats. The southeastern portion of Portage Bay has an area of freshwater marsh habitat. The remainder of the shoreline has been developed and several marinas are located in the bay. Aside from the aforementioned marsh, little natural vegetation remains in the riparian zone.

The Montlake Cut connects Portage Bay and Union Bay, which is part of Lake Washington. The Montlake Cut was dredged to an authorized depth of 30 ft (9.1 meters) and has a channel width of 100 ft (31 meters).

The LWSC extends eastward through Union Bay and terminates at Webster Point beyond which is the main body of Lake Washington. Prior to construction of the LWSC, Union Bay consisted of open water with the shoreline extending to 45th Street. After construction, Union Bay was lowered 9 feet and a marsh was created in the northern portion of the bay. The southern limits of the marsh consist of remnant cattail marshes that still exist at the southern edge of the Montlake Fill today. Much of the marsh that was created after construction has since been filled, leaving only the fringe marsh on the southern end (Jones and Jones 1975). Union Bay has several areas of freshwater marsh, milfoil, and associated fauna. The south side of the bay is bordered by the Arboretum and traversed by the Evergreen Point Floating Bridge, creating a network of smaller embayments and canals with marsh habitats. The north side of Union Bay contains a marshy area previously filled with landfill material that is owned by the University of Washington. Numerous private residences with landscaped waterfronts and dock facilities dominate the remainder of the shoreline.

Water and Sediment Quality

The water and sediment quality in the Lake Washington Basin has been, and continues to be, degraded from a variety of point and non-point sources of pollutants. Historically, Lake Washington, Lake Union, and the LWSC were the receiving water bodies for municipal sewage. Out-falls were located at numerous locations along the shorelines and limited treatment or no treatment of sewage occurred prior to discharge. Efforts in the 1960s and 1970s to clean up Lake Washington and other Seattle area waterways led to the expansion of wastewater treatment efforts and the elimination of discharges of untreated effluent into Lake Washington.

Although raw sewage can no longer be discharged directly into Lake Washington, Lake Union, and the LWSC, untreated discharges occasionally still enter these waterways during periods of high precipitation through discharge from combined sewer overflows.

Historical discharges and past dumping practices continue to impact the Lake Washington system. In historical industrial areas such as Lake Union and southern Lake Washington, sediments have been contaminated by persistent toxins, such as polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and heavy metals (King County 1995).

In addition to point sources of pollutants, a variety of non-point sources contribute to the degradation of water and sediment quality. Non-point sources include stormwater and subsurface runoff containing pollutants from road runoff, failing septic systems, underground storage tanks containing fluids such as gasoline and diesel oil, gravel pits/quarries, landfills and solid waste management facilities, sites with improper hazardous waste storage, and commercial and residential sites treated with fertilizers and pesticides. As increased urbanization has occurred in the area, sediment input into the Lake Washington system has increased.

The ecology of Lake Washington has undergone substantial changes over the last 75 years. Several non-native fish and plant species have been introduced into Lake Washington and years of sewage discharge into the lake increased phosphorus concentration and subsequently led to eutrophication. Bluegreen algae dominated the phytoplankton community, and production of some species of zooplankton was suppressed. In the mid 1960s, water quality improved dramatically as sewage was diverted from Lake Washington to Puget Sound. Dominance by blue-green algae subsided and zooplankton populations rebounded. However, around this same time period (1970s), Eurasian water-milfoil was introduced into Lake Washington.

Milfoil can cause localized water quality problems when it grows in dense clumps and/or when it forms dense floating mats that can contain other plant material. Within the clumps, the DO can be reduced below five parts per million. In the lower layers of the mats the plants die and decompose, increasing biological oxygen demand reducing DO and pH. On occasion, conditions in the clumps and mats can become anoxic. Furthermore, substrates rapidly change from sand or gravel to mud because of the large amount of organic deposition and decomposition that occurs. Milfoil has established itself in much of the shallow shoreline habitat (less than 33 ft (10 meters deep)) of Lake Washington, Lake Sammamish, Lake Union, Portage Bay, and the LWSC.

Operation of the Locks allows saltwater to intrude into Lake Union during the summer when seasonal freshwater flow decreases and boat use of the Locks increases. This intrusion creates a seasonally fluctuating saltwater layer in Salmon Bay, the Fremont Cut, and Lake Union. This system is dramatically different from the typical saltwater/freshwater interface seen in most estuarine systems of the Pacific Northwest because there is no natural tidal mixing of these layers east of the Locks.

The sediments of Lake Union are very soft, relatively deep, and contain a large amount of organic material contributed from milfoil and other macrophytes. As microorganisms in the sediment break down this material, they consume much of the oxygen in the lower part of the lake. By the end of summer, concentrations of DO in the hypolimnion of Lake Union are near zero (Washington Department of Natural Resources 1999).

Today, the mile-long Salmon Bay waterway between the Locks and Shilshole Bay serves as the estuarine/marine area, with the Locks creating an abrupt transition between fresh and marine waters. From the Locks to the upstream extent of salinity intrusion is considered the pseudo-estuarine area. Usually this pseudo-estuarine area extends to the east end of Lake Union but can extend as far as the University Bridge in a dry summer. Although it is possible for saltwater to reach the University Bridge, this phenomenon is considered a rare event and salinity never exceeds one part per thousand at the University Bridge. The estuary and pseudo-estuary are not formed by river action and associated deposition, but is primarily a human made construct. Consequently, this area lacks the diversity of habitats and brackish water refuges characteristic of other (unaltered) river estuaries.

Freshwater enters the saltwater below the Locks primarily over the spillway, through the fish ladder, or in a series of pulses during lock operation. Additionally, brackish water is returned to the estuary below the Locks from the saltwater drain. The fish ladder also provides a continuous low flow of brackish water throughout the year below the Locks. During summer months, the amount of freshwater flowing over the spillway is limited and a freshwater lens is not maintained below the Locks. The extent to which saltwater travels up the LWSC and into Lake Union is primarily controlled by outflow at the Locks and the frequency of Locks operations.

A surface lens comprised of water with relatively low salinity (less than 20 parts per thousand in concentration) may occur in the area immediately downstream from the Locks; however, most of the water has relatively high salinity. The lens at high volumes (250 to 400 cubic feet per second) may extend beyond the railroad bridge, depending on the level of discharge at the Locks and tide conditions. During periods of low freshwater flow, the salinity gradient becomes stronger and, as mentioned previously, little or no freshwater lens is formed.

A similar effect can be seen with regard to water temperature. Water temperature changes dramatically above and below the Locks. Summertime differences can be as high as 16° F (8.8° C). The thermal stratification of Lake Union results in surface temperatures regularly exceeding 68° F (20° C) for extended periods during the summer. The average temperature of Puget Sound (below the Locks) is 52 to 57° F (11 to 14° C) during this period. Because of the minimal mixing of freshwater and saltwater through the Locks the large temperature gradient is maintained.

Fish and Fish Predators in the Lake Washington Ship Canal

The purposes of the Act *are to provide a means whereby the ecosystems upon which endangered speces and threatened species depend may be conserved*…: As such the following sections include a discussion of the effects of the action on juvenile salmonids as they are important bull trout prey species. We have focused the discussion on Chinook salmon as an indictor species to represent all prey species due to their threatened status under the Act.

Within the Lake Washington system, there are three stocks of Chinook salmon, including a native/wild stock in the Cedar River, a native/wild stock in the north Lake Washington tributaries, and a composite stock (partially sustained by production from the Issaquah hatchery utilizing the Green River stock) in Issaquah Creek.

Adult and juvenile Chinook salmon migrating between the Lake Washington drainage and Puget Sound must pass through the LWSC and the Locks. As noted above, this migration route is considerably different from the migration routes in which Lake Washington Chinook salmon stocks evolved prior to the diversion of the Lake Washington outlet from the Duwamish/Green River to Shilshole Bay and probably contributes to a lower survival rate compared to the pre-reorientation situation.

Observed and potential migratory pathways for juvenile Chinook salmon and bull trout to pass through the Locks are: (1) fish ladder, (2) spillway gates, (3) smolt passage flumes, (4) “old” saltwater drain, (5) saltwater drain through the fish ladder auxiliary water supply, (6) entrainment into the small lock culvert intakes, (7) volitional migration through the small lock miter gates, (8) entrainment into the small culverts (2 ft by 4 ft (0.6 by 1.2 meter) side portals) during down lockages in the small lock, (9) entrainment into the large lock culvert intakes into the upper lock chamber, (10) entrainment into the large lock culvert intakes for the full lock chamber, (11) entrainment into the small (2 ft by 4 ft (0.6 by 1.2 meters)) culverts during down lockages (of the upper or full lock), and (12) volitional migration through the large lock miter gates (COE 2000b). Monitoring of fish passage has occurred for routes 1, 2, 3, 4, 5 (at intake), 9, and 10.

Although there are 12 possible routes, monitoring indicates that migrating juvenile salmon typically pass through the Locks by one of three main routes: the spillway (smolt passage flumes, spillway gates), large lock miter gates, or the filling culverts. Smolt migratory behavior through the project is based on 4 years of monitoring of smolt passage at the Locks and information from other water control projects in the Pacific Northwest (COE 1999a; Williams 2000).

Predation of salmon is often greatest at bottleneck areas where fish aggregate. Within the LWSC, juvenile Chinook salmon may be vulnerable to predation as they migrate from Lake Washington through the LWSC east of the Locks, as they pass through the primary outlets at the Locks, aggregate below the spillway and locks, and as they rear in the estuary.

The primary freshwater predators are non-native fish, smallmouth bass (*Micropterus dolomieui*) and largemouth bass (*Micropterus salmoides*). Another fish, northern pikeminnow (*Ptychocheilus oregonensis*) appears to be an important predator but little data are available on their abundance. There are an estimated 3,400 smallmouth and 2,500 largemouth bass in the LWSC (Tabor et al. 2000). The smallest number of smallmouth is at the west end of the LWSC in Salmon Bay (approximately 3 percent of the population) while the highest number is at the east end at Portage Bay (approximately 60 percent of the population). Few if any freshwater fish predators have been captured within the immediate vicinity of the Locks. Smallmouth bass consumed almost twice as many smolts per fish compared to largemouth bass (500 smolts vs. 280 smolts, respectively) with Chinook salmon making up 50 percent of identified smolts. Consumption of smolts occurred primarily from mid-May to the end of July, bracketing the documented migration period of Lake Washington juvenile Chinook salmon. Salmon smolts represented 50 to 70 percent of the diet of smallmouth bass during this time period (Tabor et al. 2000). The incidence of freshwater predation by fish in the LWSC may be increasing due to increasing water temperatures. There has been a long-term trend of increasing water temperatures in the LWSC which may result in increased energy demands and higher predation rates from native and non-native predators on later migrating Chinook salmon smolts (Schindler 2000).

The primary known avian and mammalian predators on juvenile Chinook salmon are glaucous-winged gulls (*Larus glaucescens* and others), harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*). Gull predation in the lock chamber has virtually been eliminated since implementation of the slow fill procedures in 1999. Prior to 1999, up to one of every eight smolts entrained in the large lock conduits were eaten by gulls (WDFW 1996). In 2000, anecdotal information has indicated there were only isolated periods when gulls may be preying on sockeye salmon smolts passed over the smolt flumes. One or two noted periods of predation included extreme low tides during the highest smolt passage day(s).

In 2000, the MIT conducted pilot studies of predation of juvenile Chinook salmon below the Locks (Footen 2000). The most abundant predators in the inner bay were sea-run cutthroat trout (*Salmo clarki clarki*) and staghorn sculpin (*Leptocottus armatus*) and in the outer bay the key predators were staghorn sculpin and resident Chinook (blackmouth). Bull trout are another important predator on juvenile Chinook salmon.

Chinook salmon made up 12 percent of the cutthroat trout diet, 34 percent were other smolts, mostly chum. Bull trout diet consisted of 27 percent Chinook salmon and 12 percent other salmonids. Fifty percent of the sculpin diet was Chinook salmon, but this estimate was influenced by one sample.

In related monitoring of PIT tagged Chinook, there were a large fraction of the tagged fish that were caught in saltwater within a few days of detection in the smolt flumes, suggesting a rapid osmotic transition had occurred. The PIT tag data suggest that the captured downstream migrants spent relatively little time in the lower salinity lens below the Locks before making the transition to higher salinity water. Those smolts not ready to transition too more saline water may swim back upstream through the Locks as suggested by past studies (fish detected twice in the flumes) (R2 Resource Consultants 2001). What remains unknown, however, is 1) whether fish that are ready to make the transition are susceptible to avian or other forms of predation during that short period while they are confined to the small freshwater area below the Locks, and 2) how necessary is the freshwater lens to less developed smolts for additional time and space to complete smoltification.

The abundance of harbor seals and California sea lions in Puget Sound has increased significantly in recent decades. Between 1985 and 1995, significant numbers of adult steelhead were consumed by sea lions. In 1996, NMFS authorized removal of several “nuisance” sea lions and subsequent sea lion predation rates declined to 2 percent of the adult steelhead run. Concurrent with removal of the animals, NMFS has been running an acoustic deterrent device or acoustic harassment device in areas near the Locks. The acoustic deterrent device acts as a behavioral barrier to sea lions, emitting sounds in the range of 10 to 15 kHz, a frequency range that appears to exclude most animals from the area below the Locks (Fox et al. 1996). Sea lions have not been observed preying on juvenile salmonids near the Locks since 1999. The acoustic deterrent device has been tested on Chinook salmon as they migrate through the fish ladder. No difference was observed in Chinook salmon behavior as the fish migrated through the fish ladder (B. Norberg, NMFS, pers. comm. 2005).

Harbor seals are present in Puget Sound year-round and are more abundant than sea lions. They commonly prey on salmon, but predation by harbor seals at the Locks has been infrequently observed. Although one or more adults can be seen on an irregular basis by the fish ladder, the number of juvenile Chinook salmon taken by harbor seals is believed to be a small percentage of the run (COE 2001).

Relevance of the Baseline to Status of the Species

Presently, within the action area, the biological requirements of bull trout are not being met under the environmental baseline conditions. The factors for decline that contributed to the need for listing these species continue to be present in the action area. The LWSC is conceptually similar to a channel. It lacks the necessary shoreline habitat that under natural conditions provides food (insects), detritus for the ecosystem, and refuge from predators and adequate water quality throughout much of the summer and fall. The water temperatures in Lake Union have reached lethal levels late in the summer for the last few years. The action area is a small fraction of the habitat that bull trout use. An estuarine (brackish water) area is essential for those juvenile salmonids (bull trout prey species) that have survived their fresh-water journey. This area is essential to allow the juveniles to undergo physiological adaptation to saltwater, grow and transition to an ocean rearing environment. Thus, as a general matter, to improve the status of the listed species, significant improvements in the estuarine habitat conditions both in and beyond the action area are needed. Improving floodplain habitat, restoring saltmarsh habitat, restoring fresh/saltwater wetland habitat, restoring distributary channels in the estuary, removing shoreline armor, eliminating barriers to fish passage, and riparian restoration are all items that could enhance salmonid production and survival in the basin.

EFFECTS OF THE ACTION

Effects of the action means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 C.F.R. 402.02). If the proposed action includes offsite measures to reduce net adverse impacts by improving habitat conditions and survival, the Service will evaluate the net combined effects of the proposed action and the offsite measures as 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 independent utility apart from the action under consideration (50 C.F.R. 402.02). Future Federal actions that are not a direct effect of the action under consideration, and not included in the environmental baseline or treated as indirect effects, are not considered in this Opinion.

Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur (50 C.F.R. 402.02). Indirect effects may occur outside the area directly affected by the action, and may include other Federal actions that have not undergone section 7 consultation but will result from the action under consideration.

Direct effects are the immediate effects of the project on the species or its habitat. Direct effects result from the agency action and include the effects of interrelated actions and interdependent actions. The project is to maintain an existing facility. Existing structures are having effects; maintenance of those structures will continue those effects. Thus, each maintenance action has both direct and indirect effects. Therefore the effects of the actions will be analyzed without respect to whether the action has direct or indirect effects.

The Service has analyzed the effects of the following activities associated with the O&M of the LWSC and have determined that these effects are minimal, insignificant and/or discountable. Therefore, the activities will not be further analyzed in this Opinion. See the Description of the Proposed Action section for a complete description of these projects.

1. Dolphin replacement
2. Annual maintenance after the large and/or small locks are dewatered
3. Special operations
4. Pier maintenance
5. Facilities maintenance
6. Gallery drains
7. Channel tidelands
8. Guide pier

The Service expects the effects of the project to be discountable because 1) the activities will be conducted in the dry (effects of dewatering are described below) or on land which will not impact the aquatic resources or listed species, 2) activities conducted above or on the water will have no effect to bull trout, and 3) activities are inside buildings.

The following activities will not be covered in this Opinion because these activities have either undergone section 7 consultation, will be subject of future section 7 consultations, or include impacts that will occur so infrequently or will have such major impacts that analysis at this time cannot be conducted.

1. Spills of toxic or hazardous material (spill response plan).
2. Use of fire suppressants.
3. Lake Washington general investigation study.

Wounding of Bull Trout as they Pass Through the Locks

Operation and maintenance of the Locks facility can lead to the physical contact between fish and Lock structures and vessels during normal cycling operations. These impacts would cause physical injury when passing through spillways or lock filling conduits. Fish would experience abrasion and strikes injuring body tissues, as well as disorientation and other sublethal injury when exposed to rapid water velocity and pressure changes causing shearing and turbulence. Furthermore, normal Locks operations will expose fish to high density of motor-powered watercraft leading to injury or death from propeller contact. The mere experience of transiting the Locks can also lead to longer-term injuries that occur after fish leave the Lock filling conduit outlets.

Wounding from abrasive impact would occur when fish contact physical structures such as concrete walls or barnacles covering the walls within the Lock conduits during operations. Historically, abrasion suffered in the large lock may have been the primary injury suffered by juvenile salmonids passing through the lock conduits.

