Habitat Factors Affecting Puget Sound Chinook Salmon and Bull Trout

"Puget Sound is like a large water bucket, full of habitat and life. Habitat losses are the holes in the bucket, and many small holes can eventually drain it. Restoration is the process of plugging the holes while protection is to prevent new holes from being formed, allowing the bucket to fill once again through natural processes."

Jacques White, The Nature Conservancy

Puget Sound settlers and tribes in the 19th Century were so accustomed to the abundance of salmon that shortages were unthinkable. Salmon had been a constant and reliable part of the tribal diet for millennia, and were an important source of sustenance for pioneer families. In 1870, the human population of the entire state numbered less than 24,000, and hundreds of thousands of Chinook salmon returned to Puget Sound rivers. Today these numbers have dramatically reversed. In addition to salmon and other marine resources, early settlers found vast stands of virgin timber, fertile river deltas suitable for agriculture, and numerous bays ideally situated for shipping and commerce. As the face of the Puget Sound landscape changed, so too did the processes that formed and sustained the habitat for salmon.

Numerous reports document the decline of salmon abundance on the west coast of the United States as a result of loss, damage or change in their natural environment. Early logging practices removed the backbone of the watersheds that had been formed by old-growth riparian forests, stripping off shade, protective cover and food supplies for the salmon. Access to important spawning and rearing areas was eliminated as a result of dams, culverts and other barriers. Other important areas for incubation and forage have vanished due to the placement of dikes, fill or structures in riparian zones and estuaries. Patches of habitat have become so fragmented that they are no longer usable by salmon as they move through their life cycle in time and space.

Scientists distinguish between the outright loss of habitat quantity and the loss of ecosystem processes that once served to form and rebuild the variety of habitat structures salmon depend on. The amount of habitat that is usable by salmon is a fraction of what was once present in Puget Sound, and the ability of salmon to recover to sustainable and harvestable levels depends directly on an increase in the quantity of available habitat of sufficient quality. Additionally, effective recovery strategies must focus on restoring the ecosystem processes that build salmon-friendly rivers and estuaries so they will sustain salmon and other ecosystem functions in the long term. Although every restoration project helps, piecemeal actions that are largely "random acts of kindness" for salmon will not achieve long term recovery in the same way as the restoration of fundamental ecosystem functions in the watersheds and estuaries.

Habitat impairments affecting Chinook salmon and bull trout in Puget Sound have been described generically and locally in numerous scientific publications as well as the watershed chapters (see box on next page), thus an exhaustive list and description is not provided in this chapter. The first section provides an overview of the changes in the Puget Sound landscape over the last 100 years and a sample of the changes and impacts in specific watersheds around the region. The following section briefly discusses the relationship of land use

activities to the habitat forming processes upon which salmon depend and describes the technical studies of habitat available for Puget Sound watersheds. The statutory framework and other conservation activities in Washington are discussed later.

Puget Sound Land Use History and Habitat Change

When Captain George Vancouver sailed into the soft grey fog of Puget Sound waters in 1792, an estimated 50,000 Indians lived in scattered villages near most of the river mouths. The Puget Sound tribes were experts at gathering food from the teeming waters of area rivers and bays, and traveled seasonally through well-defined local territories for fishing, hunting and gathering. Fur traders and missionaries soon followed Vancouver and other explorers, putting the region on a trajectory of increasing population growth and accelerated landscape change.

