Lower Columbia Salmon Recovery
And
Fish & Wildlife Subbasin Plan

Volume II – Subbasin Plan
Chapter B – Estuary Tributaries: Chinook, Wallacut and Deep

Lower Columbia Fish Recovery Board

December 15, 2004

Preface

This is one in a series of volumes that together comprise a Recovery and Subbasin Plan for Washington lower Columbia River salmon and steelhead:

--	Plan Overview	*Overview of the planning process and regional and subbasin elements of the plan.*
Vol. I	Regional Plan	*Regional framework for recovery identifying species, limiting factors and threats, the scientific foundation for recovery, biological objectives, strategies, actions, and implementation.*
Vol. II	Subbasin Plans	*Subbasin vision, assessments, and management plan for each of 12 Washington lower Columbia River subbasins consistent with the Regional Plan. These volumes describe implementation of the regional plan at the subbasin level.* *II.A. Lower Columbia Mainstem and Estuary* *II.B. Estuary Tributaries* *II.C. Grays Subbasin* *II.D. Elochoman Subbasin* *II.E. Cowlitz Subbasin* *II.F. Kalama Subbasin* *II.G. Lewis Subbasin* *II.H. Lower Columbia Tributaries* *II.I. Washougal Subbasin* *II.J. Wind Subbasin* *II.K. Little White Salmon Subbasin* *II.L. Columbia Gorge Tributaries*
Appdx. A	Focal Fish Species	*Species overviews and status assessments for lower Columbia River Chinook salmon, coho salmon, chum salmon, steelhead, and bull trout.*
Appdx. B	Other Species	*Descriptions, status, and limiting factors of other fish and wildlife species of interest to recovery and subbasin planning.*
Appdx. C	Program Directory	*Descriptions of federal, state, local, tribal, and non-governmental programs and projects that affect or are affected by recovery and subbasin planning.*
Appdx. D	Economic Framework	*Potential costs and economic considerations for recovery and subbasin planning.*
Appdx. E	Assessment Methods	*Methods and detailed discussions of assessments completed as part of this planning process.*

This plan was developed by of the Lower Columbia Fish Recovery Board and its consultants under the Guidance of the Lower Columbia Recovery Plan Steering Committee, a cooperative partnership between federal, state and local governments, tribes and concerned citizens.

Lower Columbia Fish Recovery Board
Current Members

Dave Andrew	Hydro-Electric Representative	Cowlitz PUD
John Barnett*	Tribal Representative	Cowlitz Indian Tribe
Mark Doumit	Legislative Representative	WA State Senate
Bill Dygert*	Clark County	Citizen
Dennis Hadaller	Lewis County	Commissioner
Henry Johnson*	Wahkiakum County	Citizen
Tim Leavitt	SW WA Cities Representative	City of Vancouver
Jeff Rasmussen	Cowlitz County	Commissioner
Tom Linde	Skamania County	Citizen
Al McKee*	Skamania County	Commissioner
Betty Sue Morris*	Clark County	Commissioner
Don Swanson	SW WA Environmental Representative	Citizen
Randy Sweet*	Cowlitz County & Private Property Interests	Citizen
Chuck TenPas	Lewis County	Citizen
George Trott	Wahkiakum County	Commissioner

Lower Columbia Fish Recovery Board
Past Members

Glenn Aldrich*	Lewis County	Commissioner	1998-1999
Dean Dossett*	SW WA Cities Representative	City of Camas	1998-2003
Marc Duboiski	Lewis County	Commissioner Designee	1999-2000
Tom Fox*	Lewis County	Citizen	1998-2002
Gary Morningstar*	Skamania County	Citizen	1998-2002
Bill Lehning	Cowlitz County	Commissioner	2003-2004
Ron Ozment	Wahkiakum County	Commissioner	1999-2003
John Pennington*	Legislative Representative	WA State House of Representatives	1998-2001
George Raiter	Cowlitz County	Commissioner	2001-2002
Joel Rupley*	Cowlitz County	Commissioner	1998-2001
Dan Smalley*	Wahkiakum County	Commissioner	1998-1999
Leon Smith*	Hydro-Electric Representative	Cowlitz PUD	1998-2000
Jim Stolarzyk*	SW WA Environmental Representative	Citizen	1998-2000

**Charter Member*

Lower Columbia Recovery Plan Steering Committee

Mark Bagdovitz, US Fish and Wildlife Service

John Barnett, Cowlitz Indian Tribe

Chinook Tribe

Dean Dossett, SW WA Cities Representative

Patty Dornbusch, NOAA-Fisheries

Bill Dygert, SW WA Citizen

Tony Grover, Northwest Power and Conservation Council

Mark LaRiviere, Hydro-Electric Representative

Claire Lavendel, US Forest Service, Gifford-Pinchot

Tim Leavitt, SW WA Cities Representative

Scott McEwen, Lower Columbia Estuary Partnership

Betty Sue Morris, SW WA County Commissioners Representative

Phil Miller, Governor’s Salmon Recovery Office

Randy Sweet, SW WA Citizen

George Trott, SW WA County Commissioners Representative

Paul Ward, Yakama Nation

Robert Willis, US Army Corp of Engineers

Lee VanTussenbrook, Washington Department of Fish and Wildlife

Lower Columbia Fish Recovery Board Staff

Jeff Breckel	Executive Director
Melody Tereski	Program Manager
Phil Trask	Watershed and ESA Recovery Plan Coordinator
Gary Wade	Habitat Project Coordinator
Lorie Clark	Program Assistant
Abigail Andrews	Student Intern
Kara Ouellette	Student Intern

Consultants

Ray Beamesderfer	Project Manager	SP Cramer and Associates
Kent Snyder	Project Manager	The White Co.
Guy Norman	Fish Managment Lead	SP Cramer and Associates
Gardner Johnston	Habitat Lead	SP Cramer and Associates
Mike Daigneault	Estuary Lead	SP Cramer and Associates
Caryn Ackerman	Technical Support	SP Cramer and Associates
Nick Ackerman	Technical Support	SP Cramer and Associates
Jodi Brauner Lando	Technical Support	SP Cramer and Associates
Eric Doyle	Technical Support	URS Corporation
Brandy Gerke	Technical Support	SP Cramer and Associates
Steve Hughes	Technical Support	URS Corporation
Cleve Steward	Technical Support	Steward and Associates
Barbara Taylor	Technical Support	SP Cramer and Associates
Eric Knudsen	Editorial Support	SP Cramer and Associates
Christy Osborn	Editorial Support	The White Co.

Lower Columbia River Estuary Partnership

Mobrand Biometrics

Parametrix

Research Group

WA Department of Fish and Wildlife

Zenn and Associates

Subbasin Plan Vol. II.B.
Columbia Estuary Tributaries

Contents

1.0 Columbia Estuary Tributaries – Executive Summary

This plan describes a vision, strategy, and actions for recovery of listed salmon, steelhead, and trout species to healthy and harvestable levels, and mitigation of the effects of the Columbia River hydropower system in Washington lower Columbia River subbasins. Recovery of listed species and hydropower mitigation is accomplished at a regional scale. This plan for the Estuary tributaries describes implementation of the regional approach within this basin, as well as assessments of local fish populations, limiting factors, and ongoing activities that underlie local recovery or mitigation actions. The plan was developed in a partnership between the Lower Columbia Fish Recovery Board (Board), Northwest Power and Conservation Council, federal agencies, state agencies, tribal nations, local governments, and others.

The Estuary Tributaries Basin is part of the Columbia Estuary Subbasin, one of eleven major subbasins in the Washington portion of the Lower Columbia Region. The Columbia Estuary Subbasin spans portions of both Oregon and Washington. This plan refers to the Columbia Estuary tributaries that enter from the Washington side of the Columbia from the mouth to the Deep River. The Columbia Estuary itself is covered in a separate plan in this volume. The Estuary Tributaries Basin historically supported thousands of fall Chinook, chum, and coho. Today, numbers of naturally spawning salmon have plummeted to record lows in the tens or hundreds. Chinook and chum have been listed as Threatened under the Endangered Species Act and coho is proposed for listing. The decline has occurred over decades and the reasons are many. Freshwater and estuary habitat quality has been reduced by agricultural and forestry practices. Key habitats have been isolated or eliminated by dredging and channel modifications and diking, filling, or draining floodplains and wetlands. Altered habitat conditions have increased predation. Competition and interbreeding with domesticated or non-local hatchery fish has reduced productivity. Hydropower operation on the Columbia has altered flows, habitat, and migration conditions. Fish are harvested in fresh and saltwater fisheries. All Estuary Tributary salmon will need to be restored to a high level of viability to meet regional recovery objectives. This means that the populations are productive, abundant, exhibit multiple life history strategies, and utilize significant portions of the basin.

In recent years, agencies, local governments, and other entities have actively addressed the various threats to salmon and steelhead, but much remains to be done. One thing is clear: no single threat is responsible for the decline in these populations. All threats and limiting factors must be reduced if recovery is to be achieved. An effective recovery plan must also reflect a realistic balance within physical, technical, social, cultural and economic constraints. The decisions that govern how this balance is attained will shape the region's future in terms of watershed health, economic vitality, and quality of life.

This plan represents the current best estimation of necessary actions for recovery and mitigation based on thorough research and analysis of the various threats and limiting factors that impact Estuary Tributaries fish populations. Specific strategies, measures, actions and priorities have been developed to address these threats and limiting factors. The specified strategies identify the best long term and short term avenues for achieving fish restoration and mitigation goals. While it is understood that data, models, and theories have their limitations and growing knowledge will certainly spawn new strategies, the Board is confident that by implementation of the recommended actions in this plan, the population goals in the Estuary Tributaries Basin can be achieved. Success will depend on implementation of these strategies at the program and project level. It remains uncertain what level of effort will need to be invested in each area of impact to ensure the desired result. The answer to the question of precisely how much is enough is currently beyond our understanding of the species and ecosystems and can only be answered through ongoing monitoring and adaptive management against the backdrop of what is socially possible.

1.1 Key Priorities

Many actions, programs, and projects will make necessary contributions to recovery and mitigation in the Estuary Tributaries Basin. The following list identifies the most immediate priorities.

1. Restore Passage at Tide Gates, Culverts and Other Artificial Barriers

There are passage issues related to tidegates and culverts throughout the basin. There are current efforts underway to address passage and stream flow issues at the tidegate at the mouth of the Chinook River. There are also efforts underway to upgrade culverts under Highways 401 and 101 that may be restricting passage to several small streams. Further assessment and prioritization of passage barriers is needed throughout the basin.