Abrasive impacts can cause scale loss. The potential effects of scale loss for juvenile salmonids include complications in osmoregulation leading to dehydration, gut stasis (lack of movement of intestinal contents), and increased susceptibility to disease and predation (Schreck 1982). The actual level of mortality from descaling has not been determined and Chinook salmon are known to survive even after significant descaling injuries. Modifications of lock filling procedures and yearly barnacle removal since 1999 have resulted in significant reductions in descaling injuries and other mechanical injuries.

In 2001, the COE studied juvenile coho and Chinook salmon injuries from passage through a narrow high velocity jet (80 ft per second) into contact with surfaces of varying roughness. Death and injury from descaling increased with increasing roughness (COE 2001). In the same study, the COE reported that barnacles removed from the conduits in 1999, resulted in a 75 percent reduction in the number of heavily injured smolts entrained within the conduits (COE 2001). Therefore, the COE will continue annual barnacle removal as a part of the proposed action to minimize abrasion related injury and death.

Short-term delayed injuries and modified fish behavior would result from rapid water velocity and changes in water pressures. Fish typically experience water turbulence after passing through the Locks (i.e. through a spillway or Lock conduit) in the outlet area. The extent of behavioral disruption is related to the extent of area affected by increased turbulence (a function of discharge as well as the energy dissipation characteristics of the spillway or conduit outlet). Since 1999, the COE has implemented a "slow fill" process for large Lock cycling operations to minimize the rapid, extreme variation of water flow and the effects of such conditions on fish. At the time of this consultation neither the COE nor the Service had data on short-term delayed injury of fish passage through the spillway gates or conduits of the large lock chamber. This type of injury is difficult to isolate from other types of injury (such as that occurring during passage through the conduits proper) making it difficult to study (R2 Resource Consultants 1998). Despite the lack of clear data on injury, highly turbulent conditions might be minimized in stilling basins minimizing the effects of these water conditions on fish (COE 2001). Furthermore, conditions can be made more functional for fish passage by continuing implementation of slow fill procedures, as proposed. The current method of slow fill is meant to delay or slow the fill rate, reducing fish entrainment in the lock filling culverts and avoiding any turbulence at the water surface in the lock chamber. The initial objective of eliminating turbulence was to eliminate gull predation of up-welled smolts, but the subsequent effect may have also resulted in reduced short-term delayed injuries.

The COE operates the Locks to enable transit of watercraft between Puget Sound and Lake Washington (and back). Thus, during each Lock cycle, adult fish are exposed to propeller driven watercraft in a confined area. Adult sockeye salmon are injured or killed when struck by propellers (COE 2001). There have been no observations of adult bull trout injuries from propeller strikes although this is probably because the sockeye occur in the Lake Washington system in much greater numbers than bull trout. Because sockeye salmon injured have been observed, and bull trout are exposed to the same conditions, the Service assumes these conditions kill or injure these listed, although probably in significantly lower numbers than have been observed for sockeye.

Finally, the mere passage of these fish through the locks exposes them to longer term, or delayed injury or death after leaving the Locks. Such injury or death is attributable to physical impacts and behavioral modification occurring from the conditions within these passageways, described above. For example, wounded fish are more susceptible to disease, disorientation of juvenile fish during migration, and changes in behavior that may increase susceptibility to predation. However, just as the minimization measures described above (barnacle removal and slow fill) have been effective in minimizing the immediate effects of Locks transit, so they are likely to minimize disorientation, and susceptibility to disease and predation (COE 2001).

Migration

The mere presence of the Locks, and its continuing O&M will cause the continued disruption of fish migration. The facilities create a physical barrier that alters streamflow and consequently fish passage, despite the presence of fish passage facilities.

The spillway gates at the Locks do not appear to harm bull trout. The spillway crest does not have an overly rough surface, or structures protruding from the crest or tailrace that could result in mechanical injury or mortality (R2 Resource Consultants 1998). The gate opening is at a low head (8.0 ft to 9.0 ft (2.4 to 2.7 meters)), and the average maximum velocity through the 0.5 ft (0.2 meters) spillway gate opening is between 12 and 15 cubic feet per second, well below velocities reported as causing injuries to fish. As a result, the spillway in and of itself neither appears to expose fish to injury or death by means described above, nor appear to inhibit migration.

However, when flow volume is insufficient to operate the spillway gates, bull trout behavior can be impaired, forcing fish to seek another route through the Locks, increasing their exposure to the injuries described above. Since 2000, smolt passage flumes allow spill of lesser volumes, thus providing safer passage later into the migration season, including periods of low stream flow.

Prior to 1999, climate variability and continuing development within the Lake Washington basin may have reduced base-flows (Horner and May 1998) thereby resulting in less late spring and early summer inflow to the Lake Washington system. When low flow conditions arise, the closing of all spillway gates is the first conservation measure enacted to maintain mandated lake elevations. Juveniles were then forced to travel through one of the other routes, and such diversions could potentially lead to injury. Under the proposed action, the COE will continue to operate the smolt passage flume to minimize the effects of the loss of passage through the spillway.

The following subsections describe the effects of operating the smolt passage flumes, fish ladder, and saltwater drain.

Smolt Passage Flumes. In 2000, the COE installed the smolt passage flumes to provide a means of controlling discharge flows as well as allowing outmigrating bull trout to avoid other, potentially harmful routes through the Locks. As such, the operation of the flumes results in a reduction of potential injuries to bull trout. Because the COE must maintain lake levels, the amount of available water volume dictates the duration of flume operation. If available water volume is not sufficient to operate the flumes through the outmigration period, the outmigrants may be forced to transit less fish-friendly routes and some level of injury could result. The smolt passage flumes typically do not operate during summer months past June, especially in dry years, because of the low water volume into Lake Washington and the requirement to maintain the lake level at 20 ft (6.1 meters). This factor is particularly important for juvenile Chinook salmon, whose outmigration period extends through early July.

When the smolt passage flume operation ceases, bull trout are forced to travel through the fish ladder, the saltwater drain, Lock-filling culverts, or one of the two Locks. These routes each expose outmigrant fish to the types of injuries discussed above. To minimize the need to shut down the flumes, the COE seeks a modification to the amount of saltwater that moves upstream of the University Bridge (approximately 4 miles) from Ecology, providing more water for the smolt passage flumes since less water would need to be released from above the Locks to keep the saltwater from intruding into the freshwater side, upstream of the Locks. This modification would enable operations of the flumes for a longer period of time into the summer, which would further benefit downstream smolt passage.

Fish Ladder. The fish ladder provides an upstream migration route for bull trout returning to the Lake Washington basin. The COE improved the fish ladder in 1976 whereby approximately 80 percent of the adult migrating Chinook salmon use the ladder. Fish do not appear to receive physical wounding from passage at the ladder. However, the fish ladder is imperfect as the entrance is narrow, creating a bottleneck for the fish moving upstream. This bottleneck can increase predation and delay migration. Additionally, a 16° F (8.9° C) temperature gradient exists between the entrance and exit of the ladder. This differential, occurring in such a short distance, can stress fish, impairing normal migration behavior. Research indicates that as many as 30 percent of adult Chinook salmon that passed through the fish ladder move back downstream below the Locks (Fresh et al. 1999) to return to the cooler water.

Saltwater Drain. Entrainment of fish into the saltwater drain is not considered to be a serious concern because velocities are low (5 to 8 ft per second), and the pipes are straight and smooth (no barnacles, no sharp turns). Discharge out the old drain outlet over the spillway crest is unlikely to result in any injuries or mortalities. Discharge into the diffuser well may be a problem because there is no direct outlet to Puget Sound from the well. Smolts might pass from the well through fiberglass screens (3- by 3-inch opening) at the base of five pools where the water upwells, or they may remain in the well. During annual dewatering of the fish ladder in late May, few smolts have ever been observed (COE 2001).

Direct observations and continuous monitoring indicate that few smolts go through the saltwater drain (BioSonics 2001). Although the saltwater drain cannot be eliminated as a pathway for juvenile salmonids under current operating conditions, even during periods of little or no spill, the saltwater drain intake is less likely to be a major pathway for juvenile fish than the large lock culvert intakes for several reasons:

1. The drain intake is at a greater depth (50 ft (15.2 meters) average versus 33 ft (10.0 meters) for lock culvert intake).

2. Velocities into the intake (0.5 to 1.0 ft/second) are much lower than velocities typically encountered and selected by smolts passed through either the flumes or the culvert intakes (3 to 5 feet/second).

3. Poor water quality conditions (low DO) (less than 5.0 milligrams/liter) near the drain may exist for sustained periods. This analysis is supported by fish passage research and environmental conditions at the drain intake.

4. Adult bull trout may enter the intake of the saltwater drain in the forebay of the Locks. The intake was initially screened in the 1970s, but accumulation of debris required that the screen be removed. Salmonids entering the drain should be able to swim out of the 6 ft (1.8 meters) diameter pipe since velocities are not high (5.6 feet/second). Numbers of bull trout entering the intake and time spent there is currently under investigation by tracking movements of adults in the forebay.

The COE is willing to work with regional and local governments to obtain a short-term modification of the salinity standard, which would allow increased use of the smolt passage flumes and thereby reduce use of the saltwater drain.

Migration Delay

Delayed migration leads in some cases to increased energy expenditure, stress, susceptibility to disease and predation, and altered spawning timing (where the delay represents a significant portion of time prior to spawning). An important concern is the extent to which the Locks complex delays upstream migration of salmonids from Shilshole Bay to the forebay of the Locks. The rehabilitated fish ladder was designed to reduce migration delay and facilitate upstream migration, based on the best information available at that time (COE 2000a).

Water discharge through the fish ladder may affect the time for fish to pass through the vicinity of the Locks. Studies at dams indicate increased rates of fish passage through fish ladders and other fish passage structures when even a small amount of water is spilled to attract fish (Junge and Carnegie 1973). Proposed operations would continue the 200 cubic feet per second of water released from Spillway gate 5 nearest the fish ladder from January 1 through March 31 (to attract winter steelhead). Spill water may also be released near the ladder from May through October in an attempt to attract Chinook salmon (when sufficient water is available). However, low water availability prevents spill of additional attraction water after early June of most years. Since 1995, spill through Gate 5 has been replaced by flow through the smolt passage flume, which may also serve to attract bull trout to the fish ladder. The low water availability can result in migration delay for subadult and adult bull trout, thus increasing the risk of mortality due to stress, energy expenditure, or disease susceptibility.

Water Quality

In general, bull trout encounter an abrupt change in temperature and salinity as they pass from the warm (~59 to 70° F (15 to 21° C)), less saline waters (0 to 0.3 parts per thousand) upstream of the Locks to the cool (54 to 61° F (12 to 16° C)), saline (15 to 29.7 parts per thousand) waters of Shilshole Bay (depending on the spill) and vice versa. In contrast, bull trout in a natural estuary would be free to move up and down the channel selecting preferable temperature and salinity. While the frequency and magnitude of injury to smolts at the Locks has been significantly reduced (as discussed previously), the rapid transition from the warm fresh-waters of the LWSC into cold, marine waters of Shilshole Bay (Puget Sound) will persist as long as the Locks are present and operated as proposed.

Salinity. For most Puget Sound salmonid stocks, downstream migration is followed by an extended period of estuarine residence. The estuarine environment provides intermediate and varied salinity regimes that aid in the physiological transition of salmon from freshwater to saltwater habitats. In the Lake Washington system, the estuarine environment has been dramatically altered by the creation of the LWSC and the diversion of the Cedar River into Lake Washington. The presence of the Locks causes a sharp salinity transition for smolts migrating out of Lake Washington into Puget Sound (COE 2001).

In a natural setting where a river (or stream) meets saltwater the two salinity regimes create a transition zone or estuary. At it's upper (upstream) end, the transition zone has almost no salt content. At the lower, or downstream end, the transition zone is almost entirely saltwater. The transition zone is thus a region where salt content in the water varies from almost zero to nearly 30 parts per thousand salt (in Puget Sound). This zone can be critical to physiological adaptation for either juveniles or adults when they move between fresh- and saltwater environments (Healey 1991). Without the transition zone, salmonids may well find themselves subject to stress as they attempt to undergo the physiological changes necessary to osmoregulate in a different salinity regime. In freshwater the individual is required to actively remove freshwater from its body, while in saltwater the individual is required to ingest saltwater and remove salt. Both of these activities require the expenditure of energy. Movement of salmonids from the ship canal directly into saltwater is stressful and probably results in delayed mortality that would not be seen in conditions where the salmonids can adapt to changing salinity conditions (COE 2001).

Recently emerged fry have been shown to tolerate high salinity. However, most Chinook salmon fry are not fully adapted to osmoregulation in saltwater, as evidenced by their elevated blood chloride levels (Wagner et al. 1969). Clarke et al. (1989) suggested that ocean-type Chinook salmon fry may be able to exploit estuarine areas by seeking out lower salinity habitats rather than by physiological change to greater salinity tolerance. Larger and older Chinook salmon fry and fingerlings have greater tolerance to saltwater transition than smaller and younger fish. Furthermore, faster growing fish of any length exhibit greater saltwater tolerance than slower growing fish, indicating the importance of growth rate. As such, juvenile Chinook salmon will spend time in brackish water habitat to allow for physiological acclimatized when moving from freshwater to full strength sea water.

Salinity tolerance increases rapidly once Chinook salmon fingerlings reach a size greater than 2.2 inches (55 millimeters) and even direct transfer to seawater results in high survival (Wagner et al. 1969). Based on physiological studies, ocean-type Chinook salmon are usually fully smolted at a length of 2.6 to 2.8 inches (65 to 70 millimeters). At the Locks, the point of physical separation between freshwater (Lake Union/Lake Washington) and saltwater (Puget Sound) Chinook salmon smolts has historically (1967) and recently (1998) been caught at sizes much greater than those in other river basins. The mean size was 4.3 inches (110 millimeters) (range 3.2 to 5.4 inches, or 82 to 137 millimeters) in 1967 (COE 1999a) and 4.1 inches (105 millimeters) in 1998 (Warner and Fresh 1999). Fish of this size are thought to be fully capable of rapid transition to saltwater. However, the specific effects of the transition from the freshwater above the Locks to the marine waters below the Locks have not been studied.

Saltwater preference testing has suggested that more smolted Chinook salmon are more likely to enter saltwater, while less smolted fish may avoid saltwater and remain in freshwater (Schreck and Stahl 2000). Those smolts not ready to transition to more saline water may swim back upstream through the Locks as suggested by the data collected on individual fish that were detected twice in the flumes (R2 Resource Consultants 2001). If migration delay occurs, it may affect smolts negatively by exposing the fish to higher water temperatures than they would normally migrate through. These conditions could ultimately cause mortality due to osmoregulatory stress.

Data gaps exist on whether smolts that migrate downstream through the Locks are susceptible to avian or other forms of predation during the period while they are adjusting to the salinity change. Additionally, studies have not been conducted to determine if downstream migrants are remaining in or near the freshwater lens and how necessary the freshwater lens is to less developed smolts in providing additional time and space to complete the smoltification process. Future studies can determine the susceptibility of smolts to osmoregulatory stress and predation because of rapid salinity change. When the COE obtains the proposed salinity waiver, the salinity gradient should moderate near the Locks and improving estuarine water conditions for the smolts to adjust to the salinity change.

Salinity in the fish ladder entry pool has been identified as a factor affecting attraction of adult salmonids to the ladder. Maintaining cues, such as freshwater, for homing Chinook salmon is an important function of the fish ladder.

For bull trout, no studies have been conducted on their salinity tolerances (Goetz and Jeanes 2004). Goetz and Jeanes (2004) while using acoustic telemetry have observed subadult and adult bull trout moving between freshwater, brackish, and marine habitats with little or no delay (or period of acclimation). Both subadult and adult bull were found to move into saltwater from freshwater areas and from saltwater to freshwater in a matter of hours, with little or no hesitation. Subadult and adult bull trout were also found to move back and forth between brackish and freshwater tidal areas on a daily to weekly basis. They do not know if this behavior is displayed by juvenile bull trout. The abrupt salinity differences at the Locks may not result in significant effects for bull trout.

Temperature. A temperature gradient exists between the freshwater above the Locks and the saltwater below the Locks. The temperature gradient is strongest during late summer when the surface layers of the lakes have reached their highest temperature and when no spill is occurring over the spillway.

Elevated temperatures are not a limiting factor for outmigrating juvenile Chinook salmon. Studies indicate that surface layer temperatures above the Locks were approximately 63.5° F (17.5° C) in June, increasing to 66° F (19° C) in July. By July, the majority of smolts have passed through the Locks. Additionally, temperatures above the Locks at a depth of 46 ft (14 meters) were approximately 7 to 9° F (4 to 5° C) cooler (Hansen et al. 1994).

Bull trout moving through the Locks may be greatly affected by high water temperatures. Bull trout have been observed moving through the Locks when water temperatures were around 63 to 64° F (17 to 18° C) (F. Goetz, COE, personal communication 2004). Like other systems, these bull trout may continue to migrate through the system until they find cooler waters. Bull trout may not utilize the Locks or the LWSC during August and September when temperatures are greater than 64° F (18° C).

The COE is considering alternative designs for the fish passage facilities to decrease the temperature gradient in the vicinity of the Locks under the GI Study.

Dissolved Oxygen. Low DO concentrations occur in the seasonal saline layer at the bottom of Lake Union and the LWSC because of biochemical oxygen demands of the sediment. Saltwater intrusion upstream of the Locks occurs during lock operations and eventually reaches Lake Union. Operation of the saltwater drain is regulated to ensure that saltwater concentration does not exceed one part per thousand at the University Bridge (downstream of the Montlake Cut) any time during the year, as mandated by Ecology. The anoxic layer at the bottom of Lake Union typically breaks up, along with the thermocline, in the fall.

