

Watershed Profile:

Green/ Duwamish

The Place and the People

The Green/Duwamish and central Puget Sound Watershed starts high in the Cascade mountain range at the headwaters of the Green River. The upper third of the Green flows through a forested terrain of steep slopes and narrow valleys. Below the Howard Hanson Dam, the Green starts flowing through a broader valley that opens into farm lands, small woodland lots, state and county parks, small towns, and eventually reaches the busy suburbs of the Seattle metropolitan area. The lands surrounding the river become more urban and industrialized as it moves downstream. The Green becomes the Duwamish River about eleven miles from its mouth where the Black and Cedar Rivers once entered. The Duwamish is flanked by land uses that shift from suburban to industrial as it approaches the east and west waterways at the delta. Here, sports stadiums built on a formerly expansive mudflat and giant shipping cranes welcome the Duwamish as it empties into Elliott Bay.

The Central Puget Sound marine environment is anchored by Elliott Bay to the north and Dash Point State Park to the south on the mainland. Short independent streams drain to Puget Sound from West Point south to Federal Way and the associated shorelines of Puget Sound, including Vashon and Maury Islands. Together with the shores of Vashon and Maury Islands, the Green/Duwamish and central Puget Sound Watershed provides 92

miles of marine shoreline to Pacific salmon, crabs, geoducks and other marine life.

Along the Green, recreational boaters launch canoes and kayaks, heading for stiller parts of the river. Whitewater adventurers raft the scenic Green River gorge near Flaming Geyser State Park. Commercial forestry in the Upper Green subwatershed conveys a sense of what the land was like when it was dominated



Photo courtesy the Washington State Salmon Recovery Funding Board



Photo by Dan Kowalski

by conifers. Fishers of all ages still walk the creeks and riverbanks, enjoying one of the top ten steel-head rivers in Washington. The Green River's Bass Lake wetland complex has the greatest bird species diversity of wetlands surveyed in King County.

Historically, the Green/Duwamish basin was different. The Green River used to join with the White River in Auburn. Further downstream, in what is now Tukwila, the Cedar and Black Rivers flowed into the combined Green and White Rivers and formed the Duwamish River. The Duwamish meandered about 15 more miles until it emptied into braided salt water marshes, an expansive delta and intertidal mudflats before ending up in Elliott Bay.

Industry and commerce took root in the watershed in the 1850s. From the turn of the century to about 1940, the lower river's meandering course was straightened (channelized), filled and dredged to provide for Seattle's burgeoning industrial and manufacturing district and port.

The White, Cedar and Black Rivers were rerouted away from the Green in the first two decades of the 20th century. Water diversions beginning in 1913 to help provide water for Tacoma's growing residential areas and industries blocked salmon from access to the upper reaches of the Green River. Construction of the Howard Hanson Dam in 1962 changed

the flows and landscape even more. Today, the Duwamish River still has one historic remnant oxbow and about 2% of the historic mudflat/estuary. As people say when describing the changes from historic conditions, this river has been significantly "re-plumbed."

Despite these changes, the river still offers a rich diversity of habitat, fish and wildlife. At the same time, it embodies all the challenges facing

Puget Sound salmon — growth pressures, shoreline alterations, combined sewer overflows and storm-water runoff, contaminated sediments, industrial development and up-river passage barriers and habitat changes due to dams, commercial forestry, and agriculture. The fact that fish have persisted in this degraded environment has inspired people living and working in the watershed to come together to protect and restore salmon habitat where possible.

The watershed's cities, along with King County, came together in 1998 to begin their first coordinated effort to address salmon habitat recovery. City and County officials quickly learned of the significant efforts over the past several decades to protect and improve the river. The valley cities and the Corps of Engineers worked together for over two decades to establish more fish-friendly flood control practices and re-create some of the side channels and wetlands that once existed. King County developed strong environmental regulations and an innovative program called Waterways 2000 to protect the remaining high quality habitat of the Middle Green above Auburn. Seattle and others reduced sewer overflows and toxic wastes entering into the Duwamish. An innovative pro-

