



SEATTLE'S WATERSHEDS OUTSIDE THE MUNICIPAL BOUNDARIES

Cedar

Overview

The Greater Lake Washington Basin is approximately 700 square miles in area and is located wholly within King County. The Cedar River Subbasin drains about 191 square miles and represents about 53% of the flow into Lake Washington, ultimately reaching Puget Sound through the Ship Canal and Chittenden Locks at Shilshole Bay. The upper two thirds of the subbasin (above the Landsburg Diversion Dam at RM 21.6) is protected within Seattle's Cedar River Municipal Watershed. The lower Cedar River includes the area below the Landsburg Diversion Dam and drains a 66 square-mile area. The mainstem Cedar River below Landsburg provides the majority of the current spawning habitat for chinook, sockeye, and steelhead in the Greater Lake Washington Basin.

The hydrology of the basin has been massively altered by the rerouting of the Cedar River from the Duwamish system into Lake Washington, the construction by the City of Seattle of the Landsburg Diversion Dam and Masonry Dam (RM 37) for water supply and hydro-generation, and the confinement of much of the lower Cedar River channel by levies, dikes, and revetments. Levees and revetments and flow alterations have affected some sources of gravel.

The Upper Cedar River above Landsburg Diversion Dam has an excellent intact riparian corridor with many large coniferous and deciduous trees. Currently all large woody debris (LWD) that floats downstream and accumulates on the upstream face of the Landsburg Dam is permanently removed from the river by the City of Seattle because of legal liability issues (City of Seattle, 2000a).

Upstream passage of fish at the Landsburg Diversion Dam is currently prohibited, but will be provided to chinook, coho, steelhead and sea-run coastal cutthroat trout by 2003 under

provisions of Seattle's Cedar River Habitat Conservation Plan (HCP). Levees and revetments exist along at least one bank or the other for 64 percent of the river's length. A direct loss of about 56 percent of fish habitat due to the synergistic effects of levees, revetments and altered flows has been calculated (King County 1993). It is unknown what proportion of lost habitat consisted of off-channel areas. This confined and degraded channel causes loss of rearing habitat for juvenile salmonids (particularly for juvenile chinook salmon) (Greater Lake Washington Technical Committee 2001).

Seattle's primary interest in the Cedar subbasin is based on ownership of the 141 sq. mile Cedar Watershed at the headwaters of the river and the diversion of 22% of the average annual flow of the Cedar under a flow agreement which is part of the Cedar River Habitat Conservation Plan.

Biological Resources

Chinook salmon, coho salmon, sockeye salmon, winter steelhead, bull trout, kokanee, and coastal cutthroat trout all utilize the Cedar River watershed.

Wild chinook escapement averages about 700 fish in the Cedar River (Greater Lake Washington Technical Committee 2001). The fall 2000 escapement of chinook salmon appears to be at a near-record low of about 140 fish. (Karl Burton, personal communication, City of Seattle).

A population of more than 3000 bull trout lives in Chester Morse Reservoir in Seattle's Cedar River Municipal Watershed (City of Seattle 2000a). No other viable bull trout population is known in the Cedar/ Lake Washington Basin, although the U.S. Fish and Wildlife Service has classified the Ship Canal, Lake Washington, and the Lower Cedar River as bull trout migration and over-wintering habitat.



On average (the exact number fluctuates dramatically), about 125,000 sockeye salmon return to the Cedar River and form the basis for a major recreational fishery in Lake Washington in high escapement years (Greater Lake Washington Technical Committee 2001).

Winter Steelhead escapements in recent years have averaged around 300 fish (Greater Lake Washington Technical Committee 2001).

Of particular note under the Endangered Species Act is that the river's chinook and steelhead populations are believed to be native stocks (Marshall et al. 1995 and WDF et al. 1993).

Studies in the Cedar River have identified a number of predators, including birds such as mergansers and herons, and fish, such as sculpins, cutthroat trout, and coho salmon. Exotic species contribute to predation at the mouth of the Cedar River. Predation on chinook appears to be influenced by a variety of factors, including predator abundance, size of chinook, river velocity, habitat types, water temperature, and light levels (Tabor et al. 1993, 1998).

Human Impacts

Chinook production in the Cedar River has been reduced by a combination of dams and water storage, logging, railroad construction, land development activities, and flood control measures. These actions have confined river flows, enhanced streambed scouring, and eliminated former spawning and rearing habitat (King County, 1993).

Historically, chinook salmon could access the Cedar River up to Cedar Falls, a natural barrier to migration. The Landsburg Dam, constructed in 1901, presently blocks the passage of anadromous fish to 17.5 miles (total mainstem and tributary length) of formerly occupied habitat (City of Seattle 2000a). Passage facilities will be provided by 2003 as part of Seattle's Cedar River HCP.

According to geographic information analysis performed by King County in 1999, 89.4 percent of the Lower Cedar River basin is within the local jurisdictional boundary of King County, 7.8 percent is within the local jurisdictional boundary of the city of Renton, 2.1 percent is within local jurisdictional boundary of the city of Maple Valley, and 0.8 percent is within the local

jurisdictional boundary of city of Kent as municipal watershed. Forested land cover totals 60.6 percent of the Lower Cedar River, 21.3 percent is determined to be low density development; 7.7 percent is designated as medium density development and 0.9 percent is high density development. Human population in the Lower Cedar River watershed is currently estimated to be 61,704 with an expectation to grow to 70,172 by the year 2020 (Greater Lake Washington Technical Committee 2001).

The city of Seattle removes approximately 22 percent of the Cedar River's flow (mean of 1949-1998) at the Landsburg Diversion Dam for Municipal and Industrial water supply (City of Seattle 2000a and 2000b).