Bottom waters upstream of the Locks and in Lake Union become anoxic during summer but become oxygenated during fall. Investigations of adult Chinook salmon migrating through estuaries indicate low DO can block upstream migration. This could occur for bull trout as well. Alabaster (1989) reported that Chinook salmon migration (Willamette and San Joaquin Rivers) was blocked at DO concentrations of 3.5 milligrams/liter at 70° F (21° C) or 3.9 milligrams/liter at 72° F (22.4° C). A 75 percent migration failure rate was observed at a DO concentration of 4.7 milligrams/liter at 70° F (21° C). During an extensive review of salmon oxygen requirements, Davis (1975), cited in (Weitkamp and Ruggerone 2000)) recommended DO concentrations of 7.25 milligrams/liter to protect all individuals of a population, and noted that at 5.25 milligrams/liter the average individual in a population would begin to exhibit symptoms of stress. The combined effect of moderately low DO at mid-depths and high temperature would likely cause bull trout to either move quickly through the system or avoid it altogether.

Lower DO levels at the bottom of Lake Union could negatively affect the organisms that inhabit the benthic sediments. However, studies in Lake Union indicate that the benthic macroinvertebrate communities are typical of those found in deep water lakes. These communities are characterized by hardy species, such as chironomids (important prey of juvenile salmon), oligochaete worms, and several clam species that tolerate low oxygen levels (Dillon 1993). Lake productivity does not appear to be a limiting factor for juvenile salmonids, including Chinook salmon (COE 2001).

Export of Nutrients and Food

As previously discussed, the Locks create a physical barrier separating the free exchange of marine/estuarine waters below the Locks and the freshwater above the Locks. The result is a decrease in the exchange of nutrients and food within the vicinity of the Locks. Potential adverse effects include an overall reduction in the export of nutrients and food from above the Locks to below the Locks. Studies indicate that *Daphnia* comprise 90 percent of the juvenile Chinook salmon diet in inner Shilshole Bay, while in the outer Bay fish primarily feed on smaller fish, polychaete worms, amphipods, and other benthic/epibenthic crustaceans. If the Locks block the movement of nutrients and food downstream of the Locks, less food would be available for the juvenile Chinook salmon which would translate into less food available for bull trout. A smaller overall fish size could result, which could make this population more susceptible to predation. Evidence from a 1999 UW/Battelle study (Simenstad et al. 1999) indicated poor feeding success, or behavioral disruption of feeding, in juvenile Chinook salmon immediately below the Locks.

Lake Level Effects

Operation of the Locks requires that the level of Lake Washington be maintained between approximately 20 and 22 ft (6.1 and 6.7 meters) elevation. Dillon et al. (2000) measured the water depths at the mouths of tributaries entering Lake Washington to determine whether access to spawning grounds may be inhibited during low-flow conditions. Juanita and Coal Creeks have access problems before the lake level drops to 20 ft (Weitkamp and Ruggerone 2000). In contrast, the channel depth entering the Cedar River, Sammamish River, and May, McCleer, and Thornton Creeks was greater than 1.5 ft (0.5 meters), indicating that bull trout would not have difficulty gaining access to these waterways.

Although completion of the Locks and LWSC in 1916 led to a significant lowering of the elevation of Lake Washington and would have initially affected access of salmon to spawning streams, operation of the lake level within the proposed range probably enhances access during low water years. In pristine lakes, salmon can experience difficulty entering smaller tributaries during years of low lake level and stream flow (COE 2001).

Riparian and Bank Maintenance

Maintenance and landscaping occurs periodically along both shores of the LWSC. The Programmatic Agreement for stewardship of the LWSC National Historic District requires retention and preservation of the terrain and any significant landscape features. Vegetation and landscaping (e.g., the Lombardy poplar colonnade) are considered significant features and therefore need to be maintained to preserve the historical integrity of the LWSC National Historic District.

The riparian vegetation consists of a medley of native and non-native plants. Where possible, landscape maintenance will utilize native shrubs and groundcover to reduce erosion potential along the shoreline. However, certain elements, such as the colonnade of Lombardy poplars along the Fremont Cut that are nearing the end of their life expectancy, will be replanted with the same or similar species of Poplar as needed, to maintain safety for navigation and pedestrians. The Fremont Cut Vegetation Rehabilitation Plan will guide COE restoration efforts for the next 40 years.

Similarly, large woody debris (LWD) is removed from the LWSC when it poses a risk to navigation. The role of LWD in this highly modified environment has not been established and would differ from the function it provides in natural environments (refugia, pool formation, and prey habitat). LWD would provide some benefits to the system (such as refugia). However, because of the armored shoreline and deep channelized nature of the LWSC, LWD typically moves through the system and accumulates at the Locks. Therefore, the benefits to salmonids of LWD in this setting may be limited.

The LWSC is a highly modified channel with numerous concrete bulkheads and revetments. In the Fremont Cut, the bulkheads are heavily riprapped. The concrete bulkheads, revetments and riprap are repaired or replaced as needed. Measures that stabilize river banks adversely affect the natural form and function of the river, thus affecting fish and their associated habitats. In general, bank stabilization tends to physically stabilize river banks or divert flows away from one bank to another. This change increases river flow velocities, exacerbating downstream bank erosion, leading to river bed degradation and lowering of river stages. However, in a highly developed and modified channel like the LWSC, riprapped banks can result in increased biological interactions. Interstitial spaces in riprap affect Chinook salmon and bull trout. Juvenile fish find cover between the rocks. However, increased interstitial space increases non-salmonids use (e.g. squawfish and sculpins), causing increased competition and salmonid predation.

Fish Handling during Locks Maintenance

The COE proposes to periodically dewater the large and small locks for annual maintenance. To avoid and minimize the stranding of fish leading to their injury or death, the COE proposes to capture and handle listed fish during the dewatering of the fish ladder. While fish handling is almost always incorporated into proposed actions for the purpose of minimizing the effects of other proposed activities, fish handling can cause adverse effects, some leading to injury or death. Mortality may be immediate or delayed. Handling stress, use of seines and dip nets may result in some injury and death. Under the proposed action, injury and death from handling stress, and the use of seines and dip nets will be rare.

During the fish ladder and large and small lock dewatering, fish will be captured using seines and dip nets. All fish will be removed and placed on the saltwater side of the Locks. All fish will be transported in large buckets (minimum 5 gallon) filled with stream water. The fish and water temperature will be monitored to ensure the health and condition of the fish until they are released. Given the low impact of these capture and relocation techniques, the likelihood of injury to bull trout is expected to be low.

Bull trout will be temporarily disrupted in their normal behavior during the capture and relocation activities. The trapping and movement of these fish will be conducted by qualified personnel and is not expected to result in injury or death in most cases. Handling of fish increases their stress levels and can cause a variety of injurious conditions, including reduced disease resistance, osmoregulatory problems, decreased growth, decreased reproductive capacity, and increased mortality (Kelsch and Shields 1996). The Service anticipates that the handled fish will be released shortly after their capture, minimizing bull trout stress. Depending on the number of bull trout that need to be relocated during the dewatering of the fish ladders and small and large locks, some deaths may occur during the handling and transfer process.

Summary of Direct and Indirect Effects

Bull trout will be affected by the continued O&M of the LWSC. The effects of O&M include the physical injury from abrasion and propeller contact, migration delay resulting from blockages of free movement of streamflow (and fish passage through the LWSC), inadequate water quality (salinity, temperatures, DO), low export of nutrients and food, and lake level fluctuations. Both the juvenile Chinook (bull trout prey) and bull trout life histories are negatively impacted by the Locks. Movement through the Locks is hazardous for numerous reasons. Many of the passages that juveniles can pass through bring them into turbulent water and/or in contact with rough concrete. Adult and subadult bull trout can encounter direct contact with vessels in the large lock, move abruptly into freshwater by traversing the fish ladder and some may inter to outfall from the saltwater drain. The LWSC is an artificial structure, the vast majority of which is maintained for commerce and other human use and provides little aquatic habitat for juvenile Chinook salmon and bull trout.

Interdependent and Interrelated Actions

In evaluating the effects from the interdependent and interrelated actions associated with the LWSC it is important to separate the effects of initial construction of the Locks and LWSC from continued O&M. The construction and O&M activities that occurred prior to the listing of bull trout are considered the environmental baseline. As such, the initial development and expansion of the commercial, industrial, and recreational water-dependent uses of the LWSC (including Salmon Bay, Lake Union, and Lake Washington) are not addressed.

Continued O&M of the LWSC allows continued commercial, industrial, and recreational usage in the action area. Further water-dependent development is likely to occur because of the access provided by the LWSC. However, the scale of this development is primarily dependent on outside market forces and not on O&M of the LWSC. Many of the current commercial and industrial users along these waterways have experienced a sharp downward trend in the past several decades (e.g., fishing, timber export). Recreational use, on the other hand, has probably increased.

Sustained water-dependent development in the Lake Washington Basin will continue to affect salmonid populations. However, most of the land areas surrounding the LWSC action area are fully developed.

CUMMULATIVE EFFECTS

Cumulative effects are those effects of future state, Tribal, local, or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 C.F.R. 402.02).

Within the LWSC project area, the operational plans and the Programmatic Agreement for maintenance of the National Historic District ensure that no further development will occur without coordination with the State Historic Preservation Office. Therefore, the LWSC project area itself will not be developed further and will not further contribute to any cumulative effects, although development and redevelopment will continue to occur in the Lake Washington Basin.

Between 1990 and 2000, the population of King County increased by 15.2 percent[1]. Thus, the Service assumes that future private and state actions will continue within the action area, increasing as population density rises. As the human population in the action area continues to grow, demand for agricultural, commercial, or residential development is also likely to grow.

[1] U.S. Census Bureau, State and County Quickfacts. Available at http://quickfacts.census.gov/qfd/

The effects that new development have, that are caused by that demand, are likely to further reduce the conservation value of habitat within the action area.

CONCLUSION

After reviewing the best available scientific and commercial information regarding the biological requirements and the status of bull trout considered in this Opinion, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, the Service concludes that the action, as proposed, is not likely to jeopardize the continued existence of the species.

The LWSC does not meet the biological requirements of bull trout. The LWSC is armored by riprap and concrete throughout most of its freshwater length. It contains tens if not hundreds of docks and piers, as well as numerous boat houses and many hundreds of moored vessels. The Locks is an artificial structure that was designed for use of vessels transiting, to and from, Salmon Bay. The shoreline of the LWSC between the Locks and Puget Sound is highly developed, almost devoid of natural habitat. However, despite this lack of natural habitat, bull trout must travel through the LWSC during their migrations to and from Puget Sound and Lake Washington for foraging, migrating, and overwintering.

Estuaries, shoreline areas, and foraging, migration, and overwintering habitat provide important habitat for food production, foraging areas, refuge (from predation, seasonal high flows, winter storms, etc.), and migratory corridors for bull trout. These biological requirements for bull trout are not met within the LWSC. The aquatic habitat has been dramatically altered from its pre-settlement condition. The hydrology, water quality, and the shoreline and riparian conditions of both Lake Washington and the LWSC have been degraded from urban, industrial, commercial, and residential development.

The marine life history, migration patterns, and population dynamics of bull trout in the action area are poorly understood. Bull trout from the Snohomish/Skykomish, Stillaguamish, and Puyallup River core areas may utilize the LWSC and the Lake Washington FMO habitat. The number of bull trout utilizing the action area, including Shilshole Bay, the fish ladder, or the Locks is expected to be low. In 2000 and 2001, only 13 bull trout were caught in and around the Locks. All bull trout were captured were caught from May through July when habitat conditions (temperature and DO) were more favorable for bull trout.

The O&M of the LWSC project results in numerous direct and indirect adverse effects to bull trout. Specific effects could include physical injury through abrasion from contact with the physical structures associated with the Locks or with propeller contact from vessels in the locks. Bull trout injury, mortality or delayed migration and increased energy expenditure, stress, and susceptibility to disease may result from the large differences in temperature, salinity and DO concentration above and below the Locks. Reduced food availability and potential reduced growth rates may result from the decrease in the export of nutrients and food through the Locks. The smolt flumes, fish ladder, and the saltwater drain disrupt migration through the Locks. Fish capture and handling of bull trout results in increased stress, injury, and susceptibility to disease.

While the proposed action has adverse effects on bull trout, the O&M of the LWSC will not appreciably reduce the likelihood of both the survival and recovery of the Coastal-Puget Sound bull trout Habitat Management Unit. The project is not expected to jeopardize the continued existence of the Coastal-Puget Sound Habitat Management Unit of bull trout for the following reasons:

- The adverse effects from the project will not impact the distribution or preclude the long-term presence of anadromous bull trout within the action area. Migration to and from the Lake Washington FMO will occur during the time of year and when habitat conditions are conducive to bull trout migratory behavior.

- A number of conservation measures, including removal of barnacles in the culvert of the large lock and implementation of in-water work windows for any work conducted in the water are included as part of the project. These measures will greatly minimize adverse effects to bull trout and are consistent with recovery actions (USFWS 2004b).

- The number of bull trout exposed to the effects of the action is considered to be relatively low. These individuals are likely to be from 3 of the 8 bull trout core areas of the Puget Sound Management Unit and 3 of the 34 subpopulations of bull trout in the Coastal-Puget Sound Habitat Management Unit. Therefore, the number of individuals expected to be affected from each core area or subpopulation is small and unlikely to appreciably reduce the numbers and reproduction of bull trout in the Habitat Management Unit.

STATUS OF BULL TROUT CRITICAL HABITAT

This Biological Opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

Legal Status

The Service published notice in the Federal Register the final rule designating critical habitat for bull trout for the Klamath River, Columbia River, Jarbridge River, Coastal-Puget Sound, and Saint Mary-Belly River populations of bull trout (FR 70, No 185, 56211-56311) on September 26, 2005. This final designation totals approximately 3,827 miles (6,160 kilometers) of streams, 143,218 acres (57,958 hectares) of lakes in Idaho, Montana, Oregon, and Washington, and 985 miles (1,585 kilometers) of shoreline paralleling marine habitat in Washington.

Table 5. Stream/shoreline distance and acres of reservoir or lakes designated as bull trout critical habitat by state.

	Stream/shoreline Miles	Stream/shoreline Kilometers	Acres	Hectares
Idaho	294	474	50,627	20,488
Montana	1,058	1,703	31,916	12,916
Oregon	939	1,511	27,322	11,057
Oregon/Idaho	17	27		
Washington	1,519	2,445	33,353	13,497
Washington (marine)	985	1,585		

Conservation Role and Description of Bull Trout Critical Habitat

It has been shown that species with critical habitat designated after two or more years are more likely to be stable or improving and over time are twice more likely to be improving than species without critical habitat designations (Taylor et al. 2005). Additionally, the designation of critical habitat increases the knowledge about species' status and trends, and contributes to recovery goals (Hagen and Hodges 2006). The conservation role of bull trout critical habitat is to support viable core area populations (70 FR 56212).

Critical habitat units generally encompass one or more core areas and may include foraging, migration, and overwintering areas, outside of core areas, that are important to the survival and recovery of bull trout. Because there are numerous exclusions that reflect land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments. These individual critical habitat segments are expected to contribute to the ability of the stream to support bull trout within local populations and core areas in each critical habitat unit. The core areas reflect the metapopulation[2] structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses.

The primary function of individual critical habitat units is to maintain and support core areas which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993), 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (Rieman and McIntyre 1993; MBTSG 1998), 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Rieman and McIntyre 1993; Hard 1995; Healey and Prince 1995; MBTSG 1998), and 4) are distributed throughout the historical range of the species to preserve both genetic and phenotypic adaptations (Rieman and McIntyre 1993; Hard 1995; MBTSG 1998; Rieman and Allendorf 2001).

The Olympic Peninsula and Puget Sound Critical Habitat Units are essential to the conservation of amphidromous[3] bull trout, which are unique to the Coastal-Puget Sound bull trout population.

[2] A set of partially isolated populations belonging to the same species.
[3] Migratory behavior of fish moving from fresh water to the sea and vice versa, not for breeding purposes but happening regularly at a particular stage of the life cycle (such as feeding or overwintering).

These critical habitat units contain marine nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain Primary Constituent Elements (PCEs) that are critical to adult and subadult overwintering, migration, and foraging.

Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, and sheltering. The PCEs are as follows:

1. Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72º F (0 to 22º C) but are found more frequently in temperatures ranging from 36 to 59º F (2 to 15º C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence.

2. Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and in-stream structures.

3. Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter) in diameter.

4. A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.

5. Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.

6. Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

7. An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish; and

8. Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Critical habitat includes the stream channels within the designated stream reaches, the shoreline of designated lakes, and the inshore extent of marine nearshore areas, including tidally influenced freshwater heads of estuaries. The offshore extent of critical habitat for marine nearshore areas is based on the extent of the photic zone, which is the layer of water in which organisms are exposed to light. In freshwater habitat, critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line.

Adjacent stream, lake, and shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the marine environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by altering the PCEs to such an extent that critical habitat would not remain functional to serve the intended conservation role for the species (70 FR 56212). Our evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998). Therefore, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the Coastal-Puget Sound population segments.

The action area is contained within the Puget Sound Management Unit. The Lake Washington system is in the Coastal-Puget Sound Management Unit and contains important FMO habitat necessary for bull trout recovery. Although there is currently insufficient information available to assign the Lake Washington system to a specific core area(s), it is believed to be critical to the persistence of the anadromous life history form, unique to the Coastal-Puget Sound Management Unit.

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial and resident life history patterns. The anadromous life history form is unique to this unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004b). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this unit. With only a few exceptions, bull trout continue to be present in nearly all major watersheds where they likely occurred historically within this unit. Generally, bull trout distribution has contracted and abundance has declined especially in the southeastern part of the unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching and incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Bull Trout Recovery Plan (USFWS 2004b) identifies the following conservation needs for this unit: maintain or expand the current distribution of bull trout within existing core areas; increase bull trout abundance to about 16,500 adults across all core areas; and maintain or increase connectivity between local populations within each core area.