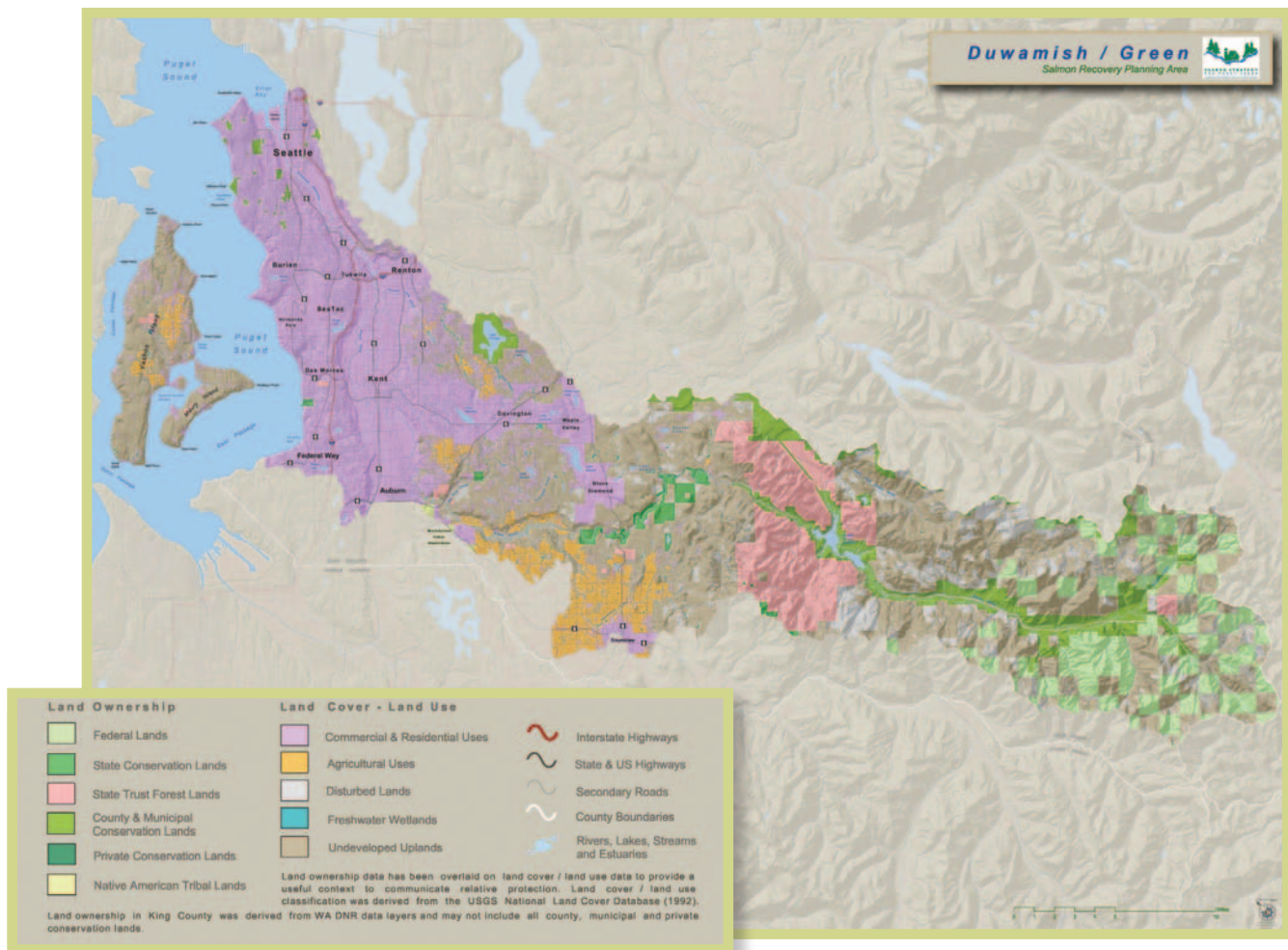
gram in the Duwamish industrial areas works with local businesses to reduce their use and discharge of chemicals. The City and Port of Seattle and others are cleaning up toxic sediments and providing some new estuarine habitat for salmon as they pass through the altered lower river.

The collection of 15 cities, King County, and City of Tacoma officials felt confident that more could be done to help salmon based on the successful habitat protection and restoration efforts that had already occurred. They developed a process, building on the foundation of these other efforts, which resulted in a watershed-wide coordinated salmon habitat conservation initiative. Participants count on each other to make and keep commitments; their efforts have already begun to improve conditions for fish. The Green/Duwamish and Central Puget Sound salmon habitat plan represents a significant

milestone in a long-range process designed by these communities. They will review and evaluate goals, objectives and achievements in the ninth or tenth year of plan implementation. They will use the results to shape the implementation activities for the next ten year horizon.

The Salmon of the Green/Duwamish Basin

The Green/Duwamish basin is home to Chinook, pink, chum, coho and steelhead as well as coastal cutthroat trout, Dolly Varden char, and other fish. Bull trout utilize the marine/nearshore areas for foraging, migrating and over-wintering. Historically, Chinook returned from the ocean to the river in the spring and fall. The early run Chinook typically spawned in the headwaters. They are believed to have declined to such low numbers that people



doubt that the population persists, even in remnant numbers. The decline is believed to be due to the re-routing of the White River and the migration blockage posed by the construction of Tacoma Headworks Dam. Pink salmon are periodically observed, and small numbers of adult sockeye - perhaps strays from Lake Washington--spawn in low numbers in the basin. Naturally spawning winter steelhead and a hatchery origin summer steelhead use the basin and rely on the freshwater habitat in streams throughout the year.