2. Restore Lower River Estuary, Floodplain, and Riparian Habitats

Much of the historically productive and accessible estuary habitats in the lower Chinook and Wallacut Rivers have been eliminated through channelization, floodplain filling, and wetland draining to facilitate agricultural uses. These activities have heavily impacted fish habitat in these areas. Removing or modifying channel control and containment structures to reconnect the stream and its floodplain, where this is feasible and can be done without increasing risks of substantial flood damage, will restore normal habitat-forming processes to reestablish habitat complexity, off-channel habitats, and conditions favorable to fish spawning and rearing. These improvements will be particularly beneficial to chum, fall Chinook, and coho and will have the added benefit of providing estuary habitat to other Columbia Basin salmonid populations. Restoration will also provide estuary, wetland, and riparian habitats critical to other fish, wildlife, and plant species. Existing floodplain/estuary function and habitats will be protected through local land use ordinances, partnerships with landowners, and the acquisition of land, where appropriate. Restoration will be achieved by working with willing landowners, non-governmental organizations, conservation districts, and state and federal agencies. Restoration efforts focusing on land acquisition and estuary restoration have already made significant progress in this basin.

3. Manage Forest Lands to Protect and Restore Watershed Processes

Much of the Estuary Tributaries Basin is managed for commercial timber production and has experienced intensive past forest practices activities. Proper forest management is critical to fish recovery. Past forest practices have reduced fish habitat quantity and quality by altering stream flow, increasing fine sediment, and degrading riparian zones. Effects have been magnified due to high rainfall and erodable soils. In addition, forest road culverts have blocked fish passage in small tributary streams. Effective implementation of new forest practices through the Department of Natural Resources' Forest Practices Rules (private lands) are expected to substantially improve conditions by restoring passage, protecting riparian conditions, reducing fine sediment inputs, lowering water temperatures, improving flows, and restoring habitat diversity. Improvements will benefit all species, particularly winter steelhead and coho.

4. Address Immediate Risks with Short-term Habitat Fixes

Restoration of normal watershed processes that allow a basin to restore itself over time has proven to be the most effective strategy for long term habitat improvements. However, restoration of some critical habitats may take decades to occur. In the near term, it is important to initiate short-term fixes to address current critical low numbers of some species. Examples in the Estuary Tributaries Basin include building chum salmon spawning channels and constructing coho overwintering habitat such as alcoves, side channels, and log jams. Benefits of structural enhancements are often temporary but will help bridge the period until normal habitat-forming processes are reestablished.

5. Manage Growth and Development to Protect Watershed Processes and Habitat Conditions

The human population in the basin is relatively low, but it is projected to grow by at least one third in the next twenty years. The local economy is also in transition with reduced reliance on forest products, fisheries, and farming. Population growth will primarily occur in lower river valleys and along the major stream corridors. This growth will result in the conversion of forestry and agricultural land uses to residential uses, with potential impacts to habitat conditions. Land-use changes will provide a variety of risks to terrestrial and aquatic habitats. Careful land-use planning will be necessary to protect and restore natural fish populations and habitats and will also present opportunities to preserve the rural character and local economic base of the basin.

6. Hatchery Priorities are Consistent with Conservation Objectives

Hatcheries throughout the Columbia basin historically focused on producing fish for fisheries as mitigation for hydropower development and widespread habitat degradation. Emphasis of hatchery production without regard for natural populations can pose risks to natural population viability. Hatchery priorities must be aligned with conservation objectives to conserve natural populations, enhance natural fish recovery, and avoid impeding progress toward recovery while continuing to provide some fishery mitigation benefits. The Sea Resources Hatchery program will produce and/or acclimate fall Chinook, chum, and coho, for use in the Estuary Tributaries Basin. Hatchery programs will continue to restore naturally reproducing populations of salmon in the Chinook River. Deep River net pens will acclimate and release coho and spring Chinook for Select Area Harvest in Grays Bay and lower Deep River.

7. Manage Fishery Impacts so they do not Impede Progress Toward Recovery

This near-term strategy involves limiting fishery impacts on natural populations to ameliorate extinction risks until a combination of measures can restore fishable natural populations. There is no directed Columbia River or tributary harvest of ESA-listed estuary tributary salmon. This practice will continue until the populations are sufficiently recovered to withstand such pressure and remain self-sustaining. Some estuary tributary salmon and steelhead are incidentally taken in mainstem Columbia River and ocean mixed stock fisheries for strong wild and hatchery runs of fall Chinook and coho. These fisheries will be managed with strict limits to ensure this incidental take does not threaten the recovery of wild populations including those from the estuary tributaries. Chum will continue to be protected from significant fishery impacts in the Columbia River and are not subject to ocean fisheries. Selective fisheries for marked hatchery coho (and fall Chinook after mass marking occurs) will be a critical tool for limiting wild fish impacts. State and federal legislative bodies will be encouraged to develop funding necessary to implement mass-marking of fall Chinook, thus enabling a selective fishery with lower impacts on wild fish. State and federal fisheries managers will better incorporate Lower Columbia indicator populations into fisheries impact models.

8. Reduce Out-of-Subbasin Impacts so that the Benefits of In-Subbasin Actions can be Realized

Estuary Tributary salmon are exposed to a variety of human and natural threats in migrations outside of the basin. Human impacts include drastic habitat changes in the Columbia River estuary, effects of Columbia Basin hydropower operation on mainstem, estuary, and nearshore ocean conditions, interactions with introduced animal and plant species, and altered natural predation patterns by northern pikeminnow, birds, seals, and sea lions. A variety of restoration and management actions are needed to reduce these out-of-basin effects so that the benefits in-basin actions can be realized. Owing to its close proximity, estuary habitat improvements including restoration of wetlands, will be particularly critical to the Estuary Tributaries salmonid populations. To ensure equivalent sharing of the recovery and mitigation burden, impacts in each area of effect (habitat, hydropower, etc.) should be reduced in proportion to their significance to species of interest.

2.0 Background

This plan describes a vision and framework for rebuilding salmon populations in Washington's Estuary Tributaries Basin. The plan addresses subbasin elements of a regional recovery plan for Chinook salmon, chum salmon, coho salmon, steelhead, and bull trout listed or under consideration for listing as Threatened under the federal Endangered Species Act (ESA). The plan also serves as a Subbasin Plan for the Northwest Power and Conservation Council (NPCC) Fish and Wildlife Program to address effects of construction and operation of the Federal Columbia River Power System.

Development of this plan was led and coordinated by the Washington Lower Columbia River Fish Recovery Board (LCFRB). The Board was established by state statue (RCW 77.85.200) in 1998 to oversee and coordinate salmon and steelhead recovery efforts in the lower Columbia region of Washington. It is comprised of representatives from the state legislature, city and county governments, the Cowlitz Tribe, private property owners, hydro project operators, the environmental community, and concerned citizens. A variety of partners representing federal agencies, Tribal Governments, Washington state agencies, regional organizations, and local governments participated in the process through involvement on the LCFRB, a Recovery Planning Steering Committee, planning working groups, public outreach, and other coordinated efforts.

The planning process integrated four interrelated initiatives to produce a single Recovery/Subbasin Plan for Washington subbasins of the lower Columbia:

- Endangered Species Act recovery planning for listed salmon and trout.
- Northwest Power and Conservation Council (NPCC) fish and wildlife subbasin planning for eight full and three partial subbasins.
- Watershed planning pursuant to the Washington Watershed Management Act, RCW 90-82.
- Habitat protection and restoration pursuant to the Washington Salmon Recovery Act, RCW 77.85.

This integrated approach ensures consistency and compatibility of goals, objectives, strategies, priorities and actions; eliminates redundancy in the collection and analysis of data; and establishes the framework for a partnership of federal, state, tribal and local governments under which agencies can effectively and efficiently coordinate planning and implement efforts.

The plan includes an assessment of limiting factors and threats to key fish species, an inventory of related projects and programs, and a management plan to guide actions to address specific factors and threats. The assessment includes a description of the subbasin, focal fish species, current conditions, and evaluations of factors affecting focal fish species inside and outside the subbasin. This assessment forms the scientific and technical foundation for developing a subbasin vision, objectives, strategies, and measures. The inventory summarizes current and planned fish and habitat protection, restoration, and artificial production activities and programs. This inventory illustrates current management direction and existing tools for plan implementation. The management plan details biological objectives, strategies, measures, actions, and expected effects consistent with the planning process goals and the corresponding subbasin vision.

3.0 Assessment

3.1 Subbasin Description

3.1.1 *Topography & Geology*

The Columbia Estuary Tributaries watershed drains 26,100 acres (41 mi^2) of the coastal estuary and lowlands in the far southwest corner of Washington. Tributaries to the Columbia River estuary include the Chinook and Wallacut Rivers, as well as several smaller streams that flow into the estuary between the Chinook River and the Deep River to the east. The Chinook and Wallacut Rivers originate in the Willapa Hills and flow through wide valley bottoms before emptying into broad estuaries and then into Baker Bay. Their basins have a combination of sedimentary and volcanic geology.

The shoreline is interspersed with rocky, forested cliffs and floodplain lowlands that have been diked. Most estuarine areas at the river mouths are made up of island complexes, tidal marshes, and tidewater sloughs. Substrate is silt and sand, and vegetation consists of emergent and forested wetlands. These areas provide not only important habitat for local fish populations, but also important estuary rearing habitat for a host of other Columbia River and marine fish populations.

3.1.2 *Climate*

Average annual rainfall across the estuary in Astoria, Oregon, is 67 inches (1701.8 mm), ranging from 1.22 inches (30.9 mm) in July to 10.53 inches (267.5 mm) in December. Temperatures are mild due to coastal influence and range from 44°-58°F (7°-15°C) (WRCC 2003).

3.1.3 *Land Use, Ownership, and Cover*

Private land ownership dominates the watershed, which is only 4% publicly owned. Residential and commercial uses increase at the west end of the watershed, spreading east from the tourist communities of Long Beach and Sea View, WA to the town of Ilwaco, WA. The State of Washington owns, and the Washington State Department of Natural Resources (DNR) manages the beds of all navigable waters within the subbasin. Any proposed use of those lands must be approved in advance by the DNR. Lower elevation areas provide space for agriculture, and the higher elevation areas support a small amount of timber harvesting. Much of the estuary habitat at the mouth of the rivers has been converted to agricultural uses, with significant diking and filling of off-channel habitats. Fishing, timber, agriculture, and tourism provide the economic base for area residents. Land ownership in the Columbia Estuary Tributaries Basin is shown in Figure 1 and land cover/land use in the basin is shown in Figure 2.