Over the past 150 years, much of the 21.7 miles of mainstem aquatic habitat in the mainstem lower Cedar River below the Landsburg Diversion Dam has been dramatically altered by human activities. Agriculture, coal mining, railroad construction, and light rural development in the late 1800s initiated changes in the condition of in-stream and riparian habitat. Land clearing associated with early agricultural and rural residential development in the floodplain was considered a main contributor to extensive erosion in the 1887 flood (Paul 1937). The city of Seattle built the Landsburg Diversion Dam in 1901 to divert water for municipal use (City of Seattle, 2000a). In 1914 the City also built Masonry Dam further upstream at RM 37 for water supply, flood control storage, and hydroelectric generation (City of Seattle, 2000a). Prior to this time, railroad construction operations had also built levees and eliminated access to some river meanders to protect the track and lessen the need for bridges. By 1936, the mainstem average channel width was reduced by approximately 30 percent from the estimated 1865 average of 250 feet to 170 feet. It is believed that this reduction is largely due to water withdrawal and flow regulation, since constructed levees and revetments bordered only about 16 percent of the river length at the time (King County, 1993).

In the 1930s, and culminating in flood control efforts by the US Army Corps of Engineers and King County in the 1960s, an extensive network of levees and revetments along the river was constructed to control flooding and prevent bank erosion. This has resulted in 64 percent of



the lower Cedar River having a revetment or levee along at least one bank. These flood control structures constricted the average channel width an additional 35 percent by 1989, when compared to the 1936 condition, to its present average of 110 feet. In all, surface area of the channel decreased by approximately 56 percent (320 acres) between 1865 and 1989. Following these flood control efforts, pockets of urbanization and industrialization of the lower reaches and surrounding plateaus have been developed, although much of the valley floor upstream of Renton is still relatively rural in nature (King County 1993).

Many fisheries scientists think that the amount of rearing habitat for juvenile chinook salmon in the Cedar River below Landsburg is inadequate because so many of the riverbanks have been rip-rapped, levied, or diked. Much of their thinking is based on comparing the results of screw trapping of juvenile chinook salmon at the mouths of the Cedar River and Bear Creek (a tributary of the Sammamish River in north Lake Washington). Trapping at the mouth of the Cedar River over the last two years has demonstrated that between 75 and 85% of the outmigrants leave the Cedar River and enter Lake Washington as fry at about 40 mm in size between January and mid-April (Seiler 2001). These chinook fry tightly hug the south Lake Washington shoreline as they rear and slowly migrate north toward the Lake Washington Ship Canal (Roger Tabor personal communication). The fry are thought to seek the shallow water as a refuge from larger predatory fish such as smallmouth bass, cutthroat trout, and northern pike minnows.

The remaining 15 to 25% of the Cedar River juvenile chinook remain in the river and grow to about 75 to 100 mm before entering Lake Washington as smolts between April and June (Seiler 2001). They appear to move through the Lake to the Ship Canal in 20 to 40 days (DeVries 2000).

This pattern of juvenile chinook outmigration from the Cedar River contrasts sharply with the outmigration pattern observed in Bear Creek. Very few of Bear Creek's banks have been rip-rapped, levied, or diked and subsequently the rearing habitat for juvenile chinook salmon generally appears to be in better condition than in the Cedar River. In Bear Creek, most juvenile

chinook tend to remain and rear in the stream and outmigrate at a larger size as smolts. Trapping at the mouth of Bear Creek in north Lake Washington in 1999 showed a nearly opposite ratio of smaller fry to larger smolts than was observed in the Cedar River. Approximately 14% of the Bear Creek outmigrants were fry and 86% were smolts (Seiler 2001). In 2000, 33% of the Bear Creek juveniles emigrated as fry and 67% as smolts.

Regional Watershed Planning

Seattle is an active participant in the Greater Lake Washington Basin watershed planning group organized under State Bill "2496", the Salmon Recovery Act. The Steering Committee formed in December 1998 and the Technical Committee formed in August 1999. Members of the planning group include representatives of Seattle, King County, Snohomish County, Bellevue, small cities, natural resource agencies, Muckleshoot Tribe (only on Technical Flow Committee) environmental groups, and business interests.

The Greater Lake Washington Basin Steering Committee adopted the following as their goal:

To develop a watershed conservation plan that will recommend actions to conserve and recover chinook salmon and other anadromous fish. The focus of this phase shall be to preserve, protect and restore habitat with the intent to recover listed species, including sustainable, genetically diverse, harvestable populations of naturally-spawning chinook salmon.

The Steering Committee recently completed its Reconnaissance Assessment Report in first quarter of 2001. It will next produce a "Near-Term Action Agenda" based on the results of the Reconnaissance Assessment Report by the fourth quarter of 2001.

Seattle's Salmon Recovery Actions in the Cedar River Subbasin

Seattle's Cedar River Habitat Conservation Plan (HCP) was signed in 2000 and is a comprehensive plan for the upper Cedar River watershed that will protect and restore it for the next 50 years. The HCP incorporates more than 10 years of scientific research and monitoring, and commits about \$89 million to improve condi-



tions for fish and wildlife. It is a multi-species, ecosystem-based plan that addresses 83 species of fish and wildlife that are found, or may potentially be found, within the Cedar River Municipal Watershed including spotted owls, marbled murrelets, common loons, bull trout, steelhead trout, and chinook and coho salmon, as well as many species of amphibians and invertebrates (City of Seattle, 2000a).

Major elements of the 50-year HCP that specifically apply to the Cedar River (City of Seattle 2000a) are listed below.