Current Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) Fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Rieman and McIntyre 1993; Dunham and Rieman 1999), 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989; MBTSG 1998), 3) the introduction and spread of non-native species as a result of fish stocking and facilitated by degraded habitat conditions, particularly for brook trout and lake trout, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993; Rieman et al. 2006), 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of main-stem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development, and 5) degradation of foraging, migration, and overwintering habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Current Condition of Critical Habitat Unit 28

The urban rivers of Puget Sound are impacted from past logging and logging roads in the upper reaches, and agriculture and urban development in the lower floodplains. Intensive channelization to protect urban development and agricultural areas has resulted in permanent loss of floodplain functions in most of the lower rivers. The loss of riparian vegetation, increasing discharge of municipal and industrial wastewater and urban stormwater runoff, has resulted in degraded water quality. The Washington Department of Ecology has placed a large number of waterways throughout Puget Sound on the 303(d) list of impaired waters. In addition to affecting water quality through flow alterations, hydroelectric dams block migration and have isolated bull trout populations in several core areas while water-control structures in the floodplains have effectively eliminated most of the estuaries and wetlands that historically provided rearing and foraging areas. All PCEs within the designated critical habitat have likely been degraded, although the severity of degradation varies on a site specific basis.

Status of Bull Trout Critical Habitat in the Action Area

The Puget Sound Recovery Team identified the Lake Washington system and marine areas of Puget Sound as containing important FMO habitat necessary for bull trout recovery (USFWS 2004b). Although there is currently insufficient information available to describe the importance of these FMO habitats to bull trout from a specific core area(s), they are believed to be critical to the persistence of the anadromous life history form, unique to the Coastal-Puget Sound population segment. These habitats currently outside of designated core areas support the unique and complex migratory behaviors and requirements of anadromous bull trout (USFWS 2004b).

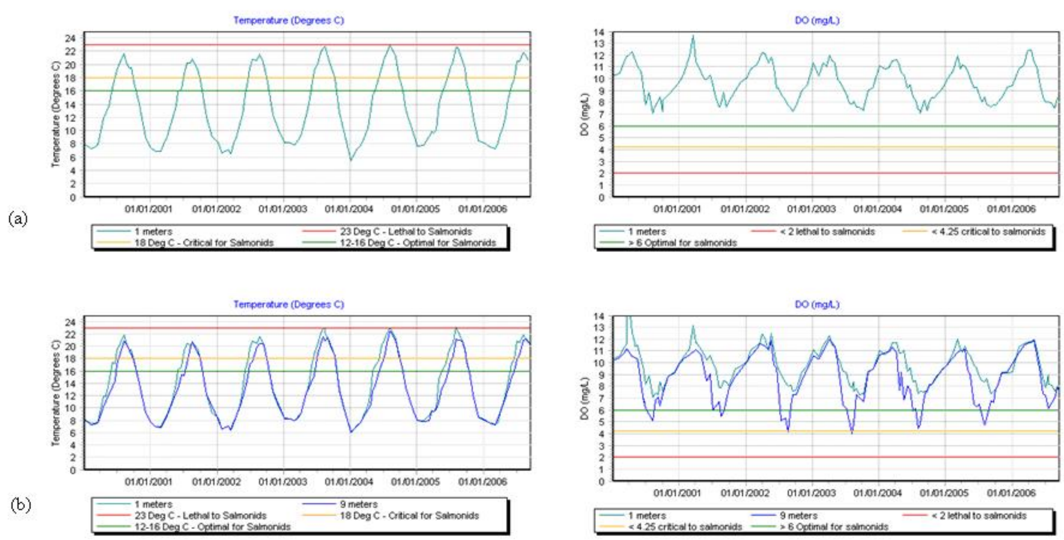
The Lake Washington FMO habitat includes the lower Cedar River, the Sammamish River, Lakes Washington, Sammamish and Union, the Lake Washington Ship Canal, and all accessible tributaries and lakes.

This section presents a brief description of baseline conditions within the action area as it pertains to each PCE. A more detailed description of the baseline is presented earlier in this document in the Environmental Baseline section. The action area contains seven of the eight PCEs that define bull trout critical habitat (50 FR 56242). The baseline conditions of each PCE in the action area are described below.

(1) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72º F (0 to 22º C) but are found more frequently in temperatures ranging from 36 to 59º F (2 to 15º C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.

Water temperature influences water column stratification, dissolved oxygen levels and delineation of habitat for aquatic life. The COE collects real-time water quality data including temperature and salinity at six stations located from Puget Sound to the University Street Bridge, including the Locks. Additionally, King County Department of Natural Resources (KCDNR 2005) also monitors water quality in the Lake Washington Ship Canal (Figure 2).

Range of Water Temperature and Dissolved Oxygen in the Vicinity of the Hiram Chittenden Locks (a)
and within the Fremont Cut (b)



From KCDNR 2005

Figure 2. Water Temperature and Dissolved Oxygen levels from 2001 through 2005 in the Lake Washington Ship Canal.

Water temperature changes dramatically above and below the Locks. Summertime differences can be as high as 16º F (8.8º C) (Figures 2). The average temperature of Puget Sound (below the Locks) is 52 to 57º F (11 to 14º C) during this period, while temperatures above the Locks are 68 to 75º F. Because of the small amount of mixing of freshwater and saltwater through the Locks the large temperature gradient is maintained throughout the summer (COE 2006).

Lake Union and the Ship Canal temperature stratification is minimal with surface temperatures within 1 to 2º F of bottom temperatures (30-40 ft). By mid-June temperatures typically exceed 68º F and by mid-July through mid-September temperatures usually range from 70 to 75º F. Concurrent with high water temperatures, dissolved oxygen levels at lower depths reach a minimum in the Ship Canal (2-5 mg/l) and Lake Union (0-4 mg/l) (COE 2006).

The area immediately above the Locks is the only location in the Lake Union system where saltwater and freshwater mixing occurs with resultant temperature stratification. This area, termed the cool water refuge, only occupies a few acres. It has a temperature gradient from 62º F at 25 to 50 ft to 70 to 75º F from 0 to 30 ft (COE 2006).

Water temperature in freshwaters of the Lake Washington basin exceeds standards during the summer months. Numerous tributaries are on the water quality 303(d) list for exceedance of the water quality standard for temperature although the lake itself is not listed for this parameter. The lake typically stratifies from June through October. Surface water temperatures range from 4 to 6º C (39 to 43º F) in winter to over 20º C (68º F) in summer.

(2) *Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and in-stream structures.*

Complex stream channels within the Lake Washington Ship Canal and the Freemont and Montlake Cuts have been severely reduced due to development and industrialization along these water bodies (Figure 3). The Fremont and Montlake Cut shoreline are completely armored or walled off along a significant proportion of their length. Additionally, the shoreline of Lake Union is almost completely urbanized eliminating complexity in this water-body as well (Figure 3).

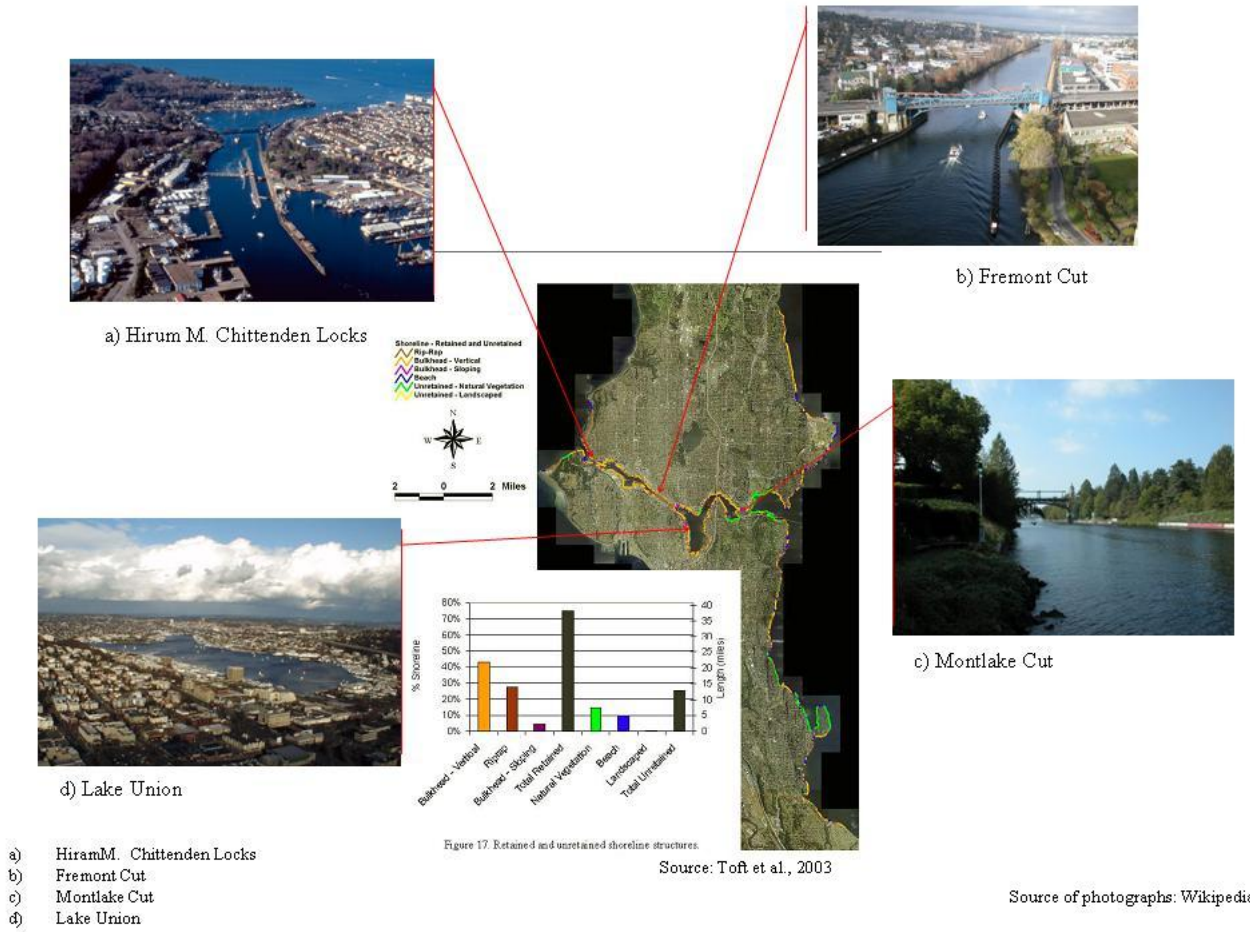


Figure 3. Shoreline Modification of the Lake Washington Ship Canal

Toft et al. (2003) conducted a shoreline survey along Lake Washington, the ship canal, and Shilshole Bay and determined that 74 percent of the shoreline was retained by riprap or bulkhead (Figure 3). Additionally, they quantified docks, over-water structures and found that there were 914 recreational and 519 marina docks and 181 over-water structures and 42 over-water platforms. Of the approximately 51 linear miles of shoreline surveyed, only 26 percent was beach, naturally vegetated or landscaped (Toft et al. 2003). The current condition in the action area leaves little shallow littoral habitat available for migrating salmonids. The majority of natural shoreline includes mostly parks and marshes. Manicured lawns provide little in the way of substrate for beach nourishment or overhanging vegetation as a source of terrestrial invertebrate prey for juvenile salmonids, which are an important component in the bull trout diet. Additionally, the loss of shallow littoral habitats through shoreline armoring results in increased predation and a reduction in available prey for juvenile salmonids.

(3) *Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter) in diameter.*

This PCE is not present in the action area.

(4) *A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.*

The LWSC is the only outlet for the Lake Washington system, and therefore the Locks are the principal control device over the water level. Since a significant portion of the inflow and outflow is controlled and regulated in this system, a substantial amount of the natural water level variability has been reduced. For Lake Washington and the Locks, the amount of flow released from the Cedar River directly affects the base flow for the LWSC.

Within Lake Washington, the natural hydrologic cycle has been temporally shifted. Historically, lake elevations peaked in winter and declined in summer. Today, lake elevation peaks in spring and begins to decline in summer during the drawdown period, reaching the lowest levels by winter when the minimum elevation of 20 ft (6.1 meters) is maintained (Figure 4).

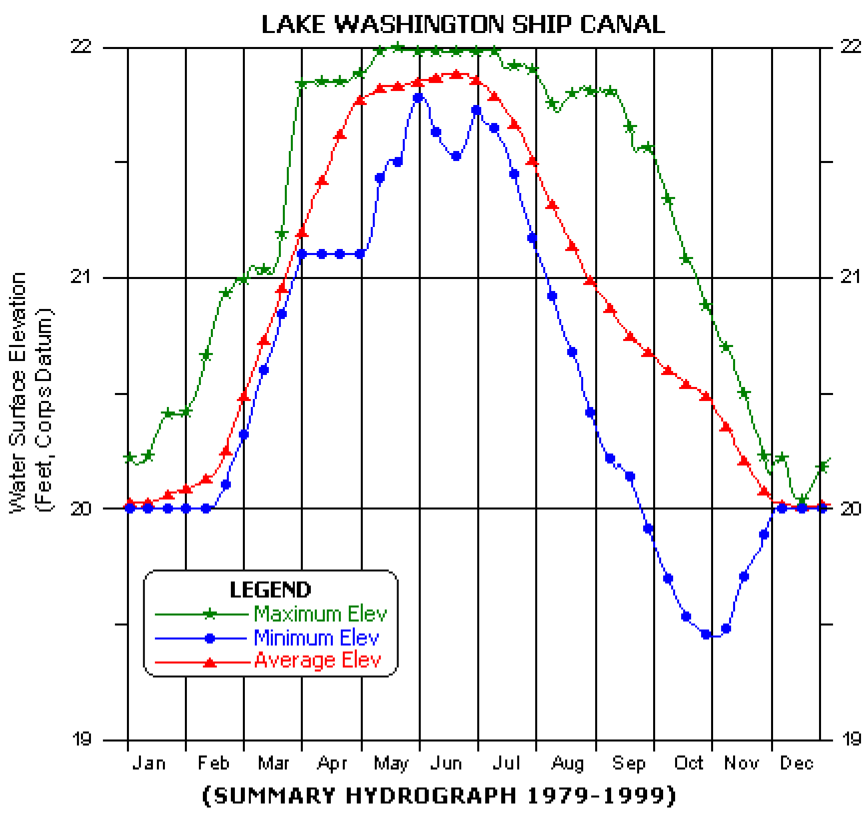


Figure 4. Lake Washington Ship Canal Hydrology (Source USACOE 2004)

Development and increased urbanization have also decreased base-flows. During peak wet weather flow the inflow and infiltration (I/I) of freshwater from groundwater and other subterranean flow into wastewater conveyance pipes can reach 3,200 gpd. This level of I/I can decrease base-flows that would otherwise flow into local water bodies. As depicted in Figure 4 its possible that significant amounts of water [4,400 to 4,970 gallons per acre per day (maximum)] are lost to I/I in Bellevue and even greater amounts (4,970 to 21,000 gallons per day) are lost in Renton and parts of northeast Seattle. This likely affects the habitat quality of many fish-bearing tributaries to Lake Washington.

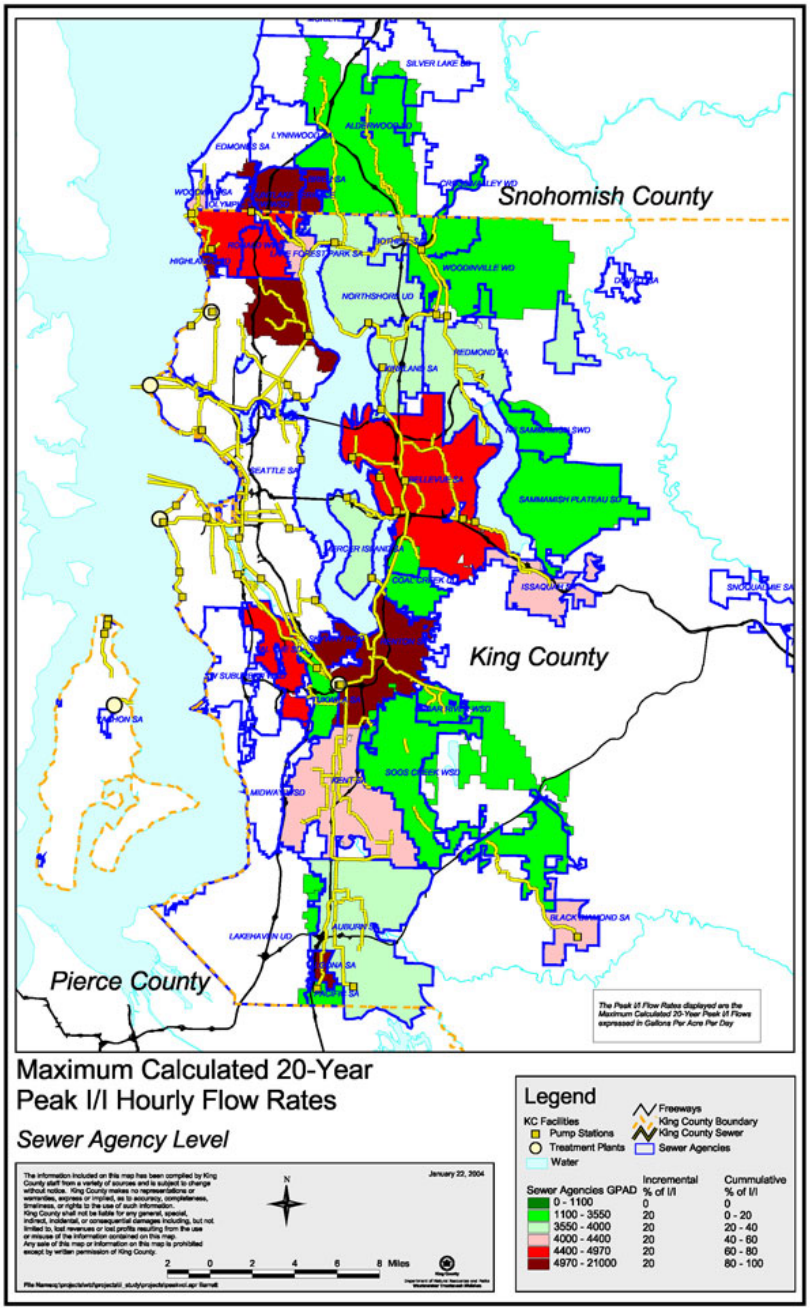


Figure 5. Maximum Predicted Inflow and Infiltration rates in King County

(5) *Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.*

Although no specific information was located regarding the presence or quality of springs, seeps, or groundwater in the action area they are likely limited to the natural shorelines. Sockeye spawning beaches are often associated with seeps. Seeps must be present along the shoreline of Lake Washington as there are at least 85 sockeye spawning beaches present (USDOT 2006). Areas that have some amount of undeveloped shoreline include Gasworks Park, the area south of SR-520 (in Lake Union and Portage Bay), and a protected cove west of Navy Pier at the south end of Lake Union. Seeps and groundwater sources will have been cut off by the man-made concrete walls of the Fremont and Montlake cuts and the general urbanization of the action area.