Chinook

The Green/Duwamish Chinook population is an integrated wild-hatchery population with a major role played by hatchery fish. There are several hatcheries operated by the Muckleshoot Tribe and Washington State Department of Fish and Wildlife. The co-managers operate the hatcheries for harvest purposes. Chinook salmon in this basin return to spawn in the summer and fall. Some of the hatchery fish spawn, as the wild-origin fish do, in the mainstem reaches of the Middle Green River, in Soos Creek and in Newaukum Creek. Juvenile Chinook are found throughout the marine nearshore, including Vashon and Maury Islands. Adult Chinook salmon are generally not found in streams draining directly into the marine nearshore. Due to support from the Chinook hatchery on Soos Creek, recent numbers of returning Chinook have not reflected the downward trend reported in other major rivers in Puget Sound. Nonetheless, there is concern that recovery to a naturally sustaining harvestable population is hindered by habitat factors as well as competition for habitat and food sources between naturally spawning fish and hatchery fish.

Estimates of historical population size vary. Independent methods predict the historical run size at approximately 37,700 returning adult fish. Green River hatchery-origin Chinook from the hatchery on Soos Creek have been returning to the river since 1904. The current mean natural-origin run-size estimates vary between 11,200 (Technical Recov-

ery Team, 2002) and 14,700 (Weitcamp and Ruggerone, 2000). Natural spawners in Newaukum Creek are genetically similar to Green River hatchery fish. The Technical Recovery Team estimates the mean natural-origin recruit spawners at 618. Forty to sixty percent of the Chinook spawning in the Green River are Green River Hatchery Chinook.

Chinook Recovery Goals

Currently there are two competing goals for the population that have not been reconciled. The co-managers are managing the river largely for hatchery production and harvest. The long term goal of the local governments working on habitat is to recover Chinook to naturally sustaining, harvestable levels. The plan developed by the Green/Duwamish and central Puget Sound Watershed Forum is intended to improve the watershed aquatic ecosystem with a focus on the needs of listed salmonid species and is the focus of discussion and conclusions in this profile.

As a practical matter, the draft plan proposes to increase the number of natural origin recruit (NOR) spawners in the river basin over the next 50 years. Knowing how many fish the habitat supported in the past, and what can be reasonably expected given current conditions is an important backdrop to choosing a target number of fish both in the short term and the long term. At the present, there isn't a complete understanding of either historic numbers or current habitat capacity.

Over the next 10 years, the Watershed Forum plans to focus on increasing the productivity of adult Chinook returning to spawn. Productivity is defined as the number of adults returning for each adult that spawns. If at least one fish returns from the ocean for each spawning adult, the expected goal is 1,000 to 4,200 natural origin spawners.

In the long term — over the next 50 to 100 years — with continued increases in Chinook population abundance and productivity, the target is 27,000 returning natural-origin spawners. This is in the mid-point of the planning range provided by the

Technical Recovery Team (17,000 to 37,000 with a productivity of 1.0, meaning that one fish will return from the ocean for each adult that spawns). However, these numbers may not be achievable unless there is agreement on how the fish are managed by the tribes, State and local governments.

What are the Key Factors Contributing to the Current Status of the Population?

What are the Key Factors Supporting the Current Population?

Despite the lack of consensus on the overall goal, a number of factors support the current status of Chinook and provide a foundation for improving conditions. Among these are strong scientific and technical studies. These have contributed to an understanding of the basin - what is working best and where, and what can be improved--so that policies and management actions are targeted where they can make the most difference for Chinook spawning and rearing.

In the Upper Green subwatershed, a fifty year Habitat Conservation Plan (HCP) negotiated between

Tacoma Public Utilities and NOAA and the U.S. Fish and Wildlife Service (USFWS) is expected to result in habitat projects and monitoring focused on salmon. The Forests and Fish Rules and the pending HCP, covering commercial forestry activities, are also expected to result in improvements that will address limiting factors in both the Upper and Middle Green subwatershed.