1. Elimination of all timber harvest for commercial purposes within the watershed will virtually eliminate large scale habitat impacts, reduce the overall level of habitat disturbance, and substantially reduce disturbance specifically resulting from road use associated with log hauling;
2. Because no commercial timber harvest will be conducted in the municipal watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements (forested and non-forested), are protected in ecological reserve status;
3. Protection of all riparian forest, as well as all upland forest, with recruitment of substantial mature and late-successional forest over time in riparian and upland areas, will improve the habitat quality of forests associated with all streams, wetlands, and the reservoir complex and its tributaries;
4. Passage facilities for chinook salmon, coho salmon, steelhead trout, and the anadromous form of coastal cutthroat trout and possibly lamprey species (sockeye salmon will be excluded because of the effect that their numerous carcasses would have on drinking water quality) will be constructed at Landsburg to restore passage at the Landsburg Diversion Dam and allow these anadromous species access to 12.5 miles of high quality mainstem Cedar River habitat and approximately 5.0 miles of potential habitat in smaller tributaries (based on current distribution of resident salmonids) within the Landsburg Drainage Subbasin in the municipal watershed.
5. Water supply intake structures at Landsburg will be screened specifically to prevent impingement of outmigrating salmonids, especially juvenile fish;
6. Structures at stream crossings in the forest road system within the municipal watershed that impede fish passage (primarily culverts) will be removed, upgraded, or replaced to restore passage of both resident and anadromous fish species;
7. Instream flows are designed to protect salmonid species during all life history stages and will be maintained in the mainstem Cedar River, including the Canyon reach upstream of the Cedar Falls Powerhouse. This plan is the culmination of 14 years of studies and analyses of instream flows by a variety of investigators. The HCP states that a potential benefit for chinook of the revised flow regime will be higher minimum flows (compared with existing flows) during the spawning and incubation period. Revised minimum winter flows should reduce the probability of dewatering some chinook redds. Higher minimum flows during spring should be beneficial to migrating juvenile chinook salmon. The HCP and the instream flow agreement also address the issue of adequate flows for adult migration by increasing guaranteed flows during summer. The HCP notes that flow requirements vary with species and that the revised flow regime may be less desirable for some species during specific periods, e.g., spawning steelhead during spring. Although this new flow regime is an improvement compared with recent flow levels, it is not intended to restore river flows to pre-development levels.
8. Provision of over \$5 million dollars to protect and restore aquatic, riparian, and floodplain habitat in the lower Cedar River downstream of the Municipal Watershed. Protection and restoration projects may include habitat acquisition and will be directed toward habitat for any and/or all species naturally reproducing salmonids in the lower Cedar basin.
9. Continued closure of the municipal watershed to unsupervised public access will be maintained, thus essentially eliminating disturbance and/or mortality of fish and wildlife species resulting from recreational/sport activities (e.g., fishing mortality of salmonids);



10. The natural maturation of second-growth forests into mature and late-successional seral stages will reestablish more natural ecosystem function in aquatic and riparian system of the watershed;
11. Silvicultural treatments, such as restoration planting (about 1,400 acres), restoration thinning (about 11,000 acres), and ecological thinning (about 2,000 acres) will be designed to accelerate the development of natural functions in riparian forests (e.g., conifer underplanting) and mature, late-successional and old-growth structural characteristics in second-growth forests in some areas;
12. Instream habitat restoration projects, such as projects to retain and/or add large woody debris to streams where LWD has been identified as deficient, are expected to improve microhabitat conditions (e.g., temperature regimes and instream habitat complexity) in many reaches;
13. Road improvements and decommissioning, and improved road maintenance, will reduce sediment loading to streams and other aquatic habitats;
14. At present, approximately 520 miles of forest road (out of a total of about 620 miles in the municipal watershed), most of which is not used for heavy haul, is regularly maintained. An aggressive road decommissioning program, however, will over time, reduce the extent of regularly maintained road to a "core system" of approximately 380 miles. An average of 10 miles of forest road per year will be decommissioned during the first 20 years of the HCP.
15. Improvement (e.g., drainage to forest floor) will be made to about 4 to 10 miles of existing road per year (occasionally more in some years), reducing the potential for sediment input to streams; and, guidelines and prescriptions will be designed to reduce sediment production and delivery to aquatic systems during watershed management activities.
16. A monitoring and research program to ensure compliance with the HCP, to determine effectiveness of mitigation, to identify trends in habitats and key species populations, to test critical assumptions in the plan, and to provide for flexible, adaptive management of conservation strategies.

Assessment and research needs on the Cedar River

Key assessment and research questions are listed below. Some or all of these questions are being considered for research prioritization and funding by the Cedar River HCP Instream Flow Commission and/or the Greater Lake Washington Technical Committee.

1. In what ecologically significant ways have physical alterations to the channel and riparian corridor altered hydraulic characteristics, fish habitat characteristics and sediment dynamics from conditions that were present in the system prior to development?
2. How do the integrated effects of stream flow regulation and alteration of the stream channel and riparian corridor affect habitat conditions in the Cedar River?
3. Are the numbers of recently emerged chinook fry that arrive at the fry trap in the Cedar River at Renton correlated with stream flow?
4. Is in-river emigration survival of chinook smolts correlated with streamflow?
5. Is chinook survival to smolt and adult correlated with early life history strategy?
6. What is the preferred rearing habitat of juvenile chinook in the Cedar River and how is it affected by stream flow?
7. What is the effect of stream flow on the temporal and spatial distribution of chinook spawning activity in the Cedar River?
8. Is there a shortage of spawning gravel in the Cedar River below the Landsburg Diversion Dam?



Habitat Improvement Projects (Cedar/Lake Washington Basin, WRIA 8)

Project Name	Habitat Objective(s)
Cedar Sockeye Hatchery \$13,254,000 Ongoing	Other - see comments
Landsburg Fish Passage Improvements \$10,134,000 Ongoing	Fish passage improvements
Road Decommissioning & Improvements \$5,369,000 in next 6 years Ongoing	Water Quality
Stream & Riparian Restoration \$4,446,000 in next 6 years Ongoing	Fish passage improvements, bank revegetation, large woody debris, bank improvements, substrate improvements
Upland Forest Restoration \$4,247,000 in next 6	Improve diversity of forest stands towards old growth

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Tolt/Snohomish

Overview

The Tolt/Snohomish basin is located in northern King County and Southern Snohomish County. It drains about 1,856 square miles and is the second largest watershed draining to Puget Sound. The Tolt river is a tributary to the Snoqualmie River. The Snoqualmie and Skykomish Rivers join near the city of Monroe to form the mainstem Snohomish, which discharges to Puget Sound at Port Gardner Bay in the city of Everett.