3.1.4 *Development Trends*

The area is sparsely populated, and the fishing port of Ilwaco and the small rural communities of Chinook and Megler are the only population centers on the Washington side. Astoria is the largest population center in the area.

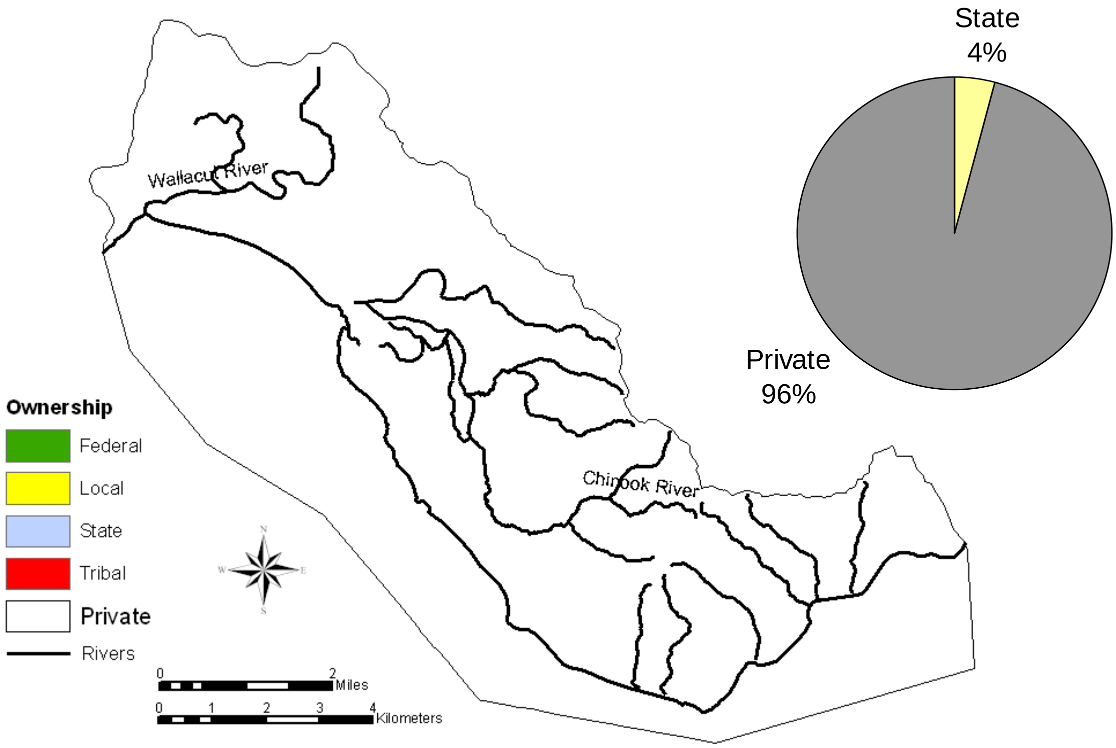


Figure 1. Landownership within the Columbia Estuary Tributaries Basin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

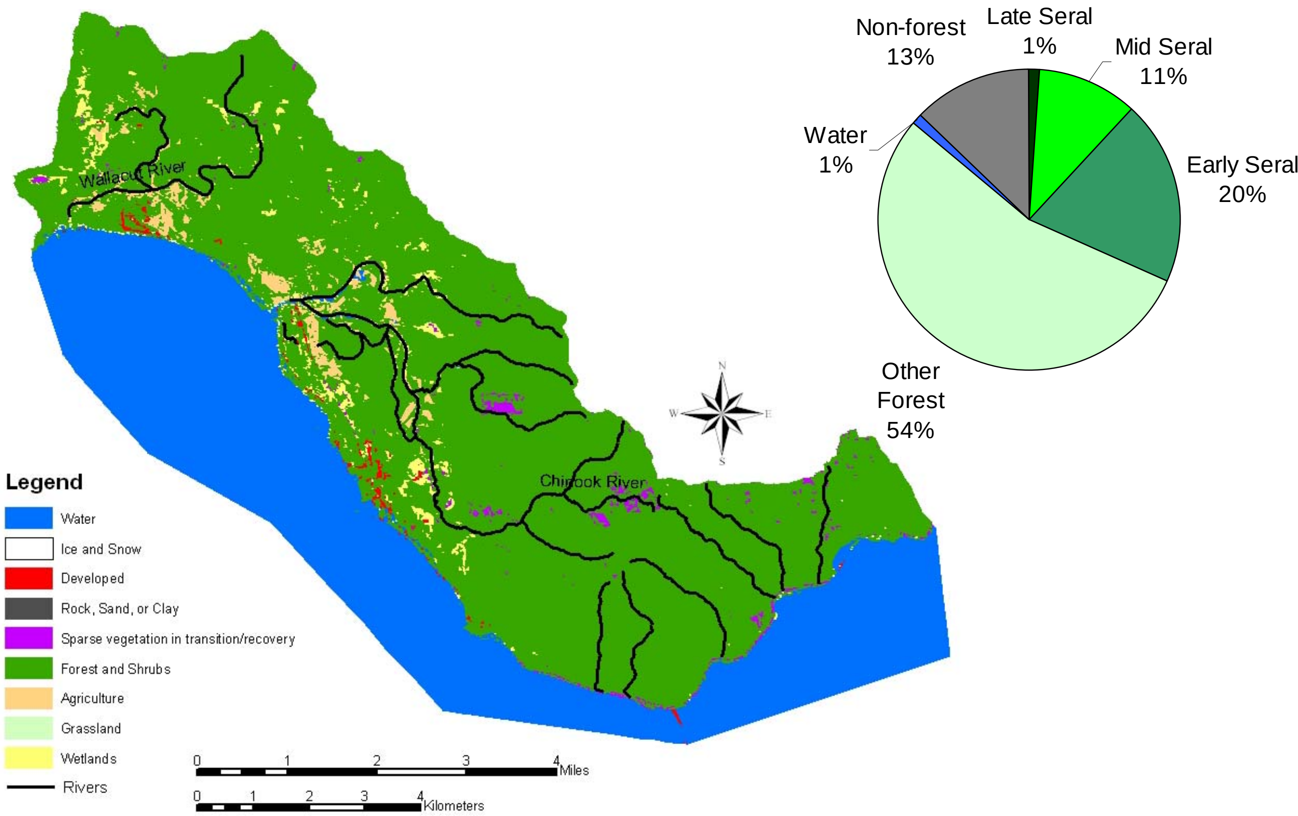


Figure 2. Land cover within the Columbia Estuary Tributaries Basin. Vegitation cover (pie chart) derived from Landsat data based on methods in Lunetta et al. 1997. Mapped data was obtained from the USGS National Land Cover Dataset (NLCD).

3.2 Focal and Other Species of Interest

Listed salmon, steelhead, and trout species are focal species of this planning effort for the Columbia Estuary Tributaries Basin. Other species of interest were also identified as appropriate. Species were selected because they are listed or under consideration for listing under the U.S. Endangered Species Act or because viability or use is significantly affected by the Federal Columbia Hydropower system. Federal hydropower system effects are not significant within the Columbia Estuary Tributaries Subbasin although anadromous species are subject to effects in the Columbia River, estuary, and nearshore ocean. The Columbia Estuary tributaries ecosystem supports and depends on a wide variety of fish and wildlife in addition to designated species. A comprehensive ecosystem-based approach to salmon and steelhead recovery will provide significant benefits to other native species through restoration of landscape-level processes and habitat conditions. Other fish and wildlife species not directly addressed by this plan are subject to a variety of other Federal, State, and local planning or management activities.

Focal salmonid species in Columbia Estuary tributary watersheds include fall Chinook, chum and coho. Bull trout do not occur in the basin. Salmon and steelhead numbers have declined to only a fraction of historical levels (Table 1). Extinction risks are significant for all focal species – the current health or viability is low for all anadromous species in the Columbia Estuary tributaries. Returns of fall Chinook, chum, and coho include both natural and hatchery produced fish in the estuary tributaries and in the Grays River. The estuary tributary salmon are combined with Grays River salmon to form Grays/Chinook populations when considering recovery objectives.

Table 1. Status of focal salmond and steelhead populations in the Columbia Estuary Tributaries Basin.

Species	ESA Status	Hatchery Component[1]	Historical Numbers[2]	Recent Numbers[3]	Current Viability[4]	Extinction risk[5]
Fall Chinook	Threatened	Yes	1,500-10,000	100-300	Low+	40%
Chum	Threatened	Yes	8,000-14,000	500-10,000	Low+	30%
Coho	Proposed	Yes	5,000-40,000	Unknown	Low+	70%

1 *Significant numbers of hatchery fish are released in the basin.*
2 *Historical population size inferred from presumed habitat conditions using Ecosystem Diagnosis and Treatment Model and NOAA back-of-envelope calculations. Numbers include Grays River..*
3 *Approximate current annual range in number of naturally-produced fish returning to the basin. Numbers include Grays River.*
4 *Prospects for long term persistence based on criteria developed by the NOAA Technical Recovery Team.Assessment includes Grays River and Chinook River populations*
5 *Probability of extinction within 100 years corresponding to estimated viability.*