Timber Harvest

Coastal Indians utilized the forest to construct cedar plank longhouses, canoes, weapons, utensils, ceremonial objects and cedar bark clothing. The huge trees formed the structure for salmon and bull trout habitat in Puget Sound watersheds. Interlocking root systems stabilized streambanks and retained soil. As trees fell into the rivers, pools and logjams formed, creating cover and low velocity areas where salmon could rest. Massive logjams moderated water velocity and interrupted the transport of sediment, providing ample areas suitable for spawning. Temperatures were kept cool by the dense shade, and insect production was high, thus salmon emerging from their redds (nests) found plenty to eat. Salmon thrived on the slowly but constantly changing environment, where pools and spawning areas could shift and re-form as wood, water and soil moved downstream. The large trees and rootwads washing down from the upper watersheds continued to provide structure and cover along the saltwater shore zones of Puget

Key documents which describe the factors that have led to the decline of Chinook, bull trout and other species of salmon include:

General information on habitat impacts to salmon:

- "Upstream: Salmon and Society in the Pacific Northwest" (National Research Council, 1996)
- "An Ecosystem Approach to Salmon Conservation" by Management Technology. (Spence, et al., 1996)
- "Factors for Decline: A Supplement to the Notice of Determination for West Coast Steelhead" (NMFS, 1996)
- "Factors Contributing to the Decline of West Coast Chinook Salmon: An Addendum to the 1996 West Coast Steelhead Factors for Decline Report" (NMFS, 1998)

Information on habitat conditions specific to Puget Sound and local watershed areas:

- "Salmon and Steelhead Habitat Limiting Factors" reports for each Water Resource Inventory Area in Washington State (Washington State Conservation Commission, 1998-2004 depending on WRIA)
- "State of Our Watersheds Report: WRIAs 1-23 (Salmon and Steelhead Habitat Inventory and Assessment Program, Northwest Indian Fisheries Commission, 2004)
- "Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout—Olympic Peninsula and Puget Sound Management Units" (USFWS, 2004)
- "State of the Sound 2004" and previous reports of the Puget Sound Action Team
- See also, watershed chapters.

Photo courtesy the Washington State Salmon Recovery Funding Board.

Sound as well, protecting the migrating salmon as they moved through the saltwater.

"Perhaps no other structural component of the environment is as important to salmon habitat as is large woody debris, particularly in coastal watersheds."

(National Research Council, 1996)

The stands of ancient forest remained largely untouched until the 1840's when small mills were constructed to supply building materials for local settlers. The arrival of the trans-continental railroad in the 1870's also brought tough and energetic lumbermen, who greatly accelerated the harvest of trees, and marketed them to the growing population in the East. Enormous tracts of timberland were purchased from the railroad companies, and large mills were constructed throughout Puget Sound ports and railroad terminuses, dumping unprecedented amounts of concentrated nutrients into Puget Sound waters from the production of lumber, pulp and paper.

The most accessible timber was that located along the Puget Sound river systems, and riparian stands in lowland areas were soon liquidated and floated downstream, removing the shade, cover and food supply for salmon. A common practice was that of "splash-damming." On many rivers and streams, small temporary dams were built. Thousands of logs were stored behind these dams, and when the timing was right, the dam was destroyed with carefully placed dynamite charges, sending a wall of water and wood down the channel towards the waiting mills. Miles of salmon habitat were scoured to bedrock by these manmade floods. As Puget Sound residents started to experience the effects of erosion and flooding from poor early timber practices, the industry began to improve harvest methods and protect environmental functions. Many upland areas remained relatively unharmed or were allowed to re-grow and heal, but the long lasting effects from permanent removal of the forest canopy in some locations, loss of the structure provided by massive old-

Timber harvest impacts are not limited to private timberlands.

• 5,451 miles of road development occurs in the Olympic and Mt. Baker-Snoqualmie National Forest land surrounding Puget Sound

• A majority of stream crossings in the national forest road system in the Pacific Northwest cannot tolerate more than a 25-year flow event without the failure of culverts and other structures associated with the road system.

(Report from the Federal Ecosystem Management and Assessment Team; part of the Northwest Forest Plan.)

growth trees along rivers and shorelines, and the erosion from the construction and failure of logging roads continue to degrade aquatic habitat.