Seattle's primary interest in this watershed is the Tolt sub-basin, where the City owns the South Fork Tolt water supply and hydroelectric projects. This combined facility contributes 30% of water supply and less than 1% of electrical power to the Seattle service area. The Tolt River drains a watershed of about 97 square miles, equal to about 5% of the entire Snohomish basin or 30% of the Snoqualmie basin downstream of Snoqualmie Falls.

The City has committed significant funds for habitat protection and restoration in the Tolt basin, through both its federal hydroelectric project license and its Early Action program in response to the ESA listing of chinook salmon. Seattle actions resulting from its license and negotiated settlement agreement are intended to mitigate for potential project impacts to salmonids occurring in the Tolt. Flows are managed to protect spawning and rearing, and minimum in-stream flows are maintained. Guaranteed minimum flows have increased as a new water filtration plant came on line in 2001. Offsite mitigation projects have made positive contributions to fish habitat downstream and in nearby watersheds. The project dam and reservoir are located upstream of a natural barrier (80 ft. high waterfall) to salmon migration.

One potentially significant issue involves gravel supply to the South Fork Tolt, a portion of which is interrupted by the dam. Assessment of this situation was conducted in 1991, and funds were set aside for mitigation. New assessment work, now being conducted or planned, will compare current conditions to the prior baseline and may define a beneficial use of these mitigation funds. Reduced gravel supply to the mainstem Tolt is not considered an issue,

because adequate supply is provided by the North Fork Tolt.

Biological Resources

The Tolt/Snohomish system includes the full range of salmonid species, with the exception of sockeye salmon. Bull trout presence has been reported in the North Fork, though their presence in the Tolt basin is unconfirmed. The Snohomish includes salmon stocks that are unusual in the Puget Sound region, including a "stream-type" chinook life history and an "even-year" pink salmon stock. The Snohomish system provides important chinook habitat, with 4 stocks identified: Snohomish River Summer; Snohomish River Fall; Bridal Veil Creek Fall; and Wallace River Summer/Fall. Under current fisheries management guidelines the composite chinook escapement goal is 5,250 fish, a goal which has been met only once in the last 18 years.

In the Snoqualmie Basin, chinook spawn in three key tributaries and in the mainstem downstream of each. In order of size, these include the Tolt and Raging Rivers and Tokul Creek. The Tolt and adjacent Snoqualmie form an important complex for Chinook spawning, with the Tolt itself accounting for at least 20% of the Snoqualmie stock. Spawning occurs throughout the 9 miles of the Tolt mainstem, and in the lower 1.6 miles of the South Fork.

Human Impacts

Human activities have impacted salmon habitat in the Snohomish Basin. Private, state, and federal forest lands occupy 74% of basin area. Two major water supply and hydroelectric dams are located on the Sultan and Tolt Rivers. (The Tolt project is above a natural barrier to fish migration.)

Population centers include the cities of Everett, Marysville, Monroe, Lake Stevens, Snohomish and many smaller towns. Not quite 6% of the basin land area is designated as Urban Growth Area, with 57% of that capacity concentrated in the estuarine and nearshore drainage areas. Overall, population in the basin is expected to increase from 206,000 in 1995 to 315,000 in



2020. Five percent of the basin is devoted to agriculture, including significant areas throughout the Snoqualmie floodplain. To support human growth and development, extensive diking and draining has taken place on the river, especially in the mainstem Snohomish and Snoqualmie sub-basins.

The city of Everett is located on the estuary and includes major port and Navy facilities. The Snohomish estuary has been affected by port and navigation channel development as well as extensive diking for agriculture. Significant areas of intertidal marsh have been restored in recent years through natural processes and mitigation projects.

Regional Watershed Planning

Seattle is an active participant in regional watershed planning in the Snohomish Basin through the Snohomish Salmon Recovery Forum organized as a State "2496" lead entity under the Salmon Recovery Act. Membership includes counties, cities, the Tulalip Tribes, and other stakeholders. The group has been working for the past two years to develop strong technical and policy planning.

The Snohomish Salmon Recovery Forum adopted the following as its goal:

Develop a multi-species salmon recovery plan to protect, restore and enhance productivity and diversity of all wild salmonid stocks in the Snohomish River watershed to a level that will sustain fisheries and other non-consumptive salmon-related cultural and ecological values.

The Forum has completed its limiting factors analysis for a breakdown of 5 sub-basins and has completed a habitat evaluation matrix at a finer scale for 63 sub-basins. The Forum is producing a Near-Term Action Agenda during 2001. The long-term recovery plan should be completed in the next 3 yrs.

In the Snoqualmie Basin, the Snoqualmie Watershed Forum was organized as a Regional Needs Assessment entity. The Forum, which includes four Snoqualmie Valley cities, King County, and citizen representative, has completed an interlocal agreement to fund its activities.

Also, at the Snohomish Basin level, there is continued discussion of initiating a watershed

planning process under the State "2514" Watershed Planning Act. The city of Everett and Tulalip Tribes have received a planning grant, although a planning unit has not yet been convened. It is currently unclear how the Watershed Planning and Salmon Recovery effort will be integrated.

Seattle's Salmon Recovery Actions in the Tolt/Snohomish Basin:

- ❑ Water supply planning. Seattle is an active member of the Puget Sound Water Suppliers Forum, which is conducting integrated water supply planning across the Central Puget Sound region. The city of Everett is the other major water supplier in the Snohomish basin and a key partner in the Water Suppliers Forum. This effort will allow future water supply plans and projects to explicitly account for the needs of fish in the Snohomish Basin.
- ❑ South Fork Tolt water filtration plant and Tolt II pipeline. This project, representing a City investment of about \$90 million, addresses turbidity issues in the South Fork Tolt reservoir and allows the City to draw the reservoir down to a lower elevation. This will boost water capacity while increasing minimum in-stream flows. The project came on line in late 2000.
- ❑ Ongoing implementation of South Fork Tolt FERC license and settlement agreement. Mitigation projects have included a river-flow return structure, replacement of blocking culverts with bridges, wetland restoration, and preservation of a large wetland known as Moss Lake. In addition to specific mitigation projects, South Fork Tolt flows are conditioned to protect fish, reducing the value of power produced. Total cost of license mitigation implementation is about \$4 million over the 40-year license.
- ❑ Lower Tolt Floodplain Reconnection project. Seattle, in cooperation with King County, is conducting a site analysis for a major habitat restoration opportunity on Tolt mainstem. This study evaluates the feasibility of moving levees away from the river channel, with a goal of increasing the quality and quantity of spawning and rearing habitat in the study area. Ultimately, the project will restore



function to a key spawning area that is now underutilized. Seattle's initial commitment is \$80,000, to date leveraging \$110,00 in additional funding from State and local sources.