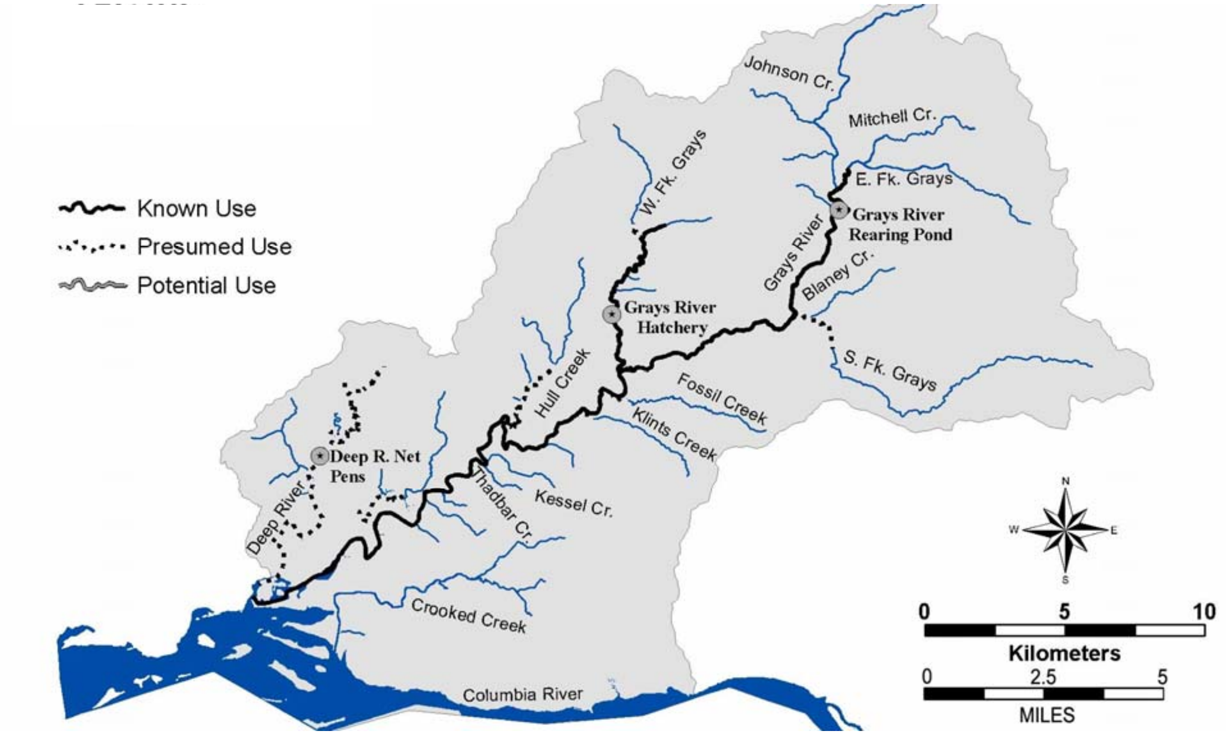
Other species of interest in the Columbia Estuary Tributaries Subbasin include coastal cutthroat trout and Pacific lamprey. These species have been affected by many of the same habitat factors that have reduced numbers of anadromous salmonids.

Brief summaries of the population characteristics and status follow. Additional information on life history, population characteristics, and status assessments may be found in Appendix A (focal species) and B (other species).

3.2.1 *Fall Chinook—Grays/Chinook Subbasin*

ESA: Threatened 1999 **SASSI: Depressed 2002**

The historical Gray/Chinook adult population is estimated from 1,500-10,000 fish. The majority of fish returned to the Grays River. Current natural spawning returns to the Grays River range from 100-300 fish. Spawning in the Grays occurs primarily in the lower Grays and west Fork mainstems. Juvenile rearing occurs near and downstream of the spawning areas. Juveniles emerge in early spring and migrate to the Columbia in spring and summer of their first year.



Distribution

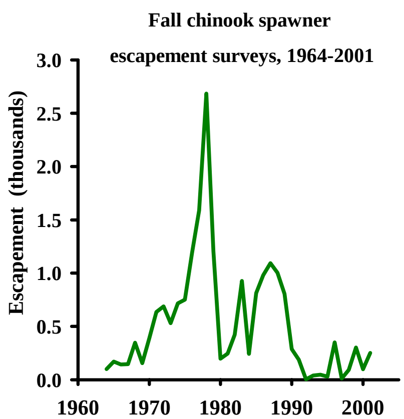
- Spawning occurs in the West Fork below the Grays River Salmon Hatchery (RM 1.4) and in the mainstem Grays River from the area of tidal influence to above the confluence of the West Fork (RM 8-14)

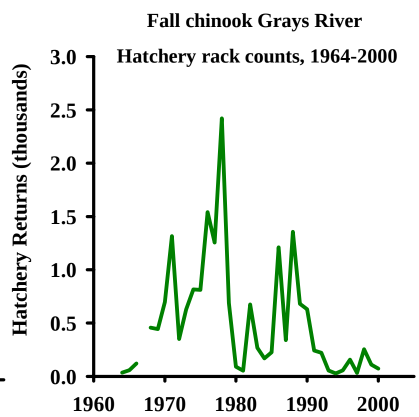
Life History

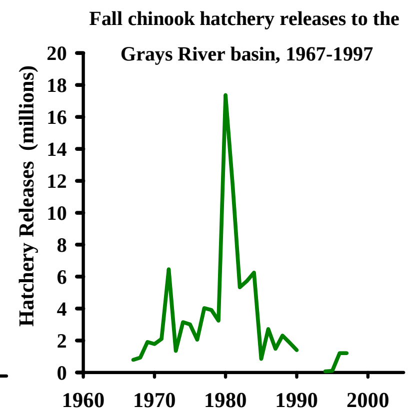
- Columbia River tule fall chinook migration occurs from mid August to mid September, depending partly on early fall rain
- Natural spawning occurs between late September and late October, peaking in mid-October
- Age ranges from 2-year-old jacks to 6-year-old adults, with dominant adult ages of 3 and 4 (averages are 27% and 57% respectively)
- Fry emerge around early April, depending on time of egg deposition and water temperature; fall chinook fry spend the summer in fresh water, and emigrate in the late spring/summer as sub-yearlings

Diversity

- Considered a component of the tule population in the lower Columbia River Evolutionarily Significant Unit (ESU)
- Stock designated based on distinct spawning distribution







Abundance

- In 1951, WDF estimated fall chinook escapement to the Grays River was 1,000 fish
- Spawning escapements from 1964-2001 ranged from 4 to 2,685 (average 523)

Productivity & Persistence

- NMFS Status Assessment indicated a 0.52 risk of 90% decline in 25 years and a 0.72 risk of 90% decline in 50 years; the risk of extinction in 50 years was 0.58
- Evidence suggests few natural fall chinook juveniles are produced annually

Hatchery

- Grays River Hatchery located about RM 2 on the West Fork; hatchery began operation in 1961
- Hatchery releases of fall chinook in the basin began in 1947; Release data are displayed for 1967-97
- The Grays River Hatchery was used as an egg bank facility for North Toutle Hatchery fall chinook stock for several years after the eruption of Mt. St. Helens
- The Grays River Hatchery fall chinook program was discontinued in 1998 because of federal funding cuts
- A significant portion of past years fall chinook spawners in the Grays River were first generation hatchery fish from the Grays River Hatchery; the Grays River Hatchery adult returns were eliminated beginning in 2002

Harvest

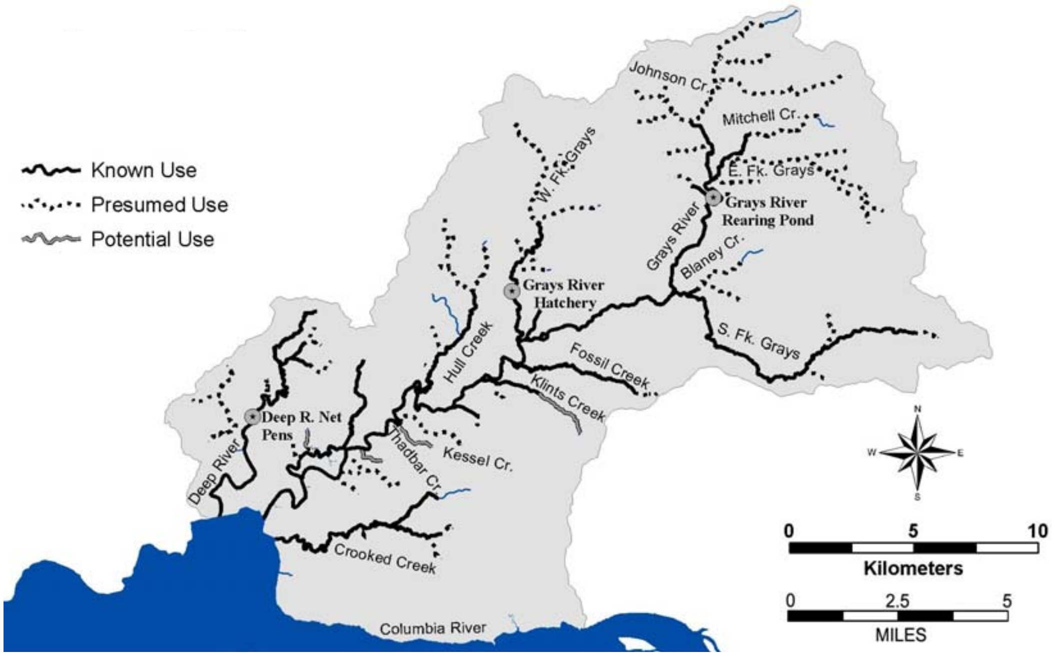
- Fall chinook are harvested in ocean commercial and recreational fisheries from Oregon to Alaska, and in Columbia River commercial gill net and sport fisheries
- Lower Columbia tule fall chinook are an important contributor to Washington ocean troll and sport fisheries and to the Columbia River estuary sport fishery
- Columbia River commercial harvest occurs primarily in September, but tule chinook flesh quality is low once they move from salt water; price is low compared to higher quality bright chinook
- CWT data analysis of the 1991-94 brood Grays River Hatchery chinook indicate a harvest rate of 54% of the Grays River stock

- The majority of the Grays River Hatchery fall chinook stock harvest occurred in Southern British Columbia (51.0%), Washington ocean (12.0%), and Columbia River (25.0%) fisheries
- Current annual harvest rate is dependent on management response to annual abundance in PSC (US/Canada), PFMC (US ocean), and Columbia River Compact forums
- Sport harvest in the Grays River averaged 156 fall chinook annually from 1981-1988. There is currently no tributary sport fishery for fall chinook in the Grays.
- Ocean and mainstem Columbia River fisheries are limited to a 49% harvest due to ESA limits on Coweeman tule fall Chinook

3.2.2 *Coho—Grays Subbasin*

ESA: Candidate 1995	**SASSI: Unknown 2002**

The historical Grays River/Chinook adult population is estimated from 5,000-40,000 fish, with the returns being late stock which spawn from late November to March. Specific population information is available for the Grays River but not the Chinook River returns. Current returns are unknown but assumed to be low. A number of hatchery produced fish spawn naturally. Natural spawning occurs primarily in upper mainstem and large tributaries throughout the basin. Juvenile rearing occurs upstream and downstream of spawning areas. Juveniles rear for a full year in these basins basin before migrating as yearlings in the spring.