In the Middle and Lower Green, two major programs, principally funded by the U.S. Army Corps of Engineers (ACOE), and conducted in cooperation with the Muckleshoot Indian Tribe, local jurisdictions, and other parties, are underway and already improving conditions for Chinook. A variety of habitat restoration projects undertaken through the Green/Duwamish Ecosystem Restoration Project (ERP), and the Howard Hanson Additional Water Storage Project (AWSP), which is designed to improve flows in the river and also entails habitat project implementation and studies and monitoring, will improve habitat conditions, and the capacity of the system to support more salmon who return home to spawn. The Green/Duwamish Ecosystem





Photo by Dan Kowalski

Restoration Project consists of 45 projects, most of which will benefit salmon habitat across the watershed. Work on the initial projects has begun. The shared funding between local governments and the federal government in this partnership is a successful model that the local governments expect will characterize additional salmon recovery efforts in the years ahead.

Of great significance for spatial structure, actions by the Corps of Engineers and Tacoma Public Utilities are expected to allow fish passage to and from the Upper green River for the first time in nearly a century. Beginning in 2007, adult salmon will be passed upstream around the Tacoma Headworks and Howard Hanson Dam. Facilities at both dams will safely pass migrating juveniles downstream.

Prior to the formalized and coordinated habitat restoration efforts that began in the late 1990s, the Port of Seattle, Corps of Engineers, USFWS, Suquamish Tribe and Muckleshoot Indian Tribe collaborated in the first restoration projects to improve estuarine and nearshore habitat for juvenile Chinook through the Coastal America program. In the early to late nineties, an expanded set of stakeholders worked with natural resource trustees -- NOAA, USFWS, The Washington Department of Ecology, the Suquamish Tribe and the Muckleshoot Indian Tribe -- to identify additional habitat restoration projects and sediment clean-up projects in the lower Duwamish and Elliott Bay. This gave a further boost to the habitat value of the estuarine area up to what is referred to as the "salt water wedge", or the "transition zone", where young Chinook adapt

from freshwater to saltwater in preparation for their ocean voyage.

King Conservation District grants that are funded by district-wide assessments support watershed priorities through habitat projects, technical studies, and stewardship opportunities.

Significant habitat factors limiting the Chinook

A little more than a century ago, a migrating adult Chinook salmon returning home to spawn would have entered a watershed of about 1,600 square miles with extensive estuarine, lake, and mainstem river, side channels and cool, shaded stream habitat for spawning and rearing. Now, a Chinook returning home has a far different experience, entering a basin that is about 30 percent of the size it was a century ago, with about 1/3 of its historic habitat and about 30% of historic flows. A mere 2% to 3% of the historic estuarine mudflats, saltwater marshes and wetlands remain for juvenile Chinook to use as they make their way from freshwater and the saltwater wedge out into the Sound as they head for the ocean waters.

Among the significant and major differences in current habitat conditions when compared with historic options for Chinook spawning and rearing are fish being blocked from habitat above the Tacoma Headworks and the Howard Hanson Dam, and the rerouting of rivers which reduced instream flows and further barred returning adult spawners from rich and varied habitat. The reduced spatial diversity, together with commercial logging in all parts of the basin, dredging, filling, flood control measures, combined with agriculture and urban development resulted in degraded habitat conditions in all parts of the basin.

For the purpose of determining strategies and actions addressing factors presently limiting Chinook, factors of decline are separately defined for the freshwater and nearshore/marine environments.

1. Reduced water quality — changes to dissolved oxygen, temperature, chemical contaminants and

nutrients, suspended sediment/turbidity. Primary causes include stormwater runoff, lack of shade due to loss of riparian vegetation, failing septic systems and increases in impervious surfaces, wastewater and historic industrial effluent.

2. Hydromodification — changes to estuarine tributary and distributary channels, cutoff of sediment supply (spawning gravels), reductions in the amount of in-channel large woody debris, and alteration of nearshore independent tributary channels. Primary causes include bank hardening, levees, clearing of mature streamside vegetation, dams, channel straightening, dredging, filling, loss of side channel and other off-channel habitats, loss of channel and habitat complexity, loss of connection to floodplain, and loss of channel migration.

3. Loss of habitat in marine nearshore rearing and migratory corridor — degradation or elimination of shallow-water habitats, such as mud flats, eelgrass, and kelp beds. Primary causes include

shoreline armoring, dredging, filling, vegetation clearing, and overwater structures.

4. Reduced Sediment Quality — increased presence of metals, organics and other substances in sediments at levels that exceed standards or affect food chains. Primary causes include historic and current stormwater runoff and point source discharges, primarily in the lower Duwamish.

5. Alteration of Habitat Forming Processes — interruption or other modification of processes that form nearshore habitat, such as sediment transport and freshwater input. Primary causes include shoreline armoring, developing on top of and below banks, bluffs, and beaches, changes in flow due to diversion of rivers or streams.

6. Degraded Riparian Condition — altering the presence or absence of native riparian vegetation along the shorelines. Primary causes include shoreline armoring, overwater structures such as piers and docks, residential and other urban development and vegetation removal.