- ❑ Habitat protection. Seattle is evaluating opportunities for habitat protection and restoration in the Tolt and the nearby Snoqualmie basin through partnerships with Cascade Land Conservancy, King County and the National Fish and Wildlife Foundation. Actions may include fee simple acquisition or the purchase of conservation easements or development credits. Together with its commitment to the Tolt Floodplain project, \$3 million in "early action" funds to benefit chinook have been committed.
- ❑ Juvenile salmon study. Seattle has committed up to \$75,000 to the Tulalip Tribe for its planned operation of a juvenile salmon trap on the Snoqualmie. The trap will produce an estimate of juvenile production for chinook and coho salmon by capturing and releasing a known proportion of juvenile outmigrants. Together with catch and spawning escapement data, this will add significantly to our understanding of the population dynamics of these stocks.
- ❑ Better picture of the relative contribution of the North and South Forks to hydrology and sediment supply on the Tolt mainstem and how this contribution will change over time.

Research needs

Assessment and research needs on the Tolt involve baseline data needed for future monitoring and information needed to prioritize and design our voluntary protection and restoration projects. Some of these needs are being addressed by others and some by Seattle's early actions. They include:

- ❑ Location-specific spawning information throughout the Tolt system.
- ❑ Enumeration of juvenile production for the Snoqualmie, through trapping.
- ❑ Method for distinguishing contribution of Tolt spawners to system-wide juvenile production.
- ❑ Better understanding of spawning and rearing habitat and habitat-forming processes on the Tolt mainstem, to identify priorities for protection and restoration.



Skagit

Overview

The Skagit Basin (WRIA 3&4) is located in Skagit, Snohomish, and Whatcom counties. The Skagit River drains an area of 3,140 square miles, and flows for 162 miles from its headwaters in the Cascade Mountains in the United States and Canada, through low-lying valleys, and finally through the broad Skagit delta to Skagit Bay, which is located in Puget Sound. The Skagit River is the largest river basin in the Puget Sound, and possesses the most abundant and diverse populations of salmon, steelhead trout, and bull trout in the region. It is the sixth largest drainage on the west coast of the continental United States. Major tributaries of the Skagit River include the Sauk, Baker, and Cascade rivers.

Seattle's primary interest in this watershed stems from its ownership of Seattle City Light's Skagit Hydroelectric Project, consisting of three dams (Ross, Diablo, and Gorge) on the upper Skagit River near River Mile 100, above a natural fish barrier to anadromous fish migration. This facility provides 40% of the City of Seattle's hydroelectric generating capacity, and represents 25% of the City's total power supply which is provided to almost 700,000 people.

The project was relicensed by the Federal Energy Regulatory Commission in 1995. As part of the relicensing process, Seattle City Light reached an historic agreement with all of the license intervenors including state and federal agencies, the Skagit tribes, and an environmental organization to mitigate for the projects impacts. The cost of the mitigation agreed to is \$100 million. In addition to license mitigation, this mitigation funding is being used to minimize impacts of river flows on anadromous and resident fish, protect and restore fish and wildlife habitat, and improve and protect recreational, cultural, and historical resources. Flows are managed under City Light's Fish First Policy.

Biological Resources

The Skagit River drainage supports the largest population of wild chinook salmon in the Puget Sound. Chinook in this basin have an average escapement of 13,000 spawners per year. The

escapement goal for summer/fall fish is 14,900 spawners per year.

Six stocks of chinook salmon have been identified in the basin: upper Skagit mainstem and tributary summer; lower Skagit mainstem and tributary fall; lower Sauk summer; upper Sauk spring; Suiattle spring; and upper Cascade spring.

The upper mainstem supports sixty percent of chinook salmon spawners in the Skagit River drainage. This area of the river supports one of the few stocks of chinook salmon in the Puget Sound considered to be "healthy" by the Washington Dept. of Fish and Wildlife (WDFW).

The Skagit River supports the largest runs of chum and pink salmon in the continental United States. The average annual escapement of chum salmon is 69,000 spawners, and the average annual escapement of pink salmon is 400,000 spawners. The basin also supports sizeable runs of coho salmon, sockeye salmon, and steelhead trout.

The Skagit River supports the largest population of native char (bull trout and Dolly Varden) in the Puget Sound, and probably contains the largest population of bull trout in the state. The native char stock in the lower Skagit River is considered to be "healthy" by WDFW. Estimates of the number of bull trout outmigrating from the upper drainage into the Skagit River delta and estuary ranges from 15,000 to 49,000 juveniles per year.

Human Impacts

The upper portion of the watershed is largely undisturbed, and is protected from future development by being located within the boundaries of the North Cascades National Park, Pasayten Wilderness Area, Skagit Valley Provincial Park, and Manning Provincial Park. This area is above a natural fish barrier for anadromous fish populations. Seattle City Light owns and operates three major dams on the upper Skagit River, which are located near River Mile 100.

Puget Sound Energy (PSE) operates a major hydroelectric project on the Baker River. The Baker River joins the Skagit at RM 56. The



upstream passage of salmon, steelhead, and native char into the Baker River is blocked by a diversion structure located just downstream of Baker Dam. Salmon are trapped at this structure by PSE, trucked upriver, and then released into the upper Baker River drainage.

The Skagit River basin has a population of about 100,000 people. Most of the population is located within the lower end of the basin below the Sauk River. The population centers are the towns of Mount Vernon and Sedro Wooley. Agriculture is the dominant land use in the lower watershed, while most of the middle and upper watershed are located within forested lands.