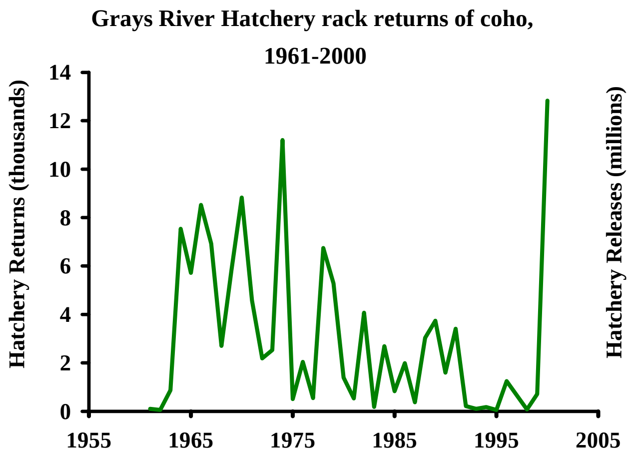


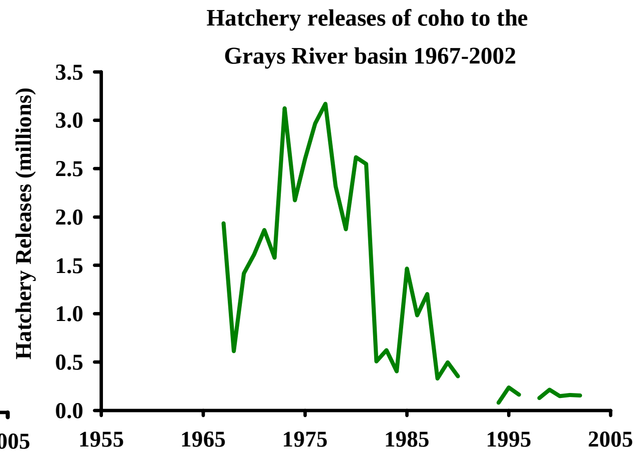
Distribution

- Managers refer to early stock coho as Type S due to their ocean distribution generally south of the Columbia River
- Managers refer to late coho as Type N due to their ocean distribution generally north of the Columbia River
- Potential natural spawning areas include the upper Grays, South Fork, West Fork, Crazy Johnson Creek, and Hull Creek
- Vicinity streams with coho spawning potential include Crooked Creek, Hitchcock Creek, and Jim Crow Creek

Life History

- Adults enter the Grays River from mid-August through February (early stock primarily from mid-August through September and late stock primarily from late September through November)
- Peak spawning occurs in late October for early stock and late November to January for late stock
- Adults return as 2-year-old jacks (age 1.1) or 3-year-old adults (age 1.2)
- Fry emerge in spring, spend one year in fresh water, and emigrate as age-1 smolts in the following spring





Diversity

- Late stock coho (or Type N) were historically present in the Grays basin with spawning occurring from late November into March
- Early stock coho (or Type S) are also present in the basin and are produced at Grays River Hatchery
- Columbia River early and late stock coho produced from Washington hatcheries are genetically similar

Abundance

- Grays River wild coho run is a fraction of its historical size
- USFWS surveys in 1936 and 1937 indicated coho presence in all accessible areas of the Grays River and its tributaries; no population estimate was made
- WDF estimated 2,500 natural spawning late coho in the Grays River in 1951
- Hatchery production accounts for most coho returning to Grays River

Productivity & Persistence

- Natural spawning of early stock coho is presumed to be very low; natural production of late stock coho is likely less then 15% of smolt density estimate
- Smolt density model estimated basin potential to be 125,874 smolts

Hatchery

- Grays River Hatchery is located about 2.5 miles upstream of Highway 4 on the West Fork; hatchery was completed in 1961; hatchery produces early stock coho
- Grays River Hatchery releases of early coho smolts ranged from about 500,000 to 3 million per year during 1967-87; the current program is reduced to 150,000 early coho smolts released annually

Harvest

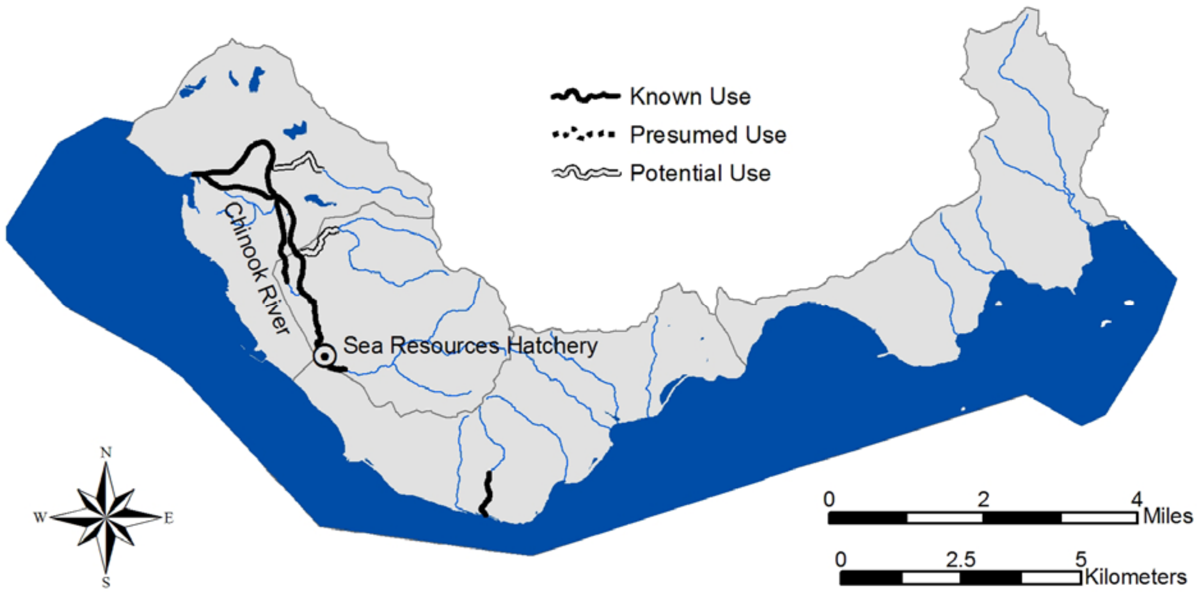
- Until recent years, natural produced Columbia River coho were managed like hatchery fish and subjected to similar harvest rates; ocean and Columbia River combined harvest rates ranged from 70% to over 90% during 1970-83
- Ocean fisheries were reduced in the mid 1980s to protect several Puget Sound and Washington coastal wild coho populations

- Columbia River commercial coho fishing in November was eliminated in the 1990s to reduce harvest of late Clackamas wild coho
- Since 1999, returning Columbia River hatchery coho have been mass marked with an adipose fin clip to enable fisheries to selectively harvest hatchery coho and release wild coho
- Natural produced lower Columbia River coho are beneficiaries of harvest limits aimed at Federal ESA listed Oregon Coastal coho and Oregon State listed Clackamas and Sandy River coho
- During 1999-2002, fisheries harvest of ESA listed coho was less than 15% each year
- Hatchery coho can contribute significantly to the lower Columbia River gill net fishery; commercial harvest of early coho is constrained by status of fall chinook and Sandy River coho management; commercial harvest of late coho is focused in October during the peak abundance of hatchery late coho
- A substantial estuary sport fishery exists between Buoy 10 and the Astoria-Megler Bridge; majority of the catch is early coho, but late coho harvest can also be substantial
- An average of 94 coho (1978-1986) were harvested annually in the Grays River sport fishery
- CWT data analysis of 1994, 1996, and 1997 brood early coho releases from Grays River Hatchery indicates 43% were captured in a fishery and 57% were accounted for in escapement
- Fishery CWT recoveries of 1994, 1996, and 1997 brood Grays early coho were distributed between Columbia River (58%), Oregon ocean (21%), Washington ocean (19%), and California ocean (1%) sampling areas

3.2.3 *Chum—Columbia River Estuary Tributaries Basin*

ESA: Threatened 1999	**SASSI: NA**

The historical Grays/Chinook adult population is estimated from 8,000-14,000 fish. Current returns range from 500-10,000 fish, with the vast majority in Grays River. In the Chinook River, natural spawning occurs in the lower 5 miles of the mainstem. Most fish are produced from Sea Resources Hatchery, which is using Grays River stock chum to supplement Chinook River chum natural production. Natural production also occurs in smaller estuary tributaries, most notably Jim Crow and Crooked creeks. Peak spawning occurs in late November-early December. Juveniles emerge in the early spring and migrate to the Columbia after a short rearing period..



Distribution

- Distribution data are not available for the Chinook River

Life History

- Lower Columbia River chum salmon run from mid-October through November; peak spawner abundance occurs in late November
- Dominant age classes of adults are age 3 and 4
- Fry emerge in early spring; chum emigrate as age-0 smolts with little freshwater time

Diversity

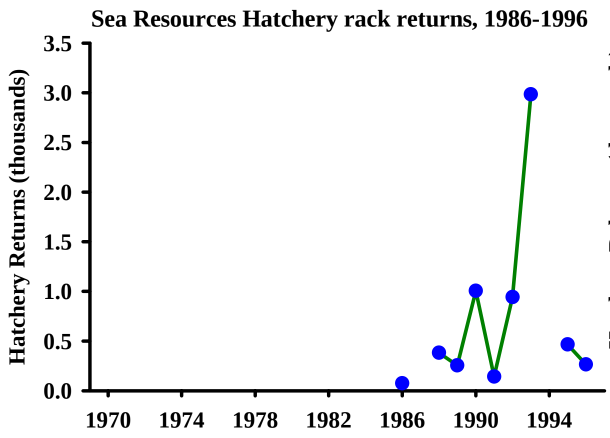
- Sea Resources Hatchery (on the Chinook River) brood stock has been taken from the Chinook, Nemah, Bear, and Naselle Rivers and other unknown stocks; current program produces only Grays River stock