7. Non-native Species — Introduction of plant and animal species whose natural distribution did not include Puget Sound. Primary causes include ballast water discharge, packing materials from foreign seafood, intentional or unintentional establishment by the aquaculture industry.



Photo courtesy the Washington State Salmon Recovery Funding Board

Future Threats

Lack of coordination and agreement between the Muckleshoot Indian Tribe, the Suquamish Tribe, the state and habitat managers on how to reconcile habitat actions with hatchery and harvest management practices will continue to impact Chinook recovery.

The Green/Duwamish and Central Puget Sound Watershed experienced rapid population growth and urbanization in the latter part of the 20th century and is now home to nearly 10% of the population of Washington State. Although the Upper Green subwatershed is protected from development due to being devoted mostly to commercial forestry, land uses in the Middle Green, Lower

Green, Duwamish and in the nearshore environments are much more intense. It is estimated that about 89% of the population lives in the Urban Growth Area (UGA), with 11% residing in rural areas. Current estimates indicate the highest rates of future development will be experienced in the Middle Green, which has functioning spawning and rearing habitat, and along the nearshore, an important area to juveniles, but which is limited in terms of restoration and rehabilitation options.

Overall Approach to Habitat Recovery

The Green/Duwamish and central Puget Sound Salmon Habitat Plan includes geographically specific recommendations for management actions. The draft plan proposes the following watershed-wide priorities for the protection and restoration of habitat to support Chinook salmon recovery:

- Duwamish Estuary transition zone habitat;
- Middle Green River, Lower Green River, Duwamish Estuary, Marine Nearshore rearing habitat, and
- Middle Green River and upper Lower Green River spawning habitat.

Also important is providing access to the Upper Green by passing fish safely upstream and downstream past the Howard Hanson Dam and Tacoma Headworks.

The goals of the draft plan are intended to:

- Protect and restore physical, chemical and biological processes and the freshwater, marine and estuarine habitats on which salmon depend,
- Protect and restore habitat connectivity where feasible, and
- Protect and improve water quality and quantity conditions to support healthy salmon populations.

Looking at the basin system as a whole, and considering factors currently limiting Chinook, the

draft plan proposed the following watershed-wide hypotheses. These hypotheses are a portion of the scientific basis for the recommendations intended to achieve the goals of the plan:

- Protecting and improving riparian conditions would provide greater juvenile growth and survival
- Allowing natural flows would result in more spawning and rearing, increasing available habitat, greater juvenile growth and higher survival rates
- Protecting and improving water quality would enhance survival of adult salmon, incubating salmon eggs and salmon prey
- Protecting and improving access to tributaries would improve amount of available habitat and result in greater juvenile salmon growth and higher survival rates
- Preventing new bank/shoreline armoring and fill would improve juvenile growth, increase available habitat and improve diversity.

Habitat management actions identified for freshwater environments are intended to protect or restore natural channel geomorphology, sediment recruitment, off-channel habitats, tributary habitats and inaccessible mainstem segments, refugia, riparian areas, water quality and water quantity. In marine and estuarine nearshore areas, actions are focused on shallow water habitats, riparian areas, sediment recruitment, habitat formation and maintenance, migratory passage, water quality, sediment quality, pocket estuary, water quantity, submerged aquatic vegetation, beaches and backshore, and salt marshes.

Key Strategies and Actions Supporting the Overall Approach to Recovery

Taking into account the irreversible historic changes within the basin, the strategy emphasizes habitat actions in all parts of the basin, with special consideration given to:



Photo courtesy the Washington State Salmon Recovery Funding Board

- The Duwamish Estuary transition zone in the vicinity of river miles 7.0 - 5.5 (and possibly extending downstream to river mile 4.8),
- Spawning habitat in the Middle Green River and upper Lower Green River, and
- Rearing habitat in the Middle Green River, Lower Green River, Duwamish Estuary, and Marine Nearshore subwatersheds.

The Upper Green subwatershed represents 45 percent of the total watershed area and stream mileage. The plan envisions restoring Chinook access to about 65% of the historically used habitat areas. Getting naturally spawning Chinook above the Howard Hanson Dam into the streams and spawning and rearing habitat that Chinook historically used, is believed to be one of the most significant actions that would increase spawning habitat for Chinook.

Actions in the next ten years: The Habitat Conservation Plans (HCPs) and new forest management rules coupled with restoration and rehabilitation efforts are expected to improve large woody debris recruitment (LWD), sediment recruitment and other processes. Water quality improvement projects are planned and protection is focused mainly on structural features of the habitat and landscape - spawning areas, side channels and late seral timber stands. Actions include one bridge and two culvert replacements, decommissioning 10 miles of USFS roads, restoration of at least 20 miles of off channel habitat, levee setback projects, and meander jams and large woody debris in the mainstem.