(6) *Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.*

Stream habitat alterations that restrict or eliminate migration corridors include impassable barriers (*e.g.*, dams and culverts), structural modification of stream habitat (*e.g.* channelization or removal of cover), alteration of natural streamflow patterns, degradation of water quality and increased amounts of fine sediments.

Construction of the Locks and LWSC was completed in 1916. Historically, large numbers of bull trout were reported to use the Duwamish River and Lower Green River (Suckley and Cooper 1860 as cited in USFWS 2004a). Bull trout were able to reach Lake Washington from the Duwamish River and Lower Green River via the Black River prior to construction of the LWSC. A local private entity rerouted the Cedar River in order to provide a Lake Washington port facility, so that the Cedar no longer maintained a connection to the Black River. This effectively cut off access to the lower Cedar River by bull trout and currently they must swim through the LWSC and Lake Washington to reach the River. Additionally, rerouting of the Cedar River to Lake Washington affected migration patterns and behavior of salmonids.

The Locks present the greatest physical obstruction to salmonid migration. Potential migratory pathways do exist for fish via the fish ladder, gates, and directly through the locks when boats are being transferred. Nevertheless migration has been physically obstructed by the Lock structure.

Artificial channels were created to construct both the Fremont and Montlake Cuts. These artificial channels have no natural shoreline and are landscaped with both native and non-native vegetation. Therefore, natural overhanging vegetation is rare and primarily consists of large trees (Figures 3b and c). Shorelines have been significantly modified by the intense commercialization and urbanization of Lakes Union and Washington such that only approximately 26 percent of the shoreline is beach, naturally vegetated or landscaped (Toft et al. 2003). Littoral habitats have been modified through changes in the lake level resulting from re-routing of the Black and Cedar Rivers in the early part of the last century. The installation of piers, docks and bulkheads have also affected the quality of littoral habitat (City of Seattle b undated). Over-water structures interrupt the growth of aquatic vegetation in littoral habitats.

Therefore there is little cover for migrating fish seeking refuge or avoiding predation in this system.

Water quality parameters that affect migration are primarily temperature and dissolved oxygen. Water temperature in the LWSC and in Lake Washington was discussed under PCE #1. Low DO concentrations occur in the seasonal saline layer at the bottom of Lake Union and the LWSC [Figure 2(b) undated] because of biochemical oxygen demands of the sediment and decomposition of the abundant invasive plant, Eurasian milfoil (*Myriophyllum spicatum*).

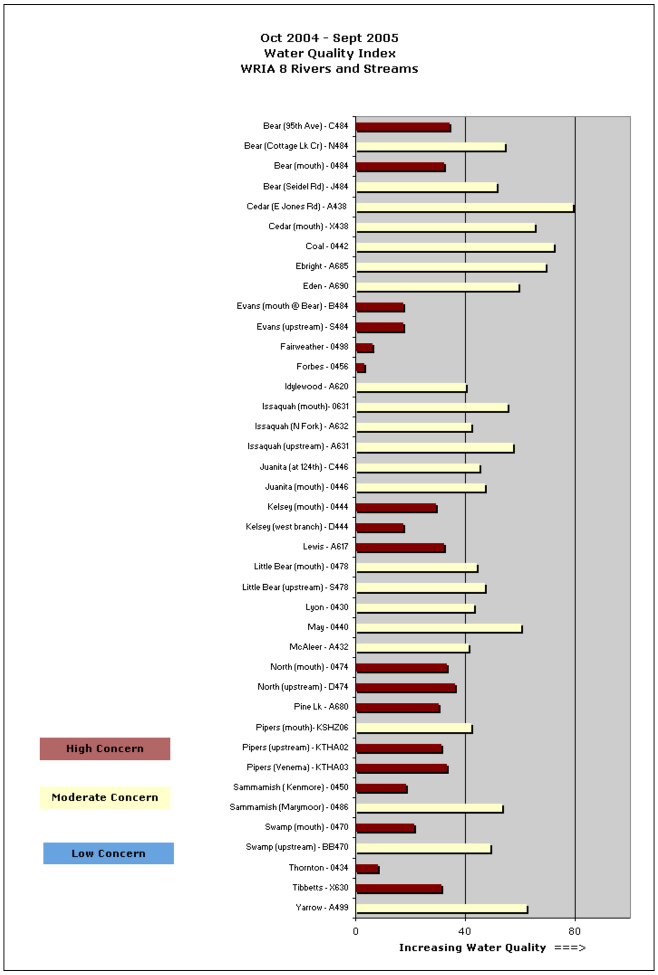
(7) *An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

A substantial number (2.5 million) of out-migrating smolts pass through the Locks on an annual basis [City of Seattle (c) undated]. According to Beauchamp et al. (2004) in 2001 52.4 million sockeye (*Oncorhynchus nerka*) fry entered Lake Washington. Coastal cutthroat trout (*Oncorhynchus clarki clarki*) and rainbow trout (*O. mykiss*) along with a number on non-native species [(e.g., yellow perch (*Perca flacescens*) and largemouth and small mouth bass (M*icropeterus salmoides* and *M. dolomeiui*)] also provide an abundant food source for this critical habitat PCE (KCDNR 2003). According to Eggers (1978) and Burgner (1991 both as cited in Beauchamp et al. 2004) “Lake Washington produces some of the largest age-1 smolts reported for sockeye salmon populations because of its prolonged growing season and relatively abundant zooplankton.

Benthic invertebrate prey is likely limited for those juvenile salmonid species that rely on this prey base due to a reduction of natural shoreline and littoral habitat. Chinook fry and smolts feed in littoral habitat along the shoreline. In addition to pelagic zooplankton they feed on benthic invertebrates. The food base for these smolts is likely reduced because of the reduction in littoral habitat necessary to support a benthic invertebrate community. A reduction in overhanging vegetation from bank armoring and shoreline modification also contributes to a reduction in the prey base for juvenile Chinook.

(8) *Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.*

Water quality is degraded in the Lake Washington basin (Figure 6). A number of water bodies including the Cedar River, Coal Creek, May Creek, McAleer Creek, North Creek, Swamp Creek and Thornton Creek which feed directly into Lake Washington, are on Ecology’s 303(d) list as category 5 waters due to exceedances of the fecal coliform and/or temperature standards. Lake Washington itself is on the 303(d) list for ammonia, fecal coliform and total polychlorinated biphenyls. Lake Union is listed for aldrin (banned insecticide), fecal coliform and lead.



Source: KCDNR 2006(a)

Figure 6. Water Quality Condition in the Lake Washington Basin.

Historical discharges and past dumping practices continue to impact the Lake Washington system. Current discharges also contribute to water quality degradation (Figure 7). In addition to point sources of pollutants, a variety of non-point sources contribute to the degradation of water quality. Lake Washington has substantially fewer point source discharges relative to Lake Union and the LWSC. Obviously, a large number of discharge permits have been issued within the action area which degrades water quality (Figure 7).

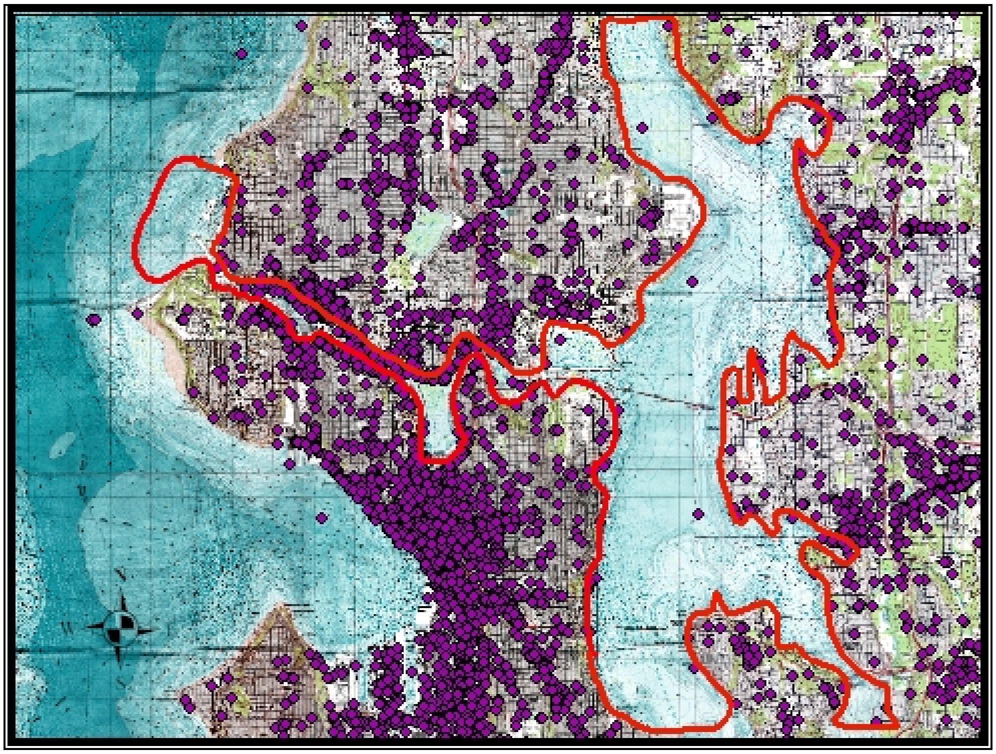


Figure 7. Facilities with Discharge Permits within and in the Vicinity of the Action Area.

Non-point sources include stormwater and subsurface runoff containing pollutants from road runoff, failing septic systems, underground storage tanks containing fluids such as gasoline and diesel oil, gravel pits/quarries, landfills and solid waste management facilities, sites with improper hazardous waste storage, and commercial and residential sites treated with fertilizers and pesticides. As increased urbanization has occurred in the area, sediment input into the Lake Washington system has increased as well.

Operation of the Locks causes saltwater intrusion, periodic reduction in DO and temperature stratification in the LWSC. Periods of low DO also occur in Lake Union, the LWSC and Lake Washington from decomposition of Eurasian milfoil and the biochemical oxygen demands of the sediment. The anoxic layer at the bottom of Lake Union typically breaks up, along with the thermocline, in the fall.

Point and non-point source pollution affect the marine water of Puget Sound. Stormwater transports a suite of contaminants including, metals (copper and zinc), organic pollutants (polycyclic aromatic hydrocarbons and phthalates) and bacteria (fecal coliform) to both freshwater and the marine waters of Puget Sound. The intertidal beaches near Shilshole Bay have regularly exceeded the water quality standard for fecal coliform (KCDNR 2001).

In summary the baseline in the action area is considered degraded which reduces the functionality of PCE numbers 1, 2, 4, 5, 6 and 8.

Effects to Critical Habitat

This Biological Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

The following section presents the direct and indirect effects of the action to each PCE of bull trout critical habitat. The Lake Washington system does not constitute nor is it within a core area, but it provides FMO habitat for subadult and adult bull trout. The effects of the continued operation and maintenance of the Locks and the LWSC allows ongoing commercial, industrial, and recreational usage in the action area. As discussed above, the baseline in the action area is degraded and has been for some time due to the re-routing of major rivers, channel development to link Lake Union and Lake Washington to Puget Sound and the resulting urbanization of these water bodies. The total effects of all past activities, including effects of the past operation of the Locks, current non-Federal activities, and Federal projects with completed section 7 consultations, form the environmental baseline. We have determined that the effects to PCEs numbers 2, 3, 4, 5, and 7 are either insignificant or discountable because either the PCE isn't present in the action area or the effects are so small as to be immeasurable.

(1) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72º F (0 to 22º C) but are found more frequently in temperatures ranging from 36 to 59º F (2 to 15º C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.

The operation of the locks maintains a temperature gradient between the freshwater above and the salt water below the Lock structure. Water temperature is elevated during the time of year when migration would be occurring. Peak migration for Chinook salmon occurs between mid-August and ranges from late July through mid-September. In natural systems subadult bull trout often follow spawning salmonids to forage on their newly deposited eggs. Although we have no observation data to document that this occurs in Lake Washington, it's possible that subadult bull trout could move through the Locks in late summer when Chinook are migrating to their spawning grounds. However, subadult bull trout movement is likely impeded because of elevated temperatures above the Locks.

In August and September surface water temperatures above the Locks range between 68° F and 72° F (20° C and 22° C). Bull trout characteristically prefer water temperatures ranging between 10 to 12° C (50 to 54° F) (Buchanan and Gregory 1997; McPhail and Murray 1979). Therefore, subadult bull trout may avoid moving through the LWSC during August and September when surface water temperatures are elevated to this extent. Under these circumstances the ability of subadult bull trout to move through the Locks may be severely impaired.

Since temperature stratification above the Locks is minimal, the narrow migratory corridor is effectively thermally severed during most of the bull trout migratory period. If the water column were thermally stratified then bull trout could theoretically maintain a swimming depth where temperatures were acceptable to continue their migration to FMO habitat in Lakes Union and Washington. Summer water temperatures in Lake Union and Lake Washington at a depth of 20 meters are within the acceptable range for bull trout (Figures 8 and 9). Therefore, if they were able to migrate through the LWSC they would find water temperatures conducive to survival. However, temperatures above the Locks are elevated to the extent that bull trout would likely avoid these waters unless cold water refugia were available close by.

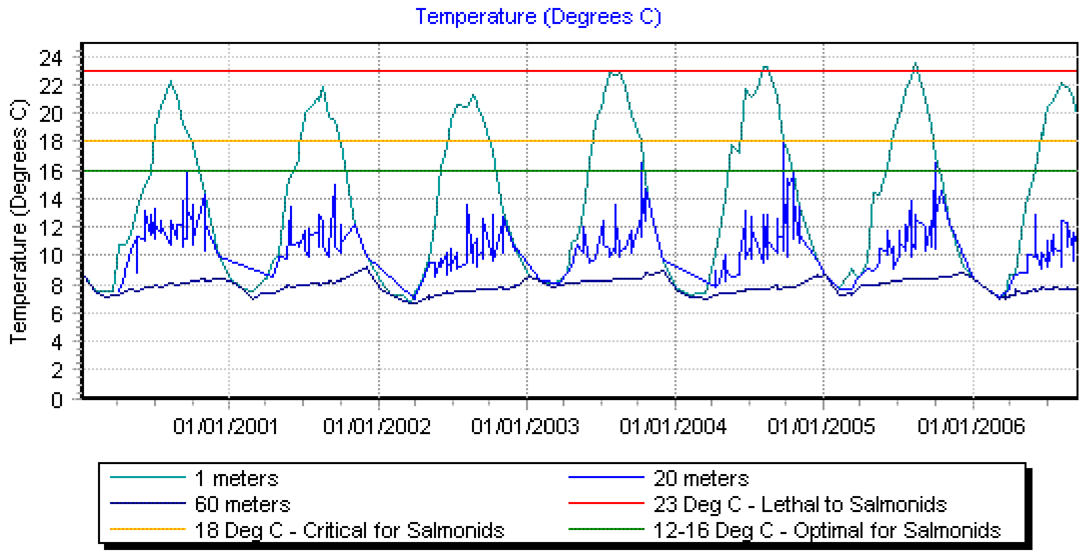


Figure 8. Water Temperature in Lake Washington (From KCDNR 2006)

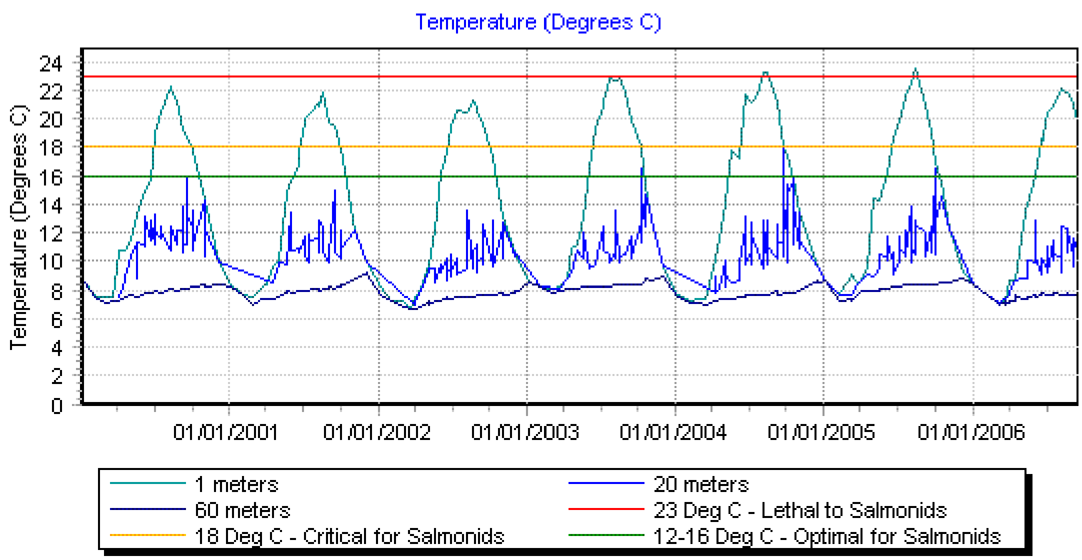


Figure 9. Water Temperature in Lake Union (From KCDNR 2006a)

When bull trout migrate through stream segments with higher water temperatures they tend to seek areas offering thermal refuge such as confluences with cold tributaries (Swanberg 1997), deep pools, or locations with surface and groundwater exchanges in alluvial hyporheic zones

(Frissell 1999). These cold water refugia are not available within the vicinity of the LWSC. The nearest cold water refugium is miles to the northeast or in south Lake Washington. They are tributaries to the Cedar River (Rock Creek) and Cottage Lake (Coldwater Creek and Cottage Lake Creek) and Coldwater Creek. All of these cold water refugia sites are miles from the LWSC and would therefore not contribute to the functionality of this PCE. Therefore, this PCE can not function when temperatures are elevated in the LWSC during August and September. Consequently, the Service concludes that the effects to PCE #1 are considered significant.