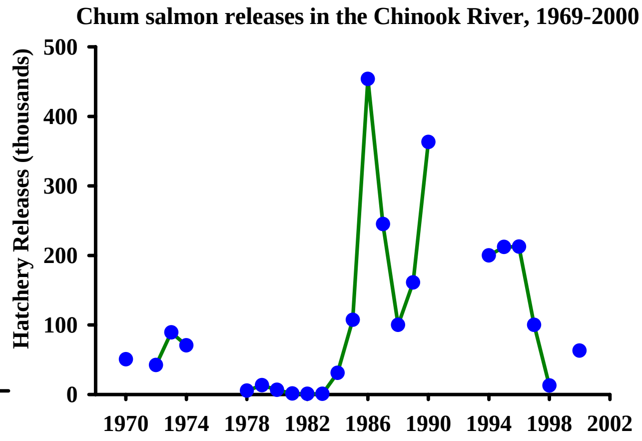
Abundance

- In 1951, estimated escapement to Crooked and Jim Crow Creeks was 1,200 chum
- In 2002 WDFW estimated natural spawning chum escapements of 11,713 in the Grays River and 53 in the Chinook River

Productivity & Persistence

- Chum salmon fecundity averaged 2,241 eggs per female at the Sea Resources Hatchery on the Chinook River between 1984–87





Hatchery

- Returns to the Sea Resources Hatchery from 1986–96 have ranged from 35 to 1,597 chum
- Sea Resources Hatchery began releasing chum salmon in the Chinook River in 1969; with local brood stock and also eggs transferred from Naselle, Nemah, and Bear Rivers
- Currently, Grays River stock is used at Sea Resources Hatchery and outside stocks are no longer transferred in

Harvest

- Currently very limited chum harvest occurs in the ocean and Columbia River and is incidental to fisheries directed at other species
- Columbia River commercial fishery historically harvested chum salmon in large numbers (80,000 to 650,000 in years prior to 1943); from 1965-1992 landings averaged less than 2,000 chum, and since 1993 less then 100 chum
- In the 1990s November commercial fisheries were curtailed and retention of chum was prohibited in Columbia River sport fisheries
- The ESA limits incidental harvest of Columbia River chum to less then 5% of the annual return

3.2.4 *Other Species*

Pacific lamprey – Information on lamprey abundance is limited and does not exist for the Grays/Chinook population. However, based on declining trends measured at Bonneville Dam and Willamette Falls it is assumed that Pacific lamprey have also declined in the Grays and Chinook rivers. The adult lamprey return from the ocean to spawn in the spring and summer. Spawning likely occurs in the small to mid-size streams of the basins. Juveniles rear in freshwater up to 6 years before migrating to the ocean.

3.3 Subbasin Habitat Conditions

This section describes the current condition of aquatic and terrestrial habitats within the basin. Descriptions are included for habitat features of particular significance to focal salmonid species including watershed hydrology, passage obstructions, water quality, key habitat availability, substrate and sediment, woody debris, channel stability, riparian function, and floodplain function. These descriptions will form the basis for subsequent assessments of the effects of habitat conditions on focal salmonids and opportunities for improvement.

3.3.1 *Watershed Hydrology*

The Chinook and Wallacut Rivers exhibit a rain-dominated flow regime, with high flows during fall and winter months and the lowest flows in late summer.

Intensive logging and road building in the 1970s potentially increased peak flow volumes in the Chinook and Wallacut River basins, though conditions are expected to improve as the forest matures. Low flow volumes are believed to be a natural condition in summer months. The impacts of flow diversions at the Sea Resources Hatchery and at the City of Chinook water supply intake are largely unknown (Wade 2002).

Results of the Integrated Watershed Assessment (IWA), which are presented in greater detail later in the chapter, indicate that the Wallacut and lower Chinook River subwatersheds are "moderately impaired" with respect to landscape conditions influencing runoff. The upper Chinook basin is rated as "impaired" and the remainder of the estuary tributary basins are rated as functional. Hydrologic impairments are related to the immature forest vegetation and the moderately high road densities in these basins (>2 mi/mi^2).

3.3.2 *Passage Obstructions*

Tidegates on the Chinook and Wallacut Rivers restrict passage. Efforts are underway to remove the tidegate at the mouth of the Chinook River (Figure 3). On Freshwater Creek, the City of Chinook's water supply dam restricts passage. The Sea Resources hatchery at river mile (RM) 4 on the Chinook River restricts passage during fall runs. A mix of wild and hatchery fish are passed above the hatchery. Many of the small streams between the towns of Knappton and Chinook once supported significant runs of salmon but access is currently blocked by culverts under Highways 401 and 101. Eight culverts in this area are currently scheduled for removal.

Figure 3. Tide gate at the mouth of the Chinook River

3.3.3 *Water Quality*

Little information exists on water quality conditions in the Chinook and Wallacut Rivers. Temperatures in excess of 68°F (20°C) have been measured in the Chinook just above the tidegates, but temperature monitoring at the hatchery has not exceeded 61°F (16º C) in recent years. Turbidity is believed to be a problem in the upper basin. The reduction in the number of returning fish may be limiting nutrient levels in the system (Wade 2002).

3.3.4 *Key Habitat Availability*

No data has been collected on pool habitat in the Chinook and Wallacut Rivers. Common evaluation criteria would not apply in the tidally-influenced reaches. Pool habitat in the middle and upper Chinook basin is believed to be fair to good, with beavers playing a large role in pool creation and maintenance (Wade 2002). Side channel habitat has been mostly eliminated in the lower reaches of the Chinook due to diking and filling. Side channels are present above tidal influence to the hatchery (RM 4), but side channel habitat is considered poor up to the headwaters (Wade 2002). Data on pools and side channel habitat on other estuary tributaries is lacking.

3.3.5 *Substrate & Sediment*

In the Chinook River, excessive fine sediment concentrations are considered a problem in the chum spawning area between tidal influence and the hatchery. Spawning substrates above the hatchery are believed to be in fair condition with regard to fines. Information is lacking for other areas (Wade 2002).

Extensive road building and logging occurred in the upper Chinook basin in the 1970s and more than 30 landslides and debris flows visible on 1974 aerial photographs contributed large volumes of sediment to stream channels (Dewberry 1997 as cited in Wade 2002). The Limiting Factors Analysis Technical Advisory Group (TAG) noted that continuing stream sediment delivery may still be related to these activities, with current sediment problems related to ATV recreational vehicle use (Wade 2002).

Results of the IWA, which are presented in greater detail later in the chapter, indicate that 1 of the 4 estuary tributary subwatersheds are "impaired" with respect to landscape conditions influencing sediment supply. The remaining 3 subwatersheds are rated as "moderately impaired". The greatest impairments are in the small tributary basins between the towns of Knappton and Chinook, where road densities are the highest.

Sediment production from private forest roads is expected to decline over the next 15 years as roads are updated to meet the new forest practices standards, which include ditchline disconnect from streams and culvert upgrades. The frequency of mass wasting events should also decline due to the new regulations, which require geotechnical review and mitigation measures to minimize the impact of forest practices activities on unstable slopes.

3.3.6 *Woody Debris*

Accumulations of large woody debris (LWD) were once common in the lower Chinook River but few remain (Dewberry 1997 as cited in Wade 2002). Poor riparian conditions in the upper basin and the tidegate at the mouth of the Chinook River restrict potential recruitment. Data for other tributaries is lacking, though LWD conditions are believed to be poor (Wade 2002).

3.3.7 *Channel Stability*

Standard metrics of bank stability do not apply to the lower, estuarine portion of the Chinook River. What was once a tidal marsh is now a single-thread stable channel confined by dikes. Cattle have access to portions of the lower river and in places may impact bank stability. Bank erosion is high in agricultural land due to incision, alluvial soils, and a lack of vegetation on the streambanks. Little information exists for bank stability in upstream reaches, although conditions are believed to be fair to good (Wade 2002).

3.3.8 *Riparian Function*

The large trees in the lower riparian areas of the Chinook River were cut in the early days of settlement (Dewberry 1997 as cited in Wade 2002), and riparian forests in the upper basin were harvested heavily in the 1970s. Today, riparian conditions are poor throughout the basin, with agricultural lands in the lower basin and young stands in the upper basin. Deciduous species and reed canary grass dominate (Wade 2002).

Riparian function is expected to improve over time on private forestlands. This is due to the requirements under the Washington State Forest Practices Rules (Washington Administrative Code Chapter 222). Riparian protection has increased dramatically today compared to past regulations and practices..

3.3.9 *Floodplain Function*

The installation of a tidegate at the mouth of the Chinook River in the 1920s and subsequent diking, dredging, and removal of logjams has degraded floodplain connectivity. Before these activities, the lower portion of the river consisted of a wide lowland marsh with numerous ponds (Dewberry 1997 as cited in Wade 2002). Diking is prevalent upstream to RM 4, and problems with channel incision extend to the headwaters (Wade 2002). A coalition of non-profit groups and government agencies is attempting to restore 80% of the original Chinook River estuary habitat (Wade 2002).

3.4 Stream Habitat Limitations

Due to the small size of the Estuary Tributaries Basin, an in-depth stream habitat assessment was not conducted using EDT. The habitat information that was used to generate priority measures and actions for the Management Plan was obtained from existing studies and from the watershed process assessment (IWA) that follows.

3.5 Watershed Process Limitations

This section describes watershed process limitations that contribute to stream habitat conditions significant to focal fish species. Reach level stream habitat conditions are influenced by systemic watershed processes. Limiting factors such as temperature, high and low flows, sediment input, and large woody debris recruitment are often affected by upstream conditions and by contributing landscape factors. Accordingly, restoration of degraded channel habitat may require action outside the targeted reach, often extending into riparian and hillslope (upland) areas that are believed to influence the condition of aquatic habitats.

Watershed process impairments that affect stream habitat conditions were evaluated using a watershed process screening tool termed the Integrated Watershed Assessment (IWA). The IWA is a GIS-based assessment that evaluates watershed impairments at the subwatershed scale (3,000 to 12,000 acres). The tool uses landscape conditions (i.e. road density, impervious surfaces, vegetation, soil erodability, and topography) to identify the level of impairment of 1) riparian function, 2) sediment supply conditions, and 3) hydrology (runoff) conditions. For sediment and hydrology, the level of impairment is determined for local conditions (i.e. within subwatersheds, not including upstream drainage area) and at the watershed level (i.e. integrating the entire drainage area upstream of each subwatershed). See Appendix E for additional information on the IWA.