A fish ladder and trap-and-haul system to pass fish upstream over the dams was recently completed in 2004 by Tacoma Public Utilities. A downstream fish passage facility at Howard Hanson Dam was well under construction by the Corps of Engineers as of 2005. NOAA Fisheries recently agreed to allow fish passage above the Howard Hanson Dam for all salmonids except hatchery-origin steelhead and Atlantic salmon.

The Middle Green subwatershed starts at the Howard Hanson Dam, at RM 64.5 and extends downstream to RM 32, near the eastern boundary of Auburn. This part of the watershed provides mainstem, off-channel and tributary habitats important to Chinook. Based on spawning survey data from 1997 to 2002, it has been concluded that about 80% of Chinook redds occur in the Middle Green mainstem. According to a 2001 report by the Trust for Public Lands, the Middle Green is one of the best river reaches for salmon remaining in Puget Sound.

Goals include restoring functioning habitats to about 65% of historical habitat area, improvements in sediment recruitment and transport rates to increase the productivity of spawning areas, and to maintain and develop spawning riffles, shallow channel edge, and other habitat, and maintenance of sources of cool, clean water from surface and ground water.



Photo by Dan Kowalski

Actions in the next ten years include: 18 large wood jams, invasive plant removals and revegetation (118 acres), placement of 12,000 tons of gravel, at least ten levee removals/setbacks, and acquisition of 383 acres for habitat protection and restoration purposes.

The Lower Green Subwatershed, beginning at about RM32, flows through a low gradient, wide valley. About 50% of the area is residential with about 27% devoted to industrial and commercial uses. Close to one fourth of the land is devoted to parks, agriculture, and mixed land uses.

The Lower Green reflects channel and floodplain modifications and intensive development, with a substantial loss in quantity and quality of mainstem spawning, winter and summer rearing, and adult holding habitat (large, channel-wide pools). About 40% of the wetlands have been filled, and about 87% of the floodplain forest has been lost.

Goals include restoring spawning habitat to about 45% of historical levels and restoring hydrologic connection to floodplain, tributaries and historical off-channel habitat to achieve access to about 45% of historical habitat area.

Actions in the next ten years include: side channel reconstructions (restoring about 5 acres), at least 7 levee setbacks, and acquisition of about 240 acres for habitat restoration and protection purposes.

The Duwamish Estuary Subwatershed has undergone the greatest change in habitat capacity, diversity and productivity. The decrease in fish productivity, assessed as the factor most linked to the decrease in salmon population viability, is believed to be closely associated with the loss of estuarine capacity and

productivity. Insofar as there is a limiting factor, the Duwamish estuary transition zone in the vicinity of the area from RM 5.5 to RM 7.0 (and possibly extending downstream to RM 4.8) is identified as a key component of Chinook recovery. About one percent of the original mudflats and eleven percent of the original tidal marshes remain in the Duwamish. In the estuary, saltwater wetlands are now gone, along with all but seven of the historic 200 hectares of freshwater wetlands. The critical transition zone, or salt water wedge, is where Chinook salmon undergo changes and acclimate to marine water. Typically, these areas provide a food-rich environment where Chinook grow and rear before moving to nearshore/marine waters. The fact that so much of this habitat has been lost underscores the importance of protecting what remains and restoring, rehabilitating or substituting habitat functions wherever possible.

Though much has been lost, restoration of 15-20 acres of intertidal habitat and sediment clean-up efforts undertaken through Coastal America and natural resource trustees in the 1990s are showing promising results.

In addition to relying on the EPA Superfund cleanup for the Lower Duwamish, the habitat strategy for the estuary includes protection of restored areas, rehabilitation of remnant habitat, and creation of new habitats. Actions include side channel reconstruction, revetment channel reconstruction, and creation of shallow water habitat.

Habitat goals to achieve necessary future conditions in the estuary to support more Chinook include:

- Improvement of mainstem, off-channel and tributary functioning habitats representing about 30% of the historical area,
- Expansion of the estuarine habitat to about 30% of the historical area.

Actions within the next ten years: Actions include restoring about 30 acres of shallow water habitat, 5 levee and revetment setback projects, re-vegetation, and acquisition of about 57 acres for habitat restoration and protection purposes.