(2) *Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and in-stream structures.*

The LWSC was constructed during the early part of the last century primarily to provide access for vessels between Lake Washington and Puget Sound. As discussed in the baseline section the majority of the shoreline in the canal is primarily composed of bulkheads, riprap and docks. The amount of natural shore along lake Washington and Lake Union is minimal (approximately 26 percent). Therefore, very little functional littoral habitat exists in the action area. There are very few sources of woody debris due to urbanization along the canal, and any woody debris that enters the canal is removed for safety reasons.

Because armoring the shoreline and development of the natural shoreline is part of the baseline, the only operation and maintenance activities addressed here that currently affects stream channels is the removal of floating debris including waterlogged pilings and logs at the Lock. Given that under baseline conditions the shoreline is highly modified with very little (~26 percent) remaining in a natural state, the Service concludes that the effect to PCE #2 of removing small amounts of floating woody debris from the LWSC would have little effect in the condition of the aquatic habitat, and is thus immeasurable and considered insignificant.

(3) *Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter) in diameter.*

This PCE is not present in the action area.

(4) *A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.*

The hydrograph of the action area is manipulated by the continued operation of the Locks to manage the water level in Lake Washington. Under normal conditions the lake level would peak in winter and decline in summer, which is the case for other water bodies in western Washington. The Corps is required to maintain the infrastructure of Lakes Washington and Union by allowing no more than a 2 ft elevation change. As a result, today the water level peaks in spring and reaches its lowest level by fall and winter through artificial drawdown using the spillway at the Locks. The artificial manipulation of the water level reduces access to some of the tributaries to

Lake Washington (Juanita and Coal Creeks). However, we don't expect this curtailed access to affect the functioning of this PCE, as access to these tributaries is not important for bull trout. Therefore, the Service concludes that the effects to PCE #4 are immeasurable and considered insignificant.

(5) *Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.*

The only remaining springs, seeps, and groundwater sources are in natural shoreline are outside the influence from O&M of the Locks. Therefore, effects to these coldwater sources from O&M of the Locks are considered discountable.

(6) *Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.*

The physical presence of the Lock structure blocks the free movement of salmonids. The primary upstream migration route is through the fish ladder. Routes for out-migration include the spillway and the saltwater drain. Bull trout can also migrate via the Locks during normal operations.

Abrupt changes in temperature and salinity and DO exist upstream and downstream of the Locks affect fish movement. Water temperatures ranging between 10 to 12° C (50 to 54° F) are conducive to proper functioning of the habitat for migration (Buchanan and Gregory 1997; McPhail and Murray 1979). Water temperatures above 15° C are believed to limit bull trout distribution.

During the summer water temperatures above and below the Locks can vary significantly, with differences as high as 8.8° C (16° F). From June to September adult and subadult bull trout can encounter surface water temperatures above the Locks between 68 and 72° F (20 and 22° C) in August and September. Cold water refugia are not available within the LWSC to alleviate exposure to these elevated temperatures. Consequently, bull trout in marine waters that are migrating back to their spawning grounds either bypass or likely avoid the area upstream of the Locks during this time of year as they do not need to navigate the LWSC to reach the known spawning areas within Puget Sound.

Lake Washington is considered FMO, and is used by subadult and adult bull trout for foraging and overwintering. The Lake Washington Basin, and in particular Lake Washington, provides productive FMO habitat that contains abundant forage for migratory bull trout entering the system. The potential for spawning in the Lake Washington basin is believed to be below, as a majority of accessible habitat is low elevation, below 500 ft (152 m), and thus not expected to have the proper thermal regime to sustain successful spawning.

Adult and subadult size individuals have been observed infrequently in the lower Cedar River (below Cedar Falls), Carey Creek (a tributary to Upper Issaquah Creek), Lake Washington, and at the Locks. No spawning activity or juvenile rearing has been observed and no distinct spawning populations are known to exist in Lake Washington outside of the upper Cedar River above Lake Chester Morse (USFWS 2004). Bull trout do not actively migrate to spawning grounds through the LWSC.

Historically bull trout were able to access Lake Washington via the Black River prior to rerouting of the Cedar River. In the early 1900s the White, Green, Black, and Cedar Rivers flowed into the Duwamish River to Elliott Bay. The Black River flowed out of Lake Washington and joined the Duwamish River. Freshwater access from Lake Washington to known spawning reaches of these rivers (i.e., White River) by bull trout was cut off when the Cedar River was rerouted to Lake Washington.

When the LWSC was constructed, the water level of Lake Washington was lowered to the extent that the connection to the Black River was cut off. The Cedar River was diverted directly to Lake Washington to create a shipping port in Lake Washington, and the only remaining outlet from Lake Washington was through Lake Union and the LWSC. Therefore, access to Lake Washington by bull trout was restricted to the route through the Locks or the fish ladder via marine waters.

The Lake Washington Basin has and continues to provide important FMO habitat for bull trout. As bull trout populations recover and increase in abundance, we anticipate greater use of FMO areas such as Lake Washington by subadult and adult life stages. They currently have access to Lake Washington and the lower Cedar River via Salmon Bay and the LWSC during most times of the year when the thermal regime is acceptable. They are likely restricted from using the LWSC from June until late fall. However, because of the major changes in historic hydrologic connections both within and outside of the Lake Washington basin it is difficult to determine the significance of this current seasonal restriction to bull trout. Information on the historic use patterns of the LWSC are unavailable; however, the seasonal temperature regime within the LWSC has been changing (i.e., increasing) (Arhonditisis et al. 2004). This increase in temperature has at the very least, reduced or precluded the opportunity for bull trout to migrate through the LWSC and access forage in this area from June to late fall period. However, accessible alternative forage areas for subadult and adult bull trout are present in Salmon Bay immediately below the Locks and in adjacent nearshore areas. This restriction late in the season does not likely constitute a significant adverse effect to most bull trout spawners as they do not need to swim through the LWSC to reach spawning grounds.

The presence of the structure creates a barrier which delays migration earlier in the year when bull trout are entering Lake Washington to feed on out-migrating salmon smolts. In order to reach FMO habitat, bull trout must either swim through the Lock or up the fish ladder. Both routes present hazards to migrating bull trout. Therefore, the Service concludes that effects to PCE #6 are considered significant. The Corps is working on solutions to reduce the temperature upstream of the Locks, but as yet the operations remain consistent with past practices.

(7) *An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

It has been suggested that the continued presence of Lock structure could be restricting the movement of nutrients from above and below the Locks resulting in reduced prey available to juvenile salmonids in the vicinity of the Lock structure. Results from a 1999 UW/Battelle study (Simenstad et al. 1999) indicated poor feeding success, or behavioral disruption of feeding in juvenile Chinook salmon immediately below the Locks.

Nevertheless, even though the number of Chinook is reduced, other prey species appear to be abundant. According to Eggers (1978), Burgner (1991), and Rieman and Myers (1992; all as cited in Beauchamp et al. 2004) a substantial number of sockeye and kokanee fry and smolts are present in Lake Washington. Other fish species are abundant as well, including bass, perch and trout which provide prey for bull trout (KCDNR 2003).

Therefore, although numbers of juvenile Chinook may be reduced by limited prey availability and modification of their feeding behavior in the vicinity of the Locks, there appears to be sufficient bull trout prey available to support the proper functioning of this PCE in the action area. The Service concludes that because sockeye and kokanee, as well as other fish species are available as bull trout prey in the action area, adverse effects to PCE #7 are considered immeasurable and therefore insignificant.

(8) *Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.*

The operation of the Locks affects water quality and hydrology of the LWSC system. As discussed under PCE #6 above, abrupt changes in water temperature, salinity and DO occur at the Locks. As a result fish moving through the fish ladder or the canal experience abrupt shifts in these parameters.

Operation of the saltwater drain is regulated to ensure that saltwater concentration does not exceed one part per thousand at the University Bridge (downstream of the Montlake Cut) any time during the year, as mandated by Ecology. Operation of the saltwater barrier perpetuates the abrupt change in salinity experienced by fish traversing the Locks or the fish ladder. However, both subadult and adult bull trout are able to survive a wide range of salinities, varying from fresh to brackish to marine waters, and are able to move between these areas with little or no delay for acclimation. As discussed under PCE #1 elevated water temperatures persist during the late summer, likely impeding bull trout movement through the Locks during that period. Coincident with elevated water temperatures are low DO levels, which also impede bull trout migration. Abrupt changes in salinity do not appear to affect bull trout; therefore, the water quality parameters that likely have the greatest influence on the proper functioning of this PCE are water temperature and DO.

The Service concludes that because water quality in the vicinity of the Locks and in the LWSC particularly water temperature and DO, in addition to the abrupt changes in these parameters above and below the Locks results in significant adverse effects to PCE #8.

Summary of Direct and Indirect Effects to Bull Trout Critical Habitat

Three of the eight freshwater-based PCE's in the action area are adversely affected by the continued O&M of the Locks; these are PCE #s 1, 6 and 8. The mere presence of the Locks and the physical structure cause abrupt changes in water temperature, salinity and DO levels (PCE #s 1 and 8), at times likely creating a barrier to fish movement into the Lake Washington system adversely affecting PCE # 6. Management of the water level of Lake Washington restricts both salmonid (prey) access to some Lake Washington tributaries, and movement of juvenile salmonids and bull trout through the smolt flumes during low water years. The spillway gates are closed or minimally open from April until October, effectively cutting off this bull trout migration route when salmon smolts are out-migrating adversely affecting PCE #6. Fish passage is provided at the Locks in the form of a fish ladder, smolt flumes, spillway, and salt water drain and through the Lock structures themselves. Nevertheless, these fish passageways, along with water management activities and degraded water quality, result in a delay in fish migration which adversely affects PCE #6.

Interdependent and Interrelated Actions

Interrelated actions are considered part of the larger action and depend on the larger action for their justification and interdependent actions have no independent utility apart from the proposed action [50 CFR § 402.02]. The primary purpose of the continued operation and maintenance of the Locks and the LWSC is to provide for navigation for commercial and recreational vessels between Lake Washington and Puget Sound. There are no other actions that are part of the larger action of operating and maintaining the Locks. Therefore we have not identified any interrelated or interdependent action related to the proposed project.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local, or private activities (non-Federal) that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The action area includes the shorelines of the LWSC in Seattle and tributaries and shorelines of Lake Washington in the major cities of the Seattle, Bellevue, Renton, and Kirkland. The primary action which could result in cumulative effects considered in this Opinion is growth and any associated increase in recreational boating resulting from that growth because of the operations of the LWSC.

The major cities where growth is anticipated are along the shoreline of Lake Washington. These cities include Seattle, Bellevue, Renton, and Kirkland. The adopted growth targets for these cities anticipated between 2001 and 2022 are increases of 51,510, 10,117, 6,198 and 5,480 households, respectively. Obviously, growth is expected and planned for in these cites. However, only the portion of development that occurs within proximity to the shoreline of Lake

Washington would adversely affect the shorelines, littoral habitat and water quality[4], and the associated PCE's. The shorelines of Lake Union are highly urbanized and additional growth in this area is unlikely, with the exception of the South Lake Union Project discussed below (Figure 3).

The action area is primarily urbanized with only 26 percent classified natural vegetation (Toft et al. 2003; Figure 3). Approximately 74 percent of the shoreline is modified (riprap and bulkhead) for development purposes. Of the areas available for development, most occur on the east shore of Lake Washington. The cities of Seattle, Bellevue, Renton, and Kirkland are all zoned for residential development along the shoreline.

The emphasis in the City of Seattle Comprehensive Plan (2005) is to preserve natural areas and fish habitat and protect and enhance natural areas or systems. The amount of new development along the west shore of Lake Washington and its effects in the action area are limited by the amount of available land. As previously stated, approximately 24 percent of the action area is natural vegetation (i.e., undeveloped). Within that only a portion of the action area is contained by the Seattle city limits. According to the zoning map the entire west shore of Lake Washington is zoned residential, although some land is set aside as parks. Indeed, of that portion of the Lake Washington Shoreline within Seattle city limits, 50 percent is designated as parks [Figure 3; City of Seattle (b)]. Land use along the west shore of Lake Washington is primarily single family residential and city-owned open space. It is highly unlikely that additional development will occur on the west shore of Lake Washington as the area appears to be completely developed with homes and parks.

A City of Seattle Project is scheduled to be built at the south end of Lake Union. This is the South Lake Union Project. A large park will be built adjacent to the shoreline and this component of the project has undergone consultation with the Service and NOAA Fisheries. Additional development is planned for this area, including a 450,000 ft^2 mixed use development including residential, retail and commercial components. This new development will concentrate greater numbers of people in the vicinity of Lake Union likely resulting in an increase in the amount of impervious surface and associated storm water runoff which may affect water quality in the Lake.

The City of Bellevue has little capacity for growth. With the exception of the downtown area where re-development can occur, there are only 961 vacant and re-developable areas which comprise less than 5 percent of the city's total non-downtown acreage. As a result most new development will occur through re-development and infill in the downtown area and not within the action area.

The City of Renton has set a growth target of 6,198 new households by the year 2022. Approximately 9 percent of the total area in Renton is considered vacant with the largest blocks found in outlying areas. The majority of the Lake Washington shoreline is zoned either low density or single family residential.

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[4] in the form of new or increasing storm water or effluent discharges

The City of Renton is creating a plan to redevelop the Urban Center – North into a lakefront community incorporating residential and commercial opportunities (City of Renton 2004). This redevelopment will have to comply with the City of Renton's Comprehensive Plan including sensitive area ordinances. Nevertheless, it will likely result in an increase in the amount of impervious surface and associated storm water runoff which may affect water quality in the lake.

As with Bellevue, Kirkland has little capacity for growth as well. Only 6 percent of the land within the city of Kirkland is considered vacant, leaving little room for additional development (City of Kirkland 2004). According to zoning maps for the City, the majority of land along the Lake Washington shoreline is zoned low or medium density residential while there are numerous (four) parks and limited commercial areas. According to the City of Kirkland Comprehensive Plan (2004) future growth will generally be infill within the City. This is consistent with the stated goal of protecting and enhancing natural systems, as the only tracts of non-impervious surface are contained in parks along the Lake Washington shoreline. If these areas are to be protected as outlined in the comprehensive plan, very little, if any, additional development will occur that will affect Lake Washington.

As a result of the development planned in south Lake Union and Renton some additional recreational boating in expected. Residents in south Lake Union will likely use the LWSC and the Locks more frequently than new boaters in south Lake Washington (Renton). Recreational boating affects water quality by leaking and discharging petroleum products, toxic metals, garbage and sewage. Two stroke engines used in personal watercraft are inefficient, discharging gas and oil mixtures out the exhaust pipe (Fields 2003). Increases in pollution from pleasure boating could impact water quality in both Lake Union and Lake Washington.

Additional growth and development is planned for in the action area. However, the capacity for growth in the action area is low in all locations with redevelopment more likely in urban centers. Some new development and redevelopment is scheduled to occur in Seattle (South Lake Union Project) and Renton (Urban Center-North). This new development will attract more people to these lake-side communities putting pressure on the shoreline areas. Stormwater will be treated prior to discharge into Lake Union through the use on an on-site wetland. Stormwater will be filtered through bioswales to enhance infiltration thereby reducing impacts to Lake Union. Additionally, stormwater management will comply with the City of Seattle Stormwater Management Program which should reduce the adverse effects from stormwater discharge on Lake Union. The Urban Center-North project will comply with the King County Stormwater Management Manual to minimize the effects from stormwater discharge on Lake Washington.

According to the Renton Shoreline Master Plan Use Environment Amendments (2004) for those environments classified as urban, the plan is to "ensure optimum utilization of shorelines within urbanized areas by providing for public use, especially access to and along the water's edge and by managing development so that it enhances and maintains shorelines for a multiplicity of viable and necessary urban uses". We assume that the Urban Center-North project is classified as urban. Therefore, development in this area will provide for and encourage public use of the Lake Washington shorelines.

The component of the South Lake Union Project that was previously consulted on was the development of the waterfront park. The activities consulted on actually improved the aquatic habitat by removing bulkheads, creosote treated pilings and enhancing aquatic habitats and substrates. However, the development of other shoreline properties aside from the park may degrade water quality.

The bull trout critical habitat PCE potentially affected by development resulting in degradation of water quality is PCE #8 (permanent water quality). This conclusion takes into account the status of critical habitat and the environmental baseline in the action area.