Agriculture

The broad, flat river deltas at the mouths of most large Puget Sound rivers attracted settlers anxious to secure a land base and supply farm products to the growing towns. By 1900 the basic farming patterns in western Washington had been established for the next century. Vegetables, bulbs, hops and berries were largely grown in the fertile river deltas, while dairy farming took hold in the foothills near large cities and towns. The expansion of farmland resulted in the removal of streamside vegetation and elevated water temperatures, which reached lethal levels for salmon in some tributaries. Salmon were further impacted by chemical and nutrient fertilizers and fine sediments from farm runoff.

Lowland deltas underwent further modification by agricultural workers who were able to expand their land base and improve crop growth by diking, draining and filling wetland areas and tidal marshes. The loss of these crucial estuarine sloughs and marsh areas for juvenile salmon, needed for their physiological adjustment to saltwater, had a profound effect on the survival of salmon. Recent studies of the Skagit River delta, for example, have estimated that 72% of intertidal and estuarine marsh habitat has been lost, coinciding with the modification of the basin for agriculture and other land uses. Skagit system studies further indicate that the quantity of certain types of delta habitat may have a major effect on juvenile Chinook productivity (Beamer, et al., 2004).

Low flows related to water withdrawals for agricultural irrigation have further stressed both adult and juvenile salmon. In some rivers, water rights were granted to remove instream flows as early as 1896. In the Dungeness watershed alone, over 100 miles of irrigation canals and ditches legally diverted the bulk of the river's flow in the late summer-the peak spawning season for Chinook salmon. Prior to the 1960's, the irrigation outtakes from the river were largely unscreened, and juvenile salmon were lost in the maze of ditches and laterals that wan-

Photo by Dan Kowalski.

dered through the fields. The irrigation system in the Dungeness is largely unique to western Washington, but water withdrawals from surface and groundwater sources are used to water crops in several major river basins of Puget Sound.

Water quality problems have been experienced in several watersheds with high proportions of agricultural land use. In the Nooksack basin, water temperatures reaching the threshold of mortality to salmon have been documented in several tributaries, along with high levels of nitrogen, phosphorous and fine sediments. Several Nooksack tributary streams are included on the list of impaired water bodies under Section 303(d) of the Clean Water Act for warm water temperatures, fine sediments, fecal coliform levels, chemical contamination and low instream flows (WCC, 2002). These problems are not the sole result of agricultural practices, as urban runoff, wastewater treatment and other inputs add to the mix.

Farming practices in the second half of the 20th century incorporated lessons learned from the Great Depression and dust bowl years. National initiatives were implemented to form soil and water conservation districts, and similar efforts were organized in Puget Sound to help control erosion and chemical contamination from agriculture. "Best management practices" for farming were developed and are continually being refined, but the extent of implementation of these practices still varies widely around Puget Sound. Many individual farmers are avid fishermen themselves, and have worked toward the improvement of water quality and quantity in their farming practices, but the cost of these improvements often limits what they can do. Farmers presently struggle to retain economic viability in the face of competitive markets, escalating land values and urban/suburban development pressures. The greatest restoration potential for salmon habitat today probably occurs on these agricultural parcels of land, which still have no pavement or other extensive infrastructure which would be costly to modify or remove in order to restore habitat features.

"Farmers in Snohomish County look toward seven generations, but it's hard to see what will happen in the next seven years."

Aaron Reardon, Snohomish County Executive

Urbanization

Early explorers to Puget Sound immediately recognized the region's geographic potential for commerce and trade, and the ideal configuration of protected harbors with year-round access. Proximity to timber resources also promoted major shipbuilding centers, which occurred in Port Townsend, Tacoma, Everett, Bellingham, Olympia and Seattle. However it was the Alaska Gold Rush of 1897 to 1903 which made Seattle into the largest city and seaport in the Pacific Northwest. The miners used the port to purchase supplies and ship them north, and shipped the gold back to determine its value. Returning miners spent their millions in the Puget Sound economy and often settled in the Seattle area. Between 1900 and 1910 the population of Seattle grew from 81,000 to 237,000 (Lambert, 2001).

Although the urbanization of Puget Sound slowed somewhat during the Great Depression, the advent of World War II and the growth of the aviation industry once again caused the population to soar.