The Marine Nearshore Subwatershed historically provided rich and diverse habitats for the abundant juveniles that moved up and down the shoreline, using shallow water habitat for food and refuge from predators. The availability of vegetated shallow nearshore and marsh habitat has been considerably reduced. About 63% of the total shoreline has armor and Seattle is the most heavily armored (90%). There are over 500 overwater structures, boat ramps, jetties, groins or breakwaters. The types of actions necessary to support larger numbers of Chinook as progress is made toward recovery goals include protection and enhancement of vegetated shallow nearshore and marsh habitat, sediment transport processes, pocket estuaries and small tributaries.

Actions within the next ten years include: culvert replacements for the mouths of five creeks and the creation of shallow water bench habitat is planned for at least 3 locations. Estuarine restoration, weir removals, and revegetation projects are also proposed.

Water Quantity – Low Flows

The Watershed Forum commissioned an assessment of current water quantity conditions. The report identifies and characterizes significant surface and groundwater linkages and inputs to the Green River system and provides a coarse water budget for people and fish in the study area. The technical work was performed in the broader policy context of identifying opportunities to manage water resources and to limit degradation of important sources of cool, clean water in the Green River. (WRIA 9 Water Quantity Assessment, Draft March 21, 2005). Recommendations and findings from this study are being evaluated by the watershed recovery team, ACOE and other stakeholders. Management actions will be tracked through monitoring and adaptive management.

Addressing Human Population Growth and Development

The key strategy for protecting habitat is to implement the state and local growth management programs. The plan calls for continued encouragement of growth in existing urban areas where new environmental impacts will likely be less than by development in rural areas. The habitat plan recommends no expansion of the urban growth boundary. In addition to guiding growth to existing areas, the plan calls for actions to reduce impacts, such as:

- Establish and enforce riparian buffers along rivers, streams, estuaries and the marine shoreline.
- Minimize impervious surfaces and forest cover removal in Rural Areas.
- Promote low impact development including natural filtration systems, grassy buffer strips, and other methods to manage runoff from paved areas, clustered development and narrower roads, and porous concrete where soils allow.

- Establish specific instream habitat goals for lowland streams.
- Reduce or eliminate industrial discharges and combined sewer overflows into waterways.
- Actively manage riparian buffers to ensure a long-range goal of at least 70% of the stream corridor as mature, coniferous-dominated forest. Strive to achieve and maintain a near-continuous riparian corridor.

Hatchery Strategy and Actions for Recovery

The goal of the hatchery program is to provide fish for harvest. The program was established using Chinook originating from the Green River. The Soos Creek Hatchery, together with its satellites, supports the Chinook salmon hatchery production program and is operated as an integrated program. The hatchery release goal is 3.2 million fingerlings at 80 fish per pound. Each year the Icy Creek satellite is stocked with 302,000 fin clipped fingerlings from Soos Creek that are released in May. All juvenile hatchery Chinook are mass marked and an index group are coded-wire tagged. The mass marking is important to provide monitoring and harvest opportunity and the coded wire tagged index fish provide an indicator of mortality and marine survival. Returning adult spawners that are not needed at the Soos Creek hatchery are often allowed to pass upstream to spawn naturally. Soos Creek fish make up approximately 33.4% of the wild spawners in the Green River (WDFW and Puget Sound Treaty Tribes, 66, 67).

The draft habitat plan recommends that co-managers consider modification of hatchery practices to support and achieve recovery, for example, by altering the schedule for hatchery fish release to reduce negative impacts on naturally spawning Chinook. Other recommendations include more natural rearing conditions, smaller releases, and genetic management.

WDFW will investigate the feasibility of removing hatchery fish from the Green River above Soos Creek in an attempt to reduce the number of

hatchery fish on the spawning ground. The agency will also conduct a study to determine the relative reproductive success of naturally produced and hatchery produced fall Chinook spawning in Soos Creek. WDFW also intends to remove the trapping facilities from the mainstem of Soos Creek. Co-managers will regularly evaluate research and monitoring results with the intent of adjusting, as appropriate, the HGMPs consistent with stock recovery and fishing objectives.

WDFW intends to eliminate the Ballard Chinook net pens and the Des Moines Net Pen Fall Chinook Program. WDFW and the Muckleshoot Indian Tribe will continue to use progeny originating from Fall Chinook salmon adults volunteering to Soos creek hatchery for the Keta Creek hatchery program, the Soos Creek Hatchery program, and the Icy Creek satellite program. (WDFW and Puget Sound Treaty Tribes, 68, 69).