The baseline in the action is degraded by reduced water quality from point and non-point source discharges. Increasing contaminant loading from storm water runoff and recreational boating can adversely affect water quality in the water column, littoral areas and can contaminate the aquatic food web. Therefore, based on the information we have reviewed to date regarding development that will occur in the action area, the status of critical habitat and the environmental baseline in the action area, the Service concludes that the cumulative effects will significantly affect PCE #8 in the action area.

CONCLUSION

After reviewing the current status of the bull trout critical habitat and the Coastal-Puget Sound Critical Habitat Management Unit, the environmental baseline for the action area, the direct and indirect effects of the proposed action, and the cumulative effects, it is the Service's Biological Opinion that the Operation and Maintenance of the Lake Washington Ship Canal as proposed, is not expected to reduce the functionality of the PCEs to serve the intended conservation role for bull trout based on the following:

- The proposed action would not impact spawning or rearing habitat.

- Elevated water temperatures due to the operation of the Locks do impair the function, and therefore adversely affect PCE #1 in the action area. However, due to the fact that the critical habitat in Lake Washington is considered FMO and is not part of a core area[5], and because of the few numbers[6] of bull trout in the system, the magnitude of the effect does not rise to the level of impairing the functionality of the PCE of the critical habitat.

- Migration through the LWSC due to the physical presence of the Locks, water management and the reduction in water quality from ongoing operations impairs the function of PCE #6 in the action area. However, bull trout are not migrating through the action area to reach spawning grounds but primarily to access FMO habitat (USFWS 2004b). The action area does not support a local population nor provide core area

[5] Maintain and support core areas which bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993).
[6] While exact numbers of individual bull trout using the Lake Washington FMO is unknown, the Service estimates that there are less than 100 and possibly less than 50 individuals in the system.

habitat. The Lake Washington FMO habitat continues to be accessible at other times of the year particularly during out-migration of juvenile salmonids. Therefore, the restriction to migration does not rise to the level of impairing the functionality[7] of the PCE throughout the entire interim recovery unit nor does it affect the conservation role of the critical habitat in Coastal-Puget Sound Management Unit for migration.

- Permanent water of sufficient quality and quantity (PCE #8) is adversely affected by the O&M of the Locks and the LWSC. Degraded water quality (DO and the abrupt thermocline) affects migration of bull trout through the action area. Additionally, water quality is degraded under baseline conditions in the action area. However, the few bull trout that utilize the system are not migrating through the action area to reach spawning grounds but only to utilize FMO habitat (USFWS 2004b). Therefore, the restriction to migration does not rise to the level of impairing the functionality[8] of the PCE throughout the entire interim recovery unit nor does it affect the conservation role of the critical habitat in Coastal-Puget Sound Management Unit.

The conservation measure targeting improvements in water quality (DO and temperature) is expected to reduce or minimize the level of adverse effects and the risks associated with the site-specific conditions. We do not anticipate the magnitude of these effects to significantly impair the ability of the PCEs to function, and we conclude that the operations and maintenance of the LWSC is not likely to affect the Coastal Puget Sound Critical Habitat Management Unit to the extent that the PCEs would no linger contribute to the conservation value of designated critical habitat. On this basis, the covered activities would not destroy or adversely modify designated critical habitat for bull trout in the critical habitat unit.

INCIDENTAL TAKE

Section 9(a)(1) of the Act prohibits the taking of listed species without a specific permit or exemption. Protective regulations adopted pursuant to Section 4(d) extend the prohibition to threatened species. Among other things, an action that harasses, wounds, or kills an individual of a listed species or harms a species by altering habitat in a way that significantly impairs its essential behavioral patterns is a taking (50 C.F.R. 222.102). Incidental take refers to takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 C.F.R. 402.02). Section 7(o)(2) exempts any taking that meets the terms and conditions of a written incidental take statement from the taking prohibition.

Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). *Harm* is defined by the Service as an act which actually kills or injures wildlife

[7] Provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (Rieman and McIntyre 1993; MBTSG 1998);
[8] Provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (Rieman and McIntyre 1993; MBTSG 1998);

(50 CFR 17.3). *Harass* is further defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3).

The measures described below are nondiscretionary and must be undertaken by the COE, as appropriate, for the exemption in section 7(o)(2) to apply. The COE has a continuing duty to regulate the activity covered by this incidental take statement. If the COE 1) fails to assume and implement the terms and conditions or 2) fails to adhere to the terms and conditions of the incidental take statement, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the COE must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

An incidental take statement specifies the amount of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize the effects and sets forth terms and conditions the action agency must comply with in order to implement the reasonable and prudent measures.

AMOUNT OR EXTENT OF ANTICIPATED INCIDENTAL TAKE

Bull Trout

The Service anticipates that incidental take of bull trout is likely to result from the proposed action. Juvenile, subadult, and adult bull trout are present throughout the year within the LWSC and Lake Washington FMO. Incidental take is likely to occur to migrating bull trout from core areas outside the Lake Washington FMO habitat. Few bull trout have been observed or captured within the LWSC. The Service anticipates incidental take of individual bull trout will be difficult to detect or quantify because: 1) the low likelihood of finding dead or injured juvenile, subadults or adults, 2) delayed mortality, 3) the rapid decomposition of fish, and 4) the removal of carcasses by scavengers.

The take exempted in this incidental take statement is extended only to actions under the jurisdiction of the COE and defined within the Opinion. The incidental take is exempted for a 5-year period from the date the Opinion is signed. The COE should reinitiate consultation on the O&M of the LWSC with the Service prior to the fifth year of this Opinion, so the take exemption does not lapse.

For habitat affecting actions, quantifying the amount of anticipated take in numbers of affected bull trout is difficult, if not impossible. This is because there is no direct relationship of the amount of habitat affected and the number of fish killed or injured. In such cases, the Service uses the best available information to frame the extent of anticipated take in terms of the amount of habitat modified and state these extents as thresholds which if exceeded, would trigger reinitiation provisions of the Opinion. The following level of incidental take can be anticipated by using the area affected by O&M of the Locks.

1. Incidental take of Coastal-Puget Sound bull trout in the form of **harm** will occur through the disruption of normal migrating and foraging behaviors associated with direct and indirect impacts resulting from the O&M of the LWSC and associated facilities. Specifically, harm of bull trout can occur through abrasion from contact with physical structures associated with the Locks including delayed injury or mortality resulting from this contact, contact with engine propellers in the large lock, habitat modifications with riprap, and from handling of bull trout during dewatering of the fish ladder and the large and small locks. The life history forms expected to be harmed by these activities are anadromous juvenile, subadult and adult bull trout. The take exempted by this incidental take statement is for:

   - While exact numbers of individual bull trout using the Lake Washington FMO is unknown, the Service estimates that there are less than 100 and possibly less than 50 individuals in the system. Therefore, assuming the number of bull trout to be taken is a small percentage (less than 10 percent) of all bull trout migrating through the LWSC, we expect no more than 5 bull trout total will be incidentally taken.

2. Incidental take of Coastal-Puget Sound bull trout in the form of **harassment** will occur through the disruption of normal migrating and foraging behaviors associated with direct and indirect impacts resulting from the O&M of the LWSC and associated facilities. Specifically, harassment of bull trout can occur from delayed migration and increased energy expenditure, stress, and susceptibility to disease due to the high and changing salinity and DO levels, increased summer temperatures, export of nutrients and food, the fish ladder, saltwater drain, and from handling of bull trout during dewatering of the fish ladder and the large and small locks. The life history forms expected to be harassed by these activities are anadromous juvenile, subadult and adult bull trout. The take exempted by this incidental take statement is for:

   - While exact numbers of individual bull trout using the Lake Washington FMO are unknown, the Service estimates that there are less than 100 and possibly less than 50 individuals in the system. Therefore, assuming the number of bull trout to be taken is a small percentage (less than 10 percent) of all bull trout migrating through the LWSC, we expect no more than 5 bull trout total will be incidentally taken.

REASONABLE AND PRUDENT MEASURES

Reasonable and prudent measures (RPM) are non-discretionary measures to avoid or minimize incidental take that must be carried out by cooperators for the exemption in Section 7(o)(2) to apply. The COE has the continuing duty to regulate the activities covered in this incidental take statement where discretionary Federal involvement or control over the action has been retained or is authorized by law. The protective coverage of Section 7(o)(2) may lapse if the COE fails to exercise its discretion to require adherence to terms and conditions of the incidental take statement, or to exercise that discretion as necessary to retain the oversight to ensure compliance with these terms and conditions. Similarly, if any applicant fails to act in accordance with the terms and conditions of the incidental take statement, protective coverage may lapse.

The Service believes that full application of the conservation measures included as part of the COE's proposed action, together with use of the RPMs and Terms and Conditions described below, are necessary and appropriate to minimize the likelihood of incidental take of listed species due to the proposed action.

The Service recognizes that the COE will not be able to apply all of the RPMs at the same time. Some are by their nature contradictory or several may result in similar improvements to survival. In these instances the COE shall consult with the Service to evaluate the situation(s) and implement an RPM or subset of RPMs that have the greatest probability of improving survival of listed fish. The Service has coordinated with the COE in the development of the RPMs and Terms and Conditions.

The COE shall:

1. Minimize the incidental take associated with migration of bull trout through the LWSC.

2. Minimize the incidental take associated with entrainment of bull trout in the saltwater drain system.

3. Minimize the incidental take associated with the degraded water quality in the LWSC.

4. Minimize the incidental take associated with riprap bulkhead habitat in the LWSC.

5. Minimize the incidental take associated with annual maintenance impacts to bull trout during dewatering of the fish ladder and/or the large and small locks.

6. Ensure completion of a monitoring and reporting program to confirm that the Terms and Conditions in this Incidental Take Statement are effective in avoiding and minimizing incidental take from permitted activities.

TERMS AND CONDITIONS

To be exempt from the prohibitions of Section 9 of the ESA, the COE must fully comply with conservation measures described as part of the proposed action and the following terms and conditions that implement the reasonable and prudent measures described above.

1. To implement RPM number 1, the COE shall undertake the following activities:

    - Barnacles will be removed each year (during large lock annual maintenance) from all the conduits, culvert intakes, and culvert outlets (portals) in the large lock chamber, both upper and lower to reduce injury of bull trout entrained into the large lock conduits.

- The large lock will be filled at the slowest feasible rate with the existing system of valves to reduce entrainment during the juvenile PS Chinook migration period.

- The COE shall seek funding to finish replacement of the Stony Gate Valves (design has been completed) in the large lock chamber.

2. To implement RPM number 2, the COE shall undertake the following activities:

   - Fish are to be kept out of the system leading to the diffuser wells, or a route that will allow fish to escape the diffuser wells is constructed.

   - Efforts are to be made to partner with one or more local entities (Tribal, State, County, City, and Federal) to seek a change from the Washington State Department of Ecology water quality standard to allow higher salinity in the LWSC at the University Bridge.

   - During the summer and fall months, when the availability of freshwater is limited, the lock complex shall be operated in a manner to conserve as much water as possible such that the fish passage flumes can be operated as late in the year past July 31 as possible.

   - The COE shall monitor and investigate how bull trout enter the fish ladder diffuser wells.

   - If the results of the monitoring indicate that bull trout are being entrained in the saltwater by-pass diversion and/or the diffuser wells then the COE shall design and install a method to prevent the entrainment.

   - If prevention of entrainment is not feasible, the COE shall seek funding to devise and implement a method of ensuring that bull trout that get to the diffuser wells will be able to return to the LWSC or Puget Sound.

3. To implement RPM number 3, the COE shall undertake the following activities:
   - Within six months of completing the section 7 consultation an expert panel will be constituted to address DO, salinity and temperature issues.

     i. The members of the expert panel shall be composed of physical oceanographers and salmon biologists in equal numbers.

     ii. The members of the expert panel shall not have any vested interest in the outcome of deliberations such as future funding support or influence over who may get future research funding.

iii. The expert panel shall not exceed eight members, but not have fewer that six members.

iv. The expert panel will meet at a minimum of once per month or more frequently as needed.

v. The expert panel will meet in future years to evaluate ideas that may come forward after completion of the first years' deliberations.

- The expert panel shall evaluate all of the ideas and proposals and any of their own ideas for improving water quality, and thus survival of bull trout, in the LWSC; the list of possible improvements follows:

    i. Pumping water from below the Lake Washington thermocline into the LWSC.
    ii. Mixing salt water into the overlying freshwater between the locks complex and Lake Union.
    iii. If (ii. above) is feasible allowing more salt water into the LWSC as a way of reducing water temperature, increasing DO and creating a brackish water pseudo estuary where bull trout could acclimate when migrating between freshwater and salt water.
    iv. Increasing flow in late summer and early fall by increasing the amount of freshwater flowing through the LWSC. This would involve raising the lake level to store more water or allowing the lake level to drop farther than now allowed, or both.
    v. Deepening the LWSC to allow water from below the Lake Washington thermocline to flow into the LWSC.
    vi. Replacing the existing fish ladder with an artificial stream that has pools and rocks, resulting in more natural habitat conditions.

- The expert panel shall report recommendations to the Service.
    i. A final report will be produced within 18 months of signing this Opinion.

    ii. The report shall list the results of the panel recommendations in order of their likelihood of success at improving water quality conditions in the LWSC.

4. To implement RPM number 3the COE shall ensure that:

    - The expert panel recommendation with the greatest likelihood of improving water quality conditions shall be implemented if need be via a temporary trial before permanent implementation. The recommendation may be tested prior to permanent implementation.

- The expert panel recommendation that is implemented shall be monitored and annual reports produced during any trial period and every three years for a period of nine years for a permanent implementation.

5. To implement RPM number 3, the COE shall ensure that :
    - In conjunction with Ecology, the maximum amount of cold, high DO, saltwater will be allowed into the LWSC, east of the lock complex in late summer and early fall, while simultaneously meeting the saltwater standard at the University Bridge.

6. .To implement RPM number 4, the COE shall undertake the following activities:

    - The COE shall attempt to partner with one or more local agencies (Tribal, State, County, City, and Federal) to seek a change from the Washington State Department of Ecology water quality standard to allow higher salinity at the University Bridge.

    - In seeking this change, the COE will conduct a pilot program to modify water management to increase fish passage flume operation.

        i. The COE will monitor and model potential impacts of increased salinity in the LWSC.

    - During the spring, summer and fall months, when the availability of freshwater is limited, the COE shall operate the Locks in a manner to conserve as much water as possible such that the fish passage flumes can be operated as late in the year as possible.

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    - The COE shall evaluate operating the fish passage flumes each time the large lock is to be filled to direct the current of water away from the large lock to attract juveniles away from the large lock toward the smolt flumes.

7. To implement RPM number 5, the COE shall undertake the following activity:

    - The COE shall place small rock (rat-rock) in the interstices of large riprap (large boulders) as maintenance occurs on existing riprap that make up the current bulkheads along the LWSC. This shall be done in a way that restores shallow water habitats for bull trout.

8. To implement RPM number 6, the COE shall undertake the following activity:

    - The COE shall utilize behavioral exclusion methods (e.g., seal bombs) in the large lock to evacuate as many fish as possible prior to operating the pumps to dewater the lock.

- All pumps used for dewatering will be screened to prevent impingement, entrapment and/or injury to bull trout.
- All capture, retention, and handling methods shall be implemented at times that will avoid temperature stress of bull trout being caught and handled.
- All live bull trout captured shall be released as soon as possible, and as close as possible to the point of capture.
- The period of time that captured bull trout are anesthetized shall be minimized. The number of bull trout that are anesthetized (if used) at one time shall be no more than what can be processed within several minutes.
- If bull trout are held, a healthy environment for the stressed fish must be provided and the holding time must be minimized. Water to water transfers, the use of shaded, dark containers, and supplemental oxygen should all be considered in designing fish handling operations.
- Large bull trout will be kept separately from any juvenile salmonids to prevent predation on juveniles.
- Prior to conducting activities that may involve handling bull trout, individuals shall ensure that hands are free of sunscreen, lotion, or insect repellent.

9. To implement RPM number 7, the COE shall undertake the following activity:

    - The COE shall submit and annual progress report to the Service describing the implementation and effectiveness of each RPM.

In addition, the Service is to be notified within 3 working days when a dead, injured, or sick endangered or threatened species specimen is located. Initial notification must be made to the Services' Law Enforcement Office at (425) 883-8122 (for species under Service jurisdiction) and to the Services' offices in Lacey, Washington, at (360) 753-9440. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed.

CONSERVATION RECOMMENDATIONS

Section 7 (a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of the threatened and endangered species. The following recommendations are discretionary measures that the Service believes are consistent with this obligation and therefore should be carried out by the COE:

The following conservation recommendations are desirable actions for salmonid conservation.

1. The Service recommends the COE seek funding to continue attempts to improve runoff forecasting abilities. Such improvements would assist the COE in real-time operation of the fish passage flumes.

2. The Service recommend that the COE institute an adaptive management plan (plan) that incorporates lessons learned from current and future monitoring and fish behavior studies. The plan should be developed in coordination with the Service and use current and future monitoring of bull trout behavior studies to improve habitat and passage conditions. The plan should include the following:

    i. An explanation on the sequence of how annual research, monitoring, and evaluation actions will be utilized to review changes in habitat, LWSC O&M, and bull trout behavior in and around the Locks and LWSC.

    ii. Elements and goals needed for implementation, recovery, process and participation; assumptions and uncertainties about key habitat and species factors related to the goals; hypotheses about contributions of actions to goals; performance measures to assess effectiveness of the actions, including decision points; data collection, analysis and evaluation supporting measures to assess effectiveness.

    iii. A systematic process for improving future management actions by learning from the outcomes of pilot or implemented actions.

    iv. An evaluation of all monitoring and research data to determine future actions. These actions will be based on best scientific information. When uncertainty exists, the plan should provide the support to continue the research and monitor the results to achieve the desired outcomes.

    v. Coordination with local resource agencies to set reasonable expectations and timeframes.

    vi. A decision making structure defining roles and responsibilities, including commitments to implementing the plan and actions.

    vii. Preparation of an annual Progress Reports to document the activities implemented and estimates of progress towards meeting performance measures or targets.

    viii. Preparation of a comprehensive programmatic evaluation of progress every 3 years. These programmatic evaluations reports would serve as checkpoints to provide a detailed evaluation of whether actions implemented are meeting the goals of the plan. These checkpoint reports would also serve as the annual progress report for the year in which they are presented.

ix. The Service should receive a copy of all progress and evaluation reports within 30 days of finalization.