Agricultural and flood control activities (dikes and levees) have resulted in the loss over 40 percent of the historic off-channel habitat in the lower Skagit River drainage. Loss of off-channel habitat due to human disturbance is especially a concern in the delta and estuary. Off-channel habitat in the mainstem river provides critical habitat to coho salmon, while off-channel habitat in the delta and estuary has been found to be valuable for juvenile chinook salmon. Over 60 percent of the historic delta and estuary area have been lost due to land development, mainly from the conversion of tidelands, estuary habitats, and freshwater wetlands to agricultural uses. An extensive system of dikes, levees, and tide gates has hydrologically isolated much of the Skagit River delta and estuary from riverine and tidal influences. Consequently, much of the habitat areas historically formed and maintained by riverine and tidal processes has been lost.

Regional Watershed Planning

Seattle is an active participant in regional watershed planning in the Skagit Basin through the Skagit Watershed Council (SWC), a non-profit organization located in Mount Vernon, Washington. The SWC includes 36 member organizations, including tribes, county, state and federal governmental entities, conservation organizations, and business and industry groups. SWC is recognized as a State "2496" lead entity under the Salmon Recovery Act.

The mission of SWC is to provide technical assistance, public outreach and education and a collaborative approach within the Skagit Watershed to understand, protect and restore the

production and productivity of healthy ecosystems in order to support sustainable fisheries. The SWC has been instrumental in the coordination, prioritization, funding, and implementation of habitat protection and restoration projects for salmon and other fish species including native char in the Skagit River basin. The SWC has two main committees: administration, and restoration and protection. There are a number of active subcommittees, including education, protection, project review and feasibility, monitoring, and research.

Watershed planning for protecting and restoring fish resources in the Skagit basin follows the SWC's "Habitat and Restoration Strategy". This landscape-based strategy is based upon the best available science regarding natural processes, human disturbance, habitat conditions, fish population distribution and trends, and ecosystem health.

The SWC has completed a basin-wide evaluation of habitat conditions for salmon, which is described in their planning document "Application of the Skagit Watershed Council's Strategy: River Basin Analysis of the Skagit and Samish Basins". This planning tool has been used to screen and prioritize fish habitat protection and restoration projects in the basin, identifying "priority" subbasins in the Skagit River watershed for protection and restoration projects.

Seattle's Salmon Recovery Actions in the Skagit Basin

Seattle is an active participant in the Skagit Watershed Council (including administrative, restoration and protection committees). Seattle City Light serves as the administrator for the Skagit Flow/Nonflow Committee, which includes federal and state agencies and tribes. The co-managers (agencies and tribes) oversee the flow measures implemented to minimize impacts of the Skagit Hydroelectric Project to fish, and the expenditure of SCL funds for chinook salmon research, steelhead production, off-channel habitat improvement, sediment reduction, and resident fish protection.

In addition to license mitigation, the City of Seattle has allocated \$3.8 million to the Skagit River over five years under the ESA Early Action Plan. The protection, restoration, and research projects being funded with the City's Early



Action funds are selected through a partnership with the SWC. Under this first year package, \$300,000 are being used for the acquisition of habitats critical to chinook salmon in the Sauk and Suiattle river drainages, \$200,000 are funding restoration activities in the Finney Creek watershed, \$100,000 are being used for an ongoing slough restoration feasibility study, and \$70,000 are being used to fund ongoing research studies on the migration behavior and habitat requirements of juvenile chinook salmon in the Skagit delta and estuary. Potential ESA Early Action Projects for 2001 include the acquisition of critical side channel habitats for chinook salmon and native char in the lower Skagit River and the Sauk River, a biological assessment and monitoring of the recently completed Deepwater Slough Project (largest levee setback project in Washington state), the continuation of a key estuary restoration feasibility study, and continued research on habitat use of juvenile chinook salmon in nearshore areas.

Research needs

Because of the biologically and commercially important fish runs in this watershed, there are more extensive data available on annual spawner escapement, smolt production, egg-to-smolt survival, the distribution of spawning and juvenile rearing areas, and limiting factors on salmonid production than in other watersheds in the region. A smolt trap on the lower Skagit River has provided smolt outmigration abundance and timing data over the past ten years. Data on salmonid populations and habitat within the basin has been collected by the Washington Dept. of Fish and Wildlife, the Skagit System Cooperative, the National Park Service, the U.S. Forest Service, Seattle City Light, Puget Sound Energy, and others. A detailed comparison of historic versus current habitat conditions was completed by the Skagit System Cooperative. Data on current limiting factors, including most recently fish passage barriers, is being compiled by the Skagit System Cooperative, Skagit County, and the Skagit Watershed Council using a Geographic Information System (GIS) database. The Skagit Chinook Workgroup is presently completing a draft assessment of habitat conditions within the watershed.

Key research and assessment issues include:

- ❑ Role of estuary habitat for juvenile chinook survival and growth.
- ❑ Estuary habitat availability and utilization by juvenile chinook salmon and bull trout
- ❑ Importance of specific chinook populations (e.g., spring chinook) to overall chinook population stability and diversity (the Skagit River possesses six distinct chinook salmon populations).
- ❑ Role of nutrients derived from salmon carcasses for salmonid and ecosystem productivity.
- ❑ Importance of flows and habitat quantity and quality on salmonid production.
- ❑ Availability and utilization of natural (e.g., woody debris, side channels) and man-made (e.g., riprap) habitat types within mainstem river sections by chinook salmon, coho salmon, and other fish species.
- ❑ Natural and human caused habitat limitations to chinook salmon production: comparison among sub-basins.
- ❑ Impacts of land disturbance and sediment on salmonid habitat and survival.
- ❑ Life history traits, abundance, spatial distribution, and genetic diversity of native char populations (bull trout and Dolly Varden).