The Columbia Estuary Tributaries Basin is divided into 4 IWA subwatersheds. The westernmost subwatershed encompasses the Wallacut River basin. The Chinook River basin lies within the 2 middle subwatersheds and the easternmost subwatershed contains several small tributaries between the communities of Chinook and Knappton. IWA results for the Columbia Estuary Tributaries watershed are shown in Table 2. A reference map showing the location of each subwatershed in the basin is presented in Figure 4. Maps of the distribution of local and watershed level IWA results are displayed in Figure 5.

3.5.1 *Hydrology*

Current Conditions.— Of the four subwatersheds comprising the Columbia Estuary Tributaries Unit, one is rated functional for IWA hydrologic conditions, two are moderately impaired, and one is classified as impaired. Overall, the watershed has very low mature vegetation cover (less than 10%), and hydrology conditions are primarily driven by road densities. The functional subwatershed (30503) is comprised of small independent streams lying at the east end of the basin, and has few roads. The upstream portion of the Chinook River has the highest road density (3.3 mi/mi^2), hence its impaired rating. Lastly, the moderately impaired subwatersheds situated in the west have road densities between 2 and 3 mi/mi^2. Because the drainages associated with these subwatersheds are small, independent, and primarily terminal systems, watershed level results matched the results from the local level analysis.

Predicted Future Trends.— Low levels of public ownership, low levels of mature forest cover, moderate to high road densities, and increasing development pressure are likely to lead to more degradation within this watershed. However, the subwatersheds are also highly influenced by tidal processes and are covered by large areas of wetland and floodplain. These factors will help dampen impacted hydrology, and control residential, commercial, and agricultural expansion. Overall, the trend in hydrologic conditions for the Columbia Estuary Tributaries watershed is expected to remain stable or slightly decline over time. Public and private actions to encourage wetland protection, road retirement, reconnection of the floodplain and riparian and wetland restoration should be encouraged.

Table 2. IWA results for the Columbia Estuary Tributaries Watershed

Subwatershed[a]	Local Process Conditions[b]			Watershed Level Process Conditions[c]		Upstream Subwatersheds[d]
	Hydrology	Sediment	Riparian	Hydrology	Sediment	
30501	M	M	ND	M	M	none
30502	M	M	ND	M	M	none
30503	F	I	ND	F	I	none
30504	I	M	ND	I	M	none

Notes:
[a] LCFRB subwatershed identification code abbreviation. All codes are 14 digits starting with 170800030#####.
[b] IWA results for watershed processes at the subwatershed level (i.e., not considering upstream effects). This information is used to identify areas that are potential sources of degraded conditions for watershed processes, abbreviated as follows:
F: Functional
M: Moderately impaired
I: Impaired
ND: Not evaluated due to lack of data
[c] IWA results for watershed processes at the watershed level (i.e., considering upstream effects). These results integrate the contribution from all upstream subwatersheds to watershed processes and are used to identify the probable condition of these processes in subwatersheds where key reaches are present.
[d] Subwatersheds upstream from this subwatershed.

Figure 4. Map of the Columbia estuary tributaries basin showing the location of the IWA subwatersheds.

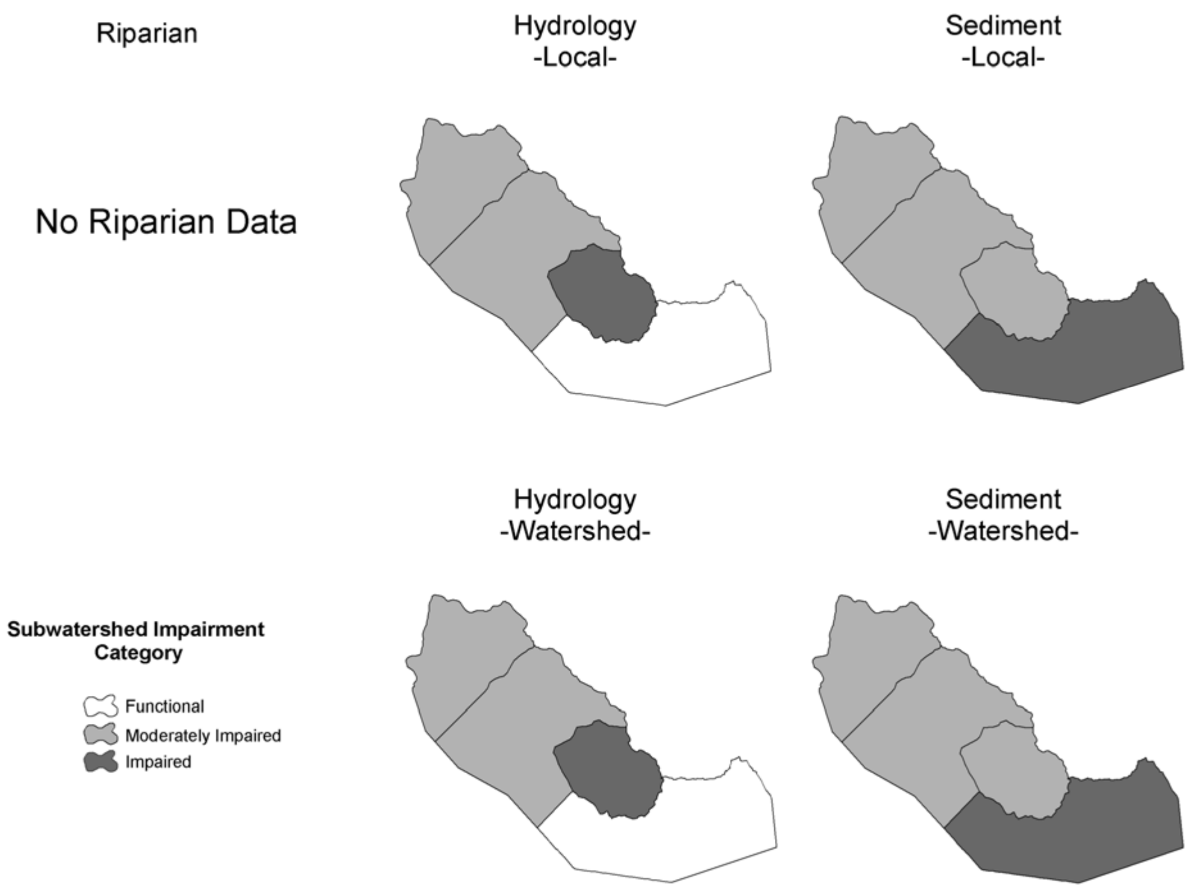


Figure 5. IWA subwatershed impairment ratings by category for the Columbia estuary tributaries basin

3.5.2 *Sediment Supply*

Current Conditions — Local sediment conditions fall primarily into the moderately impaired category, with one case of impaired conditions. The impaired subwatershed is located at the east end of the basin (30503). As with hydrologic conditions, the IWA watershed level sediment conditions are the same as the local level ratings.

Predicted Future Trends — Although sediment conditions are rated as moderately impaired or impaired in these subwatersheds, the estuarine character, coupled with moderate road densities, low to moderate stream side road density and stream crossings suggest that conditions in this subwatershed may well improve on the 20 year timescale. Management recommendations include those actions discussed for hydrology.

3.5.3 *Riparian Condition*

Current Conditions — Riparian condition data was not available for the four subwatersheds in the Columbia Estuary Tributaries watershed, including the Chinook River drainage.

Predicted Future Trends — Due to a lack of riparian data for this watershed, riparian conditions were not analyzed as part of IWA. However, additional knowledge of the basin allows for some speculation about streamside trends.

The majority of the lower Chinook River mainstem has been channelized through diking. The dikes and ditches have resulted in drained wetlands and lost side-channel habitat. Similar issues exist for the lower portions of the Wallacut, although to a lesser degree. While dikes and other channel revetments remain in place, the potential for riparian recovery will be severely constrained. However, conservation easements and other public-private partnerships (such as those already being developed by the Columbia Trust in the Grays River system) offer some promise that floodplain dynamics and riparian conditions in these critical estuarine areas may in fact improve over the next 20 years.

3.6 Other Factors and Limitations

3.6.1 *Hatcheries*

Hatcheries currently release over 50 million salmon and steelhead per year in Washington lower Columbia River subbasins. Many of these fish are released to mitigate for loss of habitat. Hatcheries can provide valuable mitigation and conservation benefits but may also cause significant adverse impacts if not prudently and properly employed. Risks to wild fish include genetic deterioration, reduced fitness and survival, ecological effects such as competition or predation, facility effects on passage and water quality, mixed stock fishery effects, and confounding the accuracy of wild population status estimates. This section describes hatchery programs in the Grays/Chinook Basin and discusses their potential effects.

Sea Resources Hatchery

The Sea Resources Hatchery on RM 4.8 of the Chinook River is operated by the non-profit Sea Resources Watershed Learning Center. The facility has produced fall Chinook, coho, and chum salmon. The Sea Resources Hatchery was completed in 1895. Since 1996, the goal of the hatchery programs is to restore naturally reproducing populations of salmon in the Chinook River in conjunction with habitat restoration projects. Annual hatchery release goals for fall Chinook, chum, and coho from the Sea Resources Hatchery are shown in Table 3.

Tule fall Chinook were released in the basin as early as 1893; the program was discontinued in 1935, restarted in 1968, and is ongoing today. Current release goals are approximately 110,000 fall Chinook fingerling; larger releases occur if hatchery incubation and rearing mortality is less than the expected 25%.

Chum salmon from the Willapa Bay broodstock were released into the basin from 1969 to 1993: beginning in 1999, chum salmon from Grays River broodstock have been released. Annual releases of chum salmon into the Chinook River generally have been around 100,000-200,000; the largest release of chum salmon (~450,000) occurred in 1986. The current production goal for this program is 147,500 juveniles per year (Table 3). Hatchery rack returns have generally been under 1,000 adults; the current chum population is not self-sustaining.

Table 3. Estuary Tributary and Grays River Hatchery Production.