3. The Service recommends the COE improve migration of bull trout through the LWSC by conducting the following:

- Describe and evaluate bull trout use of aquatic habitats above and below the Locks.

- Replace the existing fish ladder with an artificial stream that has pools and rocks, resulting in more natural habitat conditions or complete the design of a new entrance to the existing fish ladder.

- Seek funding to conduct biological and physical studies, as needed, and develop models to:

i. Study the effects of building an entirely new fish ladder, trap and haul, or a by-pass facility to improve survival of bull trout.

ii. If the modeling studies show inconclusive results or increased mortality, then no further action would be taken.

iii. If more than one facility is beneficial, then the one that shows the greatest increase in survival should be chosen for a pilot or feasibility study (in the case of a trap and haul effort, a pilot study to show the efficacy of such an operation would be initiated; in the case of a new fish ladder design or bypass system, a feasibility study of design and construction feasibility would be initiated).

iv. If the feasibility studies for a new fish ladder or bypass design show a new design to be infeasible, then no further action would be required.

v. If the pilot study for the trap and haul operation for adult salmonids shows inclusive or decreased survival, then no further action is required.

vi. If the pilot study for the trap and haul operation for adult salmonids shows that survival is improved, the COE should seek funding to study the feasibility (conceptual framework) of a trap and haul system to move bull trout from the eastern end of the LWSC to Puget Sound and vice versa.

vii. If the results of the feasibility study are positive, then the COE should obtain funding to institute a trial trap and haul program of sufficient duration to test the concept (the Columbia River experience might serve as a model).

viii. If the trial program shows increased survival of bull trout, the COE should institute the program on a permanent basis.

4. The Service recommends the COE minimize the abrupt change in salinities between the eastern and western sides of the Locks by conducting the following:

   i. Seek funding with one or more local agencies (Tribal, State, County, City, or Federal) to conduct an actual on-site pilot study if the analytical model (or models) show that mixing saltwater and freshwater between Lake Union and the Locks is feasible.

   ii. If the results of the pilot study demonstrate that survival of bull trout will improve, then the COE should seek funding to permanently implement the creation of a brackish water estuary between the Locks and Lake Union.

5. The Service recommends that the COE reduce the interaction of salmonids with boats in the large lock chamber by partnering with one or more local entities (Tribal, State, County, City, University, Watershed Resource Inventory Areas, or Federal agencies) to seek funding to study the interaction of bull trout with vessels in the large lock.

   i. If the results of the study indicate that vessels cause significant physical injury to bull trout, then the COE should institute management practices, or seek funding to modify the large lock, to minimize that contact.

   ii. If the results of the study show inconclusive results, then no further action would be needed.

6. The Service recommend the COE improve water management at the Locks by evaluating drought conservation plans to ensure the priority of water saving actions for minimizing mortality of fish passage by placing fish ladder and smolt passage flumes as a high priority for continued operation.

Please notify the Service if the COE carries out any of these recommendations so that we will be kept informed of actions that minimize or avoid adverse effects, and those that benefit species or their habitats.

REINITIATION OF CONSULTATION

Reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) if the amount or extent of taking specified in the incidental take statement is exceeded; (b) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that has an effect to the listed species or critical habitat that was not considered in the Biological Opinion; or (d) if a new species is listed or critical habitat designated that may be affected by the identified action (50 C.F.R. 402.16).

To reinitiate consultation, contact the Service's Western Washington Fish and Wildlife Office, located in Lacey, Washington, and refer to the U.S. Fish and Wildlife Service reference number assigned to this consultation.

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Appendix 1

Biological Opinions Completed for the Coastal-Puget Sound Bull Trout DPS and the Lower Columbia River Recovery Unit of the Columbia River DPS

YEAR INITIATED	PROJECT NAME	PROJECT TYPE	AGENCY	LOG NUMBER	SUB-POPULATION	ANALYSIS AREA (DPS)
1998-99	Plum Creek Timber Co. Land Exchange	HCP	USFWS	357	Yakima Little Naches Green Rivers	Columbia R. Coastal-PS
1998-00	Upper Tieton Watershed	Fisheries Studies	USFS	336	Snoqualmie River	Coastal-PS
1998-00	Gifford Pinchot National Forest	Programmatic Bull Trout	USFWS	371	Lewis River	Columbia R.
1998-01	Mount Saint Helens National Monument	Rush Creek Dispersed Campsite	USFS	372	Lewis River Rush Creek	Columbia R.
1998-01	Gifford Pinchot National Forest	Programmatic Bull Trout	USFS	1243	Lewis River	Columbia R.
1999	Wiggs Timber Sale	Forest Management	BIA	172	Quinault River	Coastal-PS
1999	Mount Saint Helens National Monument	Programmatic Bull Trout	USFS	289	Lewis River	Columbia R. Coastal-PS
1999	Four 5th Field Watershed	Forest Management	USFS	289	Lewis River	Columbia R.
1999	I-90 Sunset Interchange Modifications and South Sammamish Plateau Access Road	Transportation	FHWA	642	Issaquah Creek Sammamish River	Coastal-PS
1999	Fishing Facility at Colonial Creek Campground on Diablo Reservoir	Recreation Pier	NPS	732	Skagit River, Diablo Reservoir	Coastal-PS
1999	I-90	Forest Management	USFS	742	Snoqualmie River	Coastal-PS
1999	Plum Creek Timber Company	Land Exchange	USFS, Region 6	742	Lewis River	Columbia R. Coastal-PS
1999	White River Amphitheater	Commercial Development	BIA COE	829	White River Puyallup River	Coastal-PS
1999	Cedar Creek, Fish First Restoration Project	Restoration Project	USFWS	893	Lewis River	Columbia R.
1999	Twin Butte Sheep & Goat	Grazing	USFS	897	White Salmon River Morrison Creek	Columbia R.

YEAR INITIATED	PROJECT NAME	PROJECT TYPE	AGENCY	LOG NUMBER	SUB-POPULATION	ANALYSIS AREA (DPS)
	and Mt. Adams Cattle Allotment					
1999	Gifford Pinchot National Forest	Programmatic Fish & Wildlife	USFS	944	Lewis River	Columbia R. Coastal-PS
1999	Buckshot Timber Sale	Forest Management	USFS	1241	Queets River Moclips River Quinault River	Coastal-PS
1999-00	Habitat Restoration Activities	Restoration Programmatic	USFWS	5380539	Several	Coastal-PS
1999-00	Snohomish River Bridge Scour	Transportation	FHWA	374	Snohomish River Skykomish River	Coastal-PS
1999-00	Olympic Region Road Repair	Transportation Programmatic	FHWA	111	Several	Coastal-PS
1999-01	Hopper Timber Sale	Forest Management	BIA	1184	Quinault River	Coastal-PS
2000	Ongoing and Proposed Forest Service Activities	Transportation	USFS	0016 0242	Lewis River	Columbia R.
2000	Washington Conservation Reserve Enhancement Program	Restoration	USDA	64	Statewide	Columbia R. Coastal-PS
2000	North Boundary Management Plan	Forest Management	BIA	149	Queets River Lake Quinault	Coastal-PS
2000	Whitney Hill Bridge	Transportation	FHWA	229	Green River	Coastal-PS
2000	Seattle Cedar River HCP	Water Supply & Hydroelectric	USFWS	243	Cedar River	Coastal-PS
2000	Riverside Bridge Replacement	Transportation	FHWA	248	Lower Skagit River	Coastal-PS
2000	Kendall Creek Riparian and Wetland Restoration	Restoration	USFWS	466	Nooksack River	Coastal-PS
2000	Ten Mile Creek Riparian Restoration	Restoration	USFWS	467	Nooksack River	Coastal-PS
2000	Grays Harbor Dredging	Corps	COE	577	Chehalis River Grays Harbor	Coastal-PS
2000	Elwha River Restoration	Restoration	NPS	606	Elwha River	Coastal-PS
2000R	I - 90 - Sunset Interchange and S. Sammamish Access Road	Transportation	FHWA	642	Issaquah Creek Sammamish River	Coastal-PS
2000	Anthracite Creek Bridge Scour Protection	Transportation	FHWA	676	Snohomish River	Coastal-PS

YEAR INITIATED	PROJECT NAME	PROJECT TYPE	AGENCY	LOG NUMBER	SUB-POPULATION	ANALYSIS AREA (DPS)
2000	Asarco Smelter Superfund Site Shoreline Armoring	Bank Armoring	EPA	735	Lower Puyallup	Coastal-PS
2000	Rock Creek Culvert Replacement	Transportation	COE	1069	Green River	Coastal-PS
2000	Olympic National Park Upper Hoh River Road Protection Reinitiation	Transportation	NPS	1155	Hoh River	Coastal-PS
2000	SR 20 Debris Structure	Transportation	FHWA	1230	Lower Skagit River	Coastal-PS
2000	Stossel Creek - Harris Creek Culvert Replacement	Transportation	COE	1292	Snohomish and Skykomish Rivers	Coastal-PS
2000	Howard Hanson Additional Water Storage	Corps	COE	1381	Green River	Coastal-PS
20002001R	West Grayback Logging Unit	Yakima 1999 Forest Management	BIA	14580398	Summit Creek Klickitat River	Columbia R.
2000	Crane Creek Timber Sale	Forest Management	BIA	1459	Raft River Lake Quinault	Coastal-PS
2000	Cowlitz Subbasin Bull Trout for Cowlitz Valley Ranger District and Kirk Timber Sale	Transportation Timber Sale	USFS	14871860	Cowlitz River	Columbia R.
2000	Greenwater River Channel Relocation	Restoration	USDA	1542	Lower Puyallup River	Coastal-PS
2000	Baxter Timber Sale	Forest Management	BIA	1547	Quinault River Grays Harbor	Coastal-PS
2000	Riverside Bridge Reinitiation	Transportation	FHWA	1606	Skagit River	Coastal-PS
2000	Puyallup Nation Electron Dam Fish Ladder	Restoration	COE	1705	Puyallup River	Coastal-PS
2000	Bronze Billy Timber Sale	Forest Management	USFS	1764	Cowlitz River	Columbia R.
2000	Morrison Creek and Wicky Creek Bridge Replacement	Transportation	USFS	1854	White Salmon River	Columbia R.
2000	Morrison Creek Horse Camp	Recreation	USFS	1856	White Salmon River	Columbia R.

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2000	Mt. Adams Horse Camp	Recreation	USFS	1856	Several	Columbia R.
2000	Cowlitz River Bull Trout Programmatic	Transportation	USFS	18581487	Cowlitz River	Columbia R.
2000	Baker Lake Road Fish Passage Improvement	Transportation	FHWA	2056	Skagit River	Coastal-PS
2000	Simpson Timber HCP	Forest Management	USFWS	2098	Skokomish River(several)	Coastal-PS
2000	S. Fork Nooksack Engineered Log Jam	Transportation	BIA	4861109	Nooksack River	Coastal-PS
2000	Ongoing and Proposed Forest Service Activities	Transportation	USFS		White Salmon River	Columbia R.
2000-01	Lummi Island-Gooseberry Pt. Ferry Terminal	Emergency Ferry Maintenance	FHWA	19170170	Lower Nooksack River	Coastal-PS
2000-02	Olympic National Park Hoh Road Shoreline Protection	Transportation	NPS	1155	Hoh River	Coastal-PS
2001	Maersk Sealand Pier Extension	Transportation	COE	0065	Puyallup River	Coastal-PS
2001	Merwin, Yale, Swift No. 1 & 2 Hydroelectric Dams	Hydroelectric	FERC	70	Lewis River	Columbia R.
2001	City of Tacoma HCP	Restoration	USFWS	101	Green River	Coastal-PS
2001	Everett Bridges Seismic Retrofit	Transportation	FHWA	161	Snohomish and Skykomish Rivers	Coastal-PS
2001	Tornow Bridge Repair Scour	Transportation	FHWA	167	Chehalis River Grays Harbor	Coastal-PS
2001	Lummi Island Ferry Dock Reinitiation	Transportation	FHWA	170	Lower Nooksack River	Coastal-PS
2001	Tacoma Public Utilities, Permit for Work in the White River	Pipeline	COE	252	White River	Coastal-PS
2001	North Fork Nooksack River Bridge Culvert Replacement	Transportation	FHWA	308	Lower Nooksack River	Coastal-PS

YEAR INITIATED	PROJECT NAME	PROJECT TYPE	AGENCY	LOG NUMBER	SUB-POPULATION	ANALYSIS AREA (DPS)
2001	SR-9 Stillaguamish River to Lake Creek	Transportation	FHWA	352	Stillaguamish River Lower Skagit	Coastal-PS
2001	West Grayback Logging Unit	Yakima 1999 Timber Sale Reinitiation	BIA	398	Summit Creek Klickitat River	Columbia R.
2001	SR-2 Snohomish River Bridge Demolition	Transportation	FHWA	416	Snohomish Skykomish Rivers	Coastal-PS
2001	Trout Creek Road Repair	Transportation	USFS	440	Chehalis River Grays Harbor	Coastal-PS
2001	Lancaster Timber Sale	Forest Management	BIA	574	Lower Quinault Queets Rivers	Coastal-PS
2001	Canyon Creek Bridge	Transportation	BIA	575	Lower Quinault River	Coastal-PS
2001	Wastewater and Water Treatment Plant	Miscellaneous	BIA	697	Moclips River	Coastal-PS
2001	Asarco Smelter Superfund Site Shoreline Armoring	Reinitiation	EPA	787	Puyallup River	Coastal-PS
2001	Saxon Bank Stabilization	Bank Armoring	COE	842	Nooksack River	Coastal-PS
2001	La Conner Marina Dredging	Maintenance	COE	942	Skagit River Estuary	Coastal-PS
2001	Habitat Restoration	Restoration	USFWS	1074	Multiple	Multiple
2001	Upper Rush Creek Stream Restoration	Restoration	USFS	1246	Lewis River	Columbia R.
2001	Upper Dungeness Road Repair	Transportation	USFS	1458	Dungeness Gray Wolf Rivers	Coastal-PS
2001	Upper Rush Creek Stream Restoration	Restoration	USDA	1675	Lewis River	Columbia R.
2001	Jesse James II; South 9400; Q744 Parcels	Forest Management	BIA	167723772 378	Quinault River	Coastal-PS
2001	Fish Passage Barrier Removal Programmatic	Restoration	COE	1752	Statewide	Coastal-PS
2001	Forest Road 2180 Decom.	Restoration	USFS	1914	Chehalis River Grays River	Coastal-PS
2001	Tacoma Yacht Club Dock “A”	Reconstruction	COE	2068	Puyallup River	Coastal-PS
2001	Canyon River Emergency Relief for Federal Roads	Transportation	USFS	2222	Chehalis River Grays Harbor	Coastal-PS

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2001	Easy Timber Sale	Forest Management	BIA	2251	Quinault River	Coastal-PS
2001	Skeeters Timber Sale	Forest Management	BIA	2395	Quinault River	Coastal-PS
2002	SR 101 Nolan Creek Replacement	Transportation	FHWA	678	Hoh River	Coastal-PS
2002	Riverside Bridge Reinitiation	Transportation	FHWA	762	Skagit River	Coastal-PS
2002	Condit Hydroelectric	Hydroelectric	FERC	839	White Salmon River	Columbia R.
2002	Rock Creek Culvert Replacement Reinitiation	Transportation	COE	884	Green River	Coastal-PS
2002	SR 522 Paradise Lake Road to Cathcart Road	Transportation	FHWA	1161	Snohomish River	Coastal-PS
2002	Hylebos Waterway, Segment 5 Remediation	Superfund	COE	1203	Puyallup River	Coastal-PS
2002	SR 104, Hood Canal Bridge Retrofit	Transportation	FHWA	1484	Skokomish, Elwha, Dungeness, Puyallup, Snohomish, Stillaguamish,, and Lower Skagit Rivers	Coastal-PS
2002	Falls Creek Channel	Restoration	USFS	1584	Lake Quinault	Coastal-PS
2002	Quinault Indian Reservation 10-year Forest Management Plan	Forest Management	BIA	1602	Quinault River, Queets, River	Coastal-PS
2002	Haller/Nugents Bridge Demolition	Transportation	FHWA	1615	Nooksack River, Stillaguamish River	Coastal-PS
2002	Grandy Creek Bridge	Transportation	NPS	1765	Lower Quinault River	Coastal-PS
2002	Hylebos Waterway Area 5106, Commencement Bay Superfund Site	Restoration	EPA	1851	Puyallup River	Coastal-PS
2002	Kendall & Bonners Creek Riparian Planting and LWD Placement (KC 5-6; BC4)	Restoration	USFWS	18661867	Nooksack River	Coastal-PS

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2002	Hoh River Revetment	Shoreline Armoring	USFS	1980	Hoh River	Coastal-PS
2002	SF5, S.F. Nooksack River Salmon Carcass Distribution	Restoration	USFWS	2118	Nooksack River	Coastal-PS
2003	SR 167 Sumner Interchange	Transportation	COE	476	Lower Puyallup River	Coastal-PS
2003	Upper Hoh Road Eng. Log Jams	Transportation	FHWA	1128	Hoh River	Coastal-PS
2003	Graves Creek Road Repair	Transportation	NP	1336	Quinault River	Coastal-PS