Habitat Improvement Projects (Skagit Basin, WRIAs 3 & 4)

Project Name	Habitat Objective(s)
Bacon Creek Habitat Restoration \$20,000 Completed	Natural stream channel was impacted by sediment and bank erosion for coho salmon, chum salmon, and bull trout.
Barnaby Slough Rip Rap Removal \$32,000 Completed	Rip rap wall compromised by heavy equipment, then obliterated by high flow event. Bank softening; Streambank Restoration Half mile long section of rip rap located along south bank of river. Adjacent to key steelhead and chinook salmon areas.
Browns and Hall Slough Complex Estuary Restoration Feasibility Study \$100,000 Ongoing	Estuary restoration feasibility study. Browns and Hall Sloughs have been diked for agricultural use, resulting in loss of historic fish habitat. Project is developing and comparing levee setback and removal alternatives for restoring critical juvenile chinook habitat.
Finney Creek Roads Improvement Project \$200,000 Ongoing	Finney Creek, historically a major tributary spawning and rearing area for salmon and steelhead, has been greatly impacted by landslides and sedimentation.
Illabot Slough Side Channel Expansion \$400,000 Completed	New side channel construction within historic river migration zone.
Johnson Parcel Land Acquisition \$350,000 Completed	Side channel habitat acquisition. Natural side channel provides excellent spawning and rearing habitat for salmon and steelhead.
Lower Suiattle River Land Acquisition (Seattle Timber Parcel) \$191,000 Completed	Habitat protection of one mile section of river provides important spawning and juvenile rearing habitat to Suiattle spring chinook salmon.
Newhalem Creek Minimum Instream Flow Improvements \$47,000 per year Ongoing	Flow Regime Improvement. Flows in Newhalem Creek were previously reduced to low of 10 cfs by hydroelectric project. Now minimum flows presently range from 45 to 90 cfs, depending upon month.
Newhalem Creek Tailrace Fish Barrier \$130,000 Completed	Fish Protection Newhalem Hydroelectric Powerhouse tailrace caused potential migration delay and injury to salmon and steelhead. Fish migration barrier was constructed to prevent adult fish from straying into powerhouse tailrace.
Skagit Flow Management \$1,500,000 per year Ongoing	Flow Regime Improvement in twenty mile section of river downstream of dams produces over 70% of chinook salmon spawning within basin. Flow regimes have been modified to prevent fry stranding and protect salmon and steelhead redds.

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Project Name
Habitat Objective(s)
Skagit River Nearshore Habitat Study

\$60,000
Ongoing

Estuary restoration feasibility study. Much of Skagit River delta has been diked or modified for agriculture and other land uses. Study is mapping habitat types and juvenile chinook habitat use in Skagit nearshore areas.

Skagit Smolt Trap Operation

\$120,000 per year
Ongoing

Smolt outmigration enumeration.

Swinomish Channel Juvenile Chinook Salmon Migration Study

\$15,000
Ongoing

Migration improvement (barrier removal and channel modification feasibility study). One-mile long rock jetty currently prevents chinook smolts from migrating through Swinomish Channel to Padilla Bay estuary. Study is evaluating outmigration of juvenile chinook salmon through Swinomish Channel.

Acquisition and Preservation of Fish and Wildlife Habitat

\$20 million
95% complete

Over 4000 acres of key fish and wildlife habitat on the Skagit have been acquired to date (and an additional 4000 acres have been acquired on the Nooksack).

Taylor Side Channel Project

\$150,000
Completed

New side channel construction within historic river migration zone. Mitigation for salmon habitat access restrictions to natural side channels caused by reduced peak flows.



Pend Oreille

Overview

The Pend Oreille watershed (WRIA 62) is located in Pend Oreille County in the north-eastern corner of Washington State. The entire watershed covers about 25,000 square miles in Idaho and Montana and about 25,000 square miles in British Columbia. Only 1,300 square miles are in Washington State, which is less than three percent of the watershed. The Pend Oreille River is a tributary of the Columbia River with the confluence in British Columbia. Annual runoff is produced primarily by melting snow, with peak flows typically occurring from April through June. Base (low) flow typically occurs in August and September.

Elevations in the WRIA range from less than 1,500 feet above mean sea level to greater than 6,000 feet above mean sea level. Major natural lakes in the WRIA include Sullivan Lake which feeds the largest stream (Sullivan Creek) in the WRIA. Sullivan Creek drains a basin of approximately 142 square miles.

There are several dams on the Pend Oreille/Clark Fork River system in Montana, Idaho, Washington and Canada. Downstream of Seattle's Boundary Project, the Pend Oreille River flows past two dams in Canada, Seven Mile owned and operated by B.C. Hydro and Waneta owned and operated by Cominco, before it enters the Columbia River. Box Canyon Dam, owned and operated by Pend Oreille PUD, is 17 miles upstream of Boundary Dam and Albeni Falls Dam (Army Corps of Engineers) is 60 miles upstream of Box Canyon Dam, near the Washington-Idaho border. Albeni Falls Dam controls the outflow from Lake Pend Oreille which then determines the flows for the City Light dam.

Much of the land within the lower Pend Oreille sub-basin lies within the Colville National Forest. State, tribal and private land holdings make up the majority of the remaining ownership within the sub-basin. Rangeland and agricultural land are located adjacent to the Pend Oreille River corridor. Farmland accounts for approximately 63,000 acres within the sub-basin. Agricultural uses include cultivated crops, grazing and cattle ranches.

Seattle's interest in the Pend Oreille Basin is based on the City-owned, 350 foot high, Boundary Dam Hydroelectric Project, which is located on the lower Pend Oreille River, 1 mile south of the Washington-Canadian border. The Boundary Project generates approximately 50% of the City of Seattle's power supply. The Federal Energy Regulatory Commission License for the Boundary Project expires in 2011. Seattle is actively engaged in research and in resource management to protect fish in the project area.

Biological Resources

Due to Columbia River dams that block fish passage, anadromous fish do not reach the Pend Oreille. There is discussion among resource agencies, however, about creating fish passage for resident fish. Meanwhile, initial surveys have been conducted to assess bull trout populations at Boundary. Bull trout have not been found in any tributaries to Boundary, but an occasional bull trout is captured in the reservoir. It is likely that bull trout originate from Lake Pend Oreille where a self sustaining population exists.