Harvest Strategy and Actions for Recovery

Reduced harvest rates for Green River Chinook have had a positive effect on the number of returning adults. Currently, the majority of fishing impacts occur in recreational, net and troll fisheries for Washington (2001, Comprehensive Chinook Management Plan - Harvest Management Component, 78). Currently, the co-managers goal is to ensure that 5,800 Green River Chinook return to home waters to spawn. The overall intent is to ensure that harvest management practices do not impede recovery of the Chinook ESU. The Comprehensive Chinook Management Plan reports that "the central objective of terminal area fisheries management is to assure adequate natural spawning escapement and to supply broodstock to the fisheries enhancement program" (ibid, 79). Concern has been expressed that hatchery-origin spawners, by inter-breeding with natural-origin spawners, are reducing genetic fitness of the natural-origin fish. However, no genetic distinction between natural-origin recruits and hatchery adults has been detected (op.cit.).

The draft habitat plan suggests using live capture techniques to catch hatchery salmon in order to release natural salmon thus reducing mortality of naturally-produced salmon (4-39).

Results

The watershed plan for the Green/Duwamish and Central Puget Sound watershed was reviewed by the Puget Sound Technical Recovery Team (TRT: a group of seven scientists) and an interagency committee facilitated by the Shared Strategy staff. The TRT reviewed the plan to determine the degree of certainty that the plan can achieve recovery goals. The conclusions of this analysis are below. For the most part, the issues identified below by the analysis are discussed in the watershed plan to some extent, but the reviewers felt they merited particular attention or additional effort to increase the certainty of achieving plan outcomes. Where the analysis identified key uncertainties, proposals are included for consideration. If implemented along with the watershed plan's other actions, these proposals would increase the certainty of results and achieve the requirements for a recovery plan under the Endangered Species Act.

The Green/Duwamish Watershed Forum plan is based on a solid foundation of information about how the landscape conditions affect habitat attributes in the river for Chinook. The plan lays out the conditions believed necessary to achieve a naturally self-sustaining population of Chinook based on the assumption that since the watershed is much reduced in size and altered irreversibly from its historical conditions, then strategies and actions can only support a reduced population. Neither historic conditions can be met nor can fish numbers be expected to recover to near-historic levels. Achieving the results predicted for a self-sustaining population will require major changes to the current river conditions and surrounding landscape. Since the river and land have been highly altered, and integrated habitat, harvest and hatchery strate-

gies have not been developed, there is significant uncertainty about the technical feasibility of restoring natural processes that would support a self-sustaining system.

The certainty of achieving this plan's outcomes and the resulting contribution to overall ESU recovery will increase if the following issues receive focused attention as described below.

One of the first priorities in the next two years should be to gain consensus between the Tribe, State and Watershed Forum on the goals for Chinook in this system. The agreement will influence the watershed priorities, including habitat actions, that would logically follow.

In the interim, reducing harm to the fish as they migrate through the lower Duwamish, and protecting the Middle Green will be important regardless of the ultimate objectives for the fish. This approach will preserve future options for the population.

The adaptive management and monitoring program, slated for completion by December 2005 is expected to incorporate measures relating to the issues identified in the results section above.

The review process also identified a number of issues and uncertainties that are common to many Puget Sound watersheds. Strategies to address these issues that are contained in this local watershed chapter are a good approach, based on the current state of scientific understanding. Nevertheless, because (1) these issues are very important to the success of watershed approaches to recovery and (2) the effects of some of these strategies on salmon populations at watershed scales are relatively untested, these issues deserve particular attention. Reducing the uncertainties in the issues below could come through local and/or regional inclusion in adaptive management and monitoring programs, regional or local pilot studies to explicitly test their effects, or through additional implementation actions. The complexities associated with these issues are discussed in the regional strategy section of this document or in the regional adaptive

management and monitoring program. The “cross-watershed” issues identified are:

- The importance of habitat protection strategies and the need to assess the results for fish from the combination of protection tools available,
- The need to develop H-Integration strategies or, where they are included, to move them further along the integration continuum over time,
- The need to reconcile local nearshore strategies and actions with the regional nearshore chapter,
- The need to address water resources, both water quality and water quantity,
- The need to better link the effects of land use to habitat-forming processes and to habitat conditions. In turn, the effects of these changes in habitat, processes and landscapes on salmon populations need to be estimated,
- The need to develop or complete a robust adaptive management and monitoring program.

If the proposals above are implemented and the uncertainties addressed, this watershed and its Chinook population will provide a critical contribution to the recovery of Puget Sound Chinook and a spatial linkage between the Central-South Sound fish and their neighboring watersheds in the North.

Important Note re draft plan: The draft plan was developed by the Steering Committee and released for public review and comment on March 10, 2005. Following the comment period, which closed on April 25th, the Steering Committee will make revisions and present the draft to the Forum, made up of elected officials representing the 17 jurisdictions who are funding the effort. Forum members will be asked to approve the Final Plan or refer it back to the Steering Committee. No later than November 16, 2005, Forum members will refer the plan to the local governments of the inter-local agreement for ratification.