Historically, salmon and steelhead utilized the lower 20 miles of the Pend Oreille River and were reported to be abundant until declines began in the late 19th century and early 20th century.

Non-native fish are abundant in the watershed, including species such as yellow perch, large-mouth bass, pumpkinseed, brook trout, brown trout and rainbow trout. The State and the Kalispel Tribe plant bass and rainbow trout grown in hatcheries into the Pend Oreille River on an annual basis.

Human Impacts

The population of Pend Oreille County is about 12,000. The city of Newport is the largest city in the WRIA and is located on the Washington-Idaho border. Other developed areas include Cusick, Metaline, Ione and Usk.

The Pend Oreille River has been changed extensively by dams. Historically, the aquatic habitat consisted of riverine habitat. Currently most of the aquatic habitat is inundated by reservoirs.



The operation of hydroelectric projects alters the natural hydrograph of the sub-basin both seasonally and daily, depending on the section of river. Modifications to flow releases are made for flood control, power peaking, flow augmentation, fisheries enhancement, cultural site protection, recreation and aesthetics.

The Pend Oreille River is on the 1998 WDOE 303(d) list for temperature, pH and exotic aquatic plants (eurasian milfoil). Water temperatures can exceed 75°F in the summer months. Total dissolved gas in the Pend Oreille River exceeds Washington State standards at certain times of the year and can reach levels as high as 150%.

Flood control activities (dikes and levees) have resulted in the loss of a significant portion of the historic river channel.

Regional Watershed Planning

There are multiple watershed planning efforts in the Pend Oreille sub-basin. Seattle participates in some and closely monitors others.

Seattle is an active participant in Pend Oreille basin regional watershed planning including efforts organized under the State "2496" Salmon Recovery Act and "2514" Watershed Planning Act. The Pend Oreille Conservation District leads both groups and membership includes the Kalispel Tribe and other governmental entities, conservation organizations, business and industry groups. The mission statement of the 2496 process is:

Restore native salmonid populations in WRIA 62 to healthy, harvestable levels and improve the habitat on which they rely through a cooperative effort between private citizens and local, state, federal and tribal governments.

The mission statement of the 2514 process is:

Develop and implement a watershed plan addressing local concerns, watershed health and economic stability.

In addition, the Northwest Power Planning Council has a Pend Oreille sub-basin planning effort underway which includes state and federal resource agencies and Indian tribes, many of whom are also active in the 2496 and 2514 processes. This effort is part of the Columbia Basin Fish and Wildlife Program, which was

established to mitigate for the impacts of the federal hydropower system in the Columbia River. Sub-basin planning will develop an overall framework for mitigation efforts and specific implementation goals and plans. This group has completed draft plans for both the upper and lower Pend Oreille. Mitigation will be funded by the Bonneville Power Administration (BPA) through the Northwest Power Planning Council. Discussions are ongoing about how to link the sub basin planning with 2496 and 2514 processes. Seattle is monitoring this effort.

Various habitat enhancement efforts are underway in tributaries to Box Canyon Reservoir. These efforts include culvert replacement, riparian planting, livestock fencing and the placement of instream structures. These projects focus on improvements for native fish such as native cutthroat trout and bull trout. A few are funded through the 2496 process and some have been funded by the PUD. The Kalispel tribe has received a grant for some of the work and Seattle is contributing to some projects.

Baseline fisheries studies have been completed in Box Canyon Reservoir and its tributaries through the Federal Energy Regulatory Commission relicensing process for the Box Canyon Project. This process is not yet complete and additional studies may occur in 2001. Seattle is monitoring this work.

A sub-basin assessment (resident fish stock status) is underway by the Kalispel Tribe and the Washington State Department of Fish and Wildlife. This effort is funded by the Bonneville Power Administration. For those studies in Boundary Reservoir and its tributaries, additional funding was provided by Seattle City Light in 2000. The results of this assessment are not yet available.

A resident fish (bull trout and sturgeon) Biological Opinion has been developed for the federal hydropower system to address the operation of various federal hydroelectric and storage projects in the Pend Oreille-Clark Fork rivers, including Albeni Falls Dam. Reports were issued in 1995, 1998, and 2000 with a final report expected in 2003. Seattle is reviewing these reports and assessing their effects on the project.



An adhoc group, the Transboundary Gas Group, has formed to address the issue of high levels of dissolved gas in the Columbia River basin. Their focus is in coordinating the multiple efforts throughout the basin and modeling dissolved gas problems. They have issued several reports. Seattle is participating in this effort.

A recovery team has been formed by the USFWS to address bull trout recovery. They expect to have a plan out later in 2001.

In 1996, BPA funded and the Kalispel Tribe constructed a largemouth bass hatchery on Box Canyon Reservoir. Annual production is approximately 150,000 juvenile bass.

Bass habitat enhancement efforts have been conducted on Box Canyon Reservoir for the past several years. This project is intended to increase the survival of juvenile bass and includes the placement of enhancement structures in the reservoir.

Seattle's Salmon Recovery Actions in the Pend Oreille Basin:

The City is in the very early stages of relicensing the Boundary Project. A relicensing strategy is currently being developed, but the general approach for relicensing the Project is to work in a collaborative process to reach settlement agreements with agencies, tribes, and other stakeholders to mitigate for impacts of the hydroelectric project. To date, Seattle City Light has funded resident fish assessments and bull trout studies in Boundary Reservoir and its tributaries and examined dissolved gas levels above and below the Boundary Hydroelectric Project

Research needs

Key issues and research needs include:

- ❑ Evaluation of abundance and utilization of Boundary reservoir by bull trout and other resident species. Some effort has been made on these studies.
- ❑ Better understanding of upstream impoundment and flow management as it influences temperature and dissolved gas in water entering Boundary reservoir.
- ❑ Evaluation of potential engineering and operating strategies at Boundary for their potential to affect temperature and dissolved gas downstream.
- ❑ Evaluation of land management activities that may affect water in stream flowing directly into Boundary reservoir.