Hatchery	Release Location	Spring Chinook	Fall Chinook	Coho	Chum
Grays River	Deep River			200,000	
Cowlitz Salmon or Lewis Salmon	Deep River	200,000			
Sea Resources	Chinook River		107,500	52,000	147,500

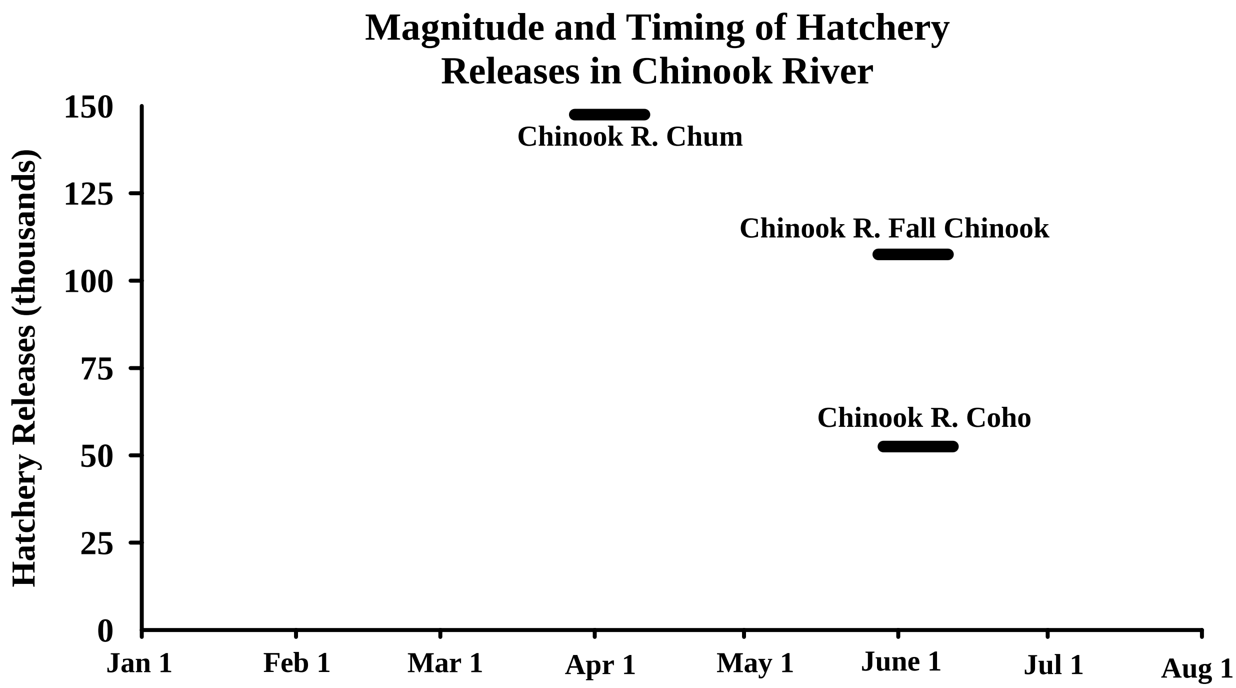


Figure 6. Magnitude and timing of hatchery releases in the Chinook River basins by species, based on 2003 brood production goals.

Hatchery Effects

Genetics—Broodstock for the historical (late 1800s/early 1900s) fall chinook hatchery program at the Sea Resources Hatchery was obtained from fish traps distributed on the lower Columbia River. There is some uncertainty in the origin of broodstock for the fall chinook hatchery program that restarted in 1968; Spring Creek National Fish Hatchery (NFH) tule fall chinook may have been used to start the program. Current broodstock collection comes from adults returning to the hatchery, except in years of hatchery return shortfalls. In 1989 and 1994, eggs were transferred from the Washougal River Hatchery to meet hatchery production goals.

Broodstock for the coho salmon hatchery program at the Sea Resources Hatchery was derived from lower Columbia early coho stock; current broodstock collection comes from adults returning to the hatchery.

Chum salmon broodstock for the Sea Resources Hatchery had historically been taken from the Chinook, Nemah, Bear, Naselle, and other unknown rivers. Use of multiple broodstocks over time can result in one homogenous population with some characteristics from each broodstock. However, most chum stocks used in the Sea Resources Hatchery have been from local rivers, which likely had similar characteristics originally. Currently, the program only uses Grays River chum stock and thus has reduced any genetic mixing among broodstock from multiple locations and eliminated stocks from outside the Columbia basin. The Grays River chum stock is one of the primary wild chum salmon populations remaining in the lower Columbia River.

Interactions—Historical hatchery fall chinook and coho returns to the Sea Resources Hatchery have been low. Prior to 1996, all fall chinook and coho salmon captured at the hatchery were utilized for broodstock or surplused; no fish were returned to the river and allowed to spawn naturally. Beginning in 1996, approximately half of the small hatchery return has been allowed to spawn naturally in the Chinook River but competition with wild fall chinook or coho adults is likely to be limited because few wild fish are present.

Wild chum salmon are at low levels throughout the lower Columbia River and few wild chum salmon have been observed in the Chinook River. Most of the hatchery chum return is utilized for broodstock and few hatchery fish escape to spawn naturally so wild and hatchery chum salmon interactions in the Chinook River are likely minimal. Predation by chinook and coho smolts on naturally produced chum fry is likely negligible because releases are made in June after chum juveniles have left the watershed.

Water Quality/Disease—Water for the facility comes entirely from the Chinook River; the water intake is located approximately 0.6 miles upstream of the facility and is piped via gravity flow. Hatchery effluent is released to a settling pond to remove most of the suspended solids before the water is discharged to the Chinook River.

Fish health is monitored through compliance with the Co-Managers Fish Health Policy procedures. Fish receive a pathology screening by a WDFW pathologist prior to release.

Mixed Harvest—Historically, exploitation rates of hatchery and wild fall chinook and coho were likely similar. Fall chinook and coho are an important target species in ocean and Columbia River commercial and recreational fisheries, as well as tributary recreational fisheries. Regulations for wild fish release have been in place for coho fisheries in recent years, and all coho released from the hatchery are adipose fin-clipped to allow for selective harvest. Specific hatchery-selective commercial and recreational fisheries in the lower Columbia target hatchery coho. Therefore, in recent years the exploitation rates of coho by commercial and recreational fisheries are higher for Sea Resources Hatchery coho than wild fish. Hatchery and wild fall chinook harvest rates remain similar and are constrained by ESA harvest limitations.

There are no directed chum salmon fisheries on lower Columbia River chum stocks. Minor incidental harvest occurs in fisheries targeting fall chinook and coho. Retention of wild chum salmon in the lower Columbia River is prohibited. There probably is little difference in fishery exploitation rates of lower Columbia River wild and Sea Resources Hatchery chum salmon.

Passage—The adult collection facility at the Sea Resources Hatchery consists of a 12’x12’ weir trap with a “V” entrance; fish are transferred from the trap to holding pens for broodstock collection. During low flow conditions, the weir captures the majority of adults returning to the hatchery. During high flow conditions, there is a channel where returning adults can bypass the hatchery weir trap and continue upstream.

Supplementation—Prior to 1996, Sea Resources’ hatchery management practices were based on the premise that the hatchery could compensate for the nearly complete lack of natural production in the Chinook River system. However, in spite of significant hatchery releases, the numbers of returning adults were consistently poor, averaging about 0.1%. In 1996, the hatchery management strategy shifted from mass production towards rearing smaller numbers of fish, preparing them for the natural environment, and restoring conditions in the watershed to better support juvenile salmon rearing and natural production. The goal of the hatchery programs at the Sea Resources Hatchery is to restore naturally reproducing populations of salmonids in the Chinook River in conjunction with habitat restoration projects.

Deep River Hatchery Programs

While there are no hatcheries in Deep River, two net pen programs are operating. The Deep River spring chinook net pen program works in conjunction with the Cowlitz and Lewis Salmon Hatcheries; current release goals are 200,000 yearling spring Chinook (Figure 7). The Deep River early run coho net pen program works in cooperation with the Grays River Hatchery; current release goals 400,000 (type-S) yearling coho (Figure 7).

The main threats associated with the Deep River programs are potential domestication of natural produced coho if non harvested adults stray to adjacent streams, and possible ecological interactions between hatchery released juveniles and natural produced juvenile salmon. There is no known natural salmon or steelhead production in the Deep River basin.

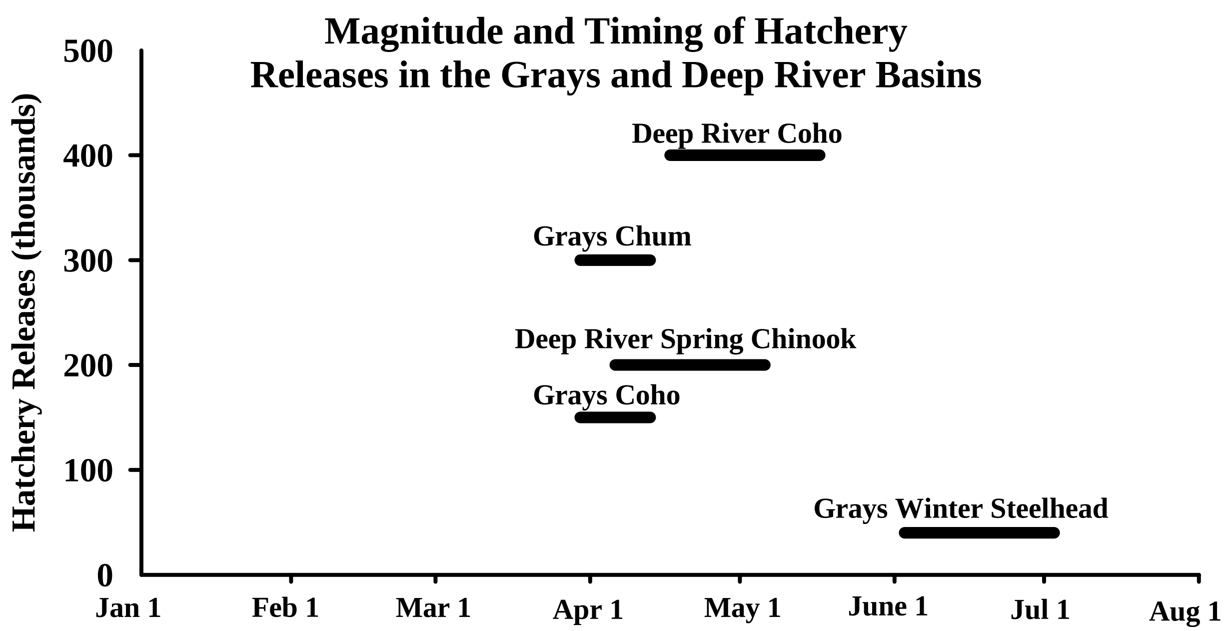


Figure 7.Magnitude and timing of hatchery releases in the Deep River and Grays River basins by species, based on 2003 brood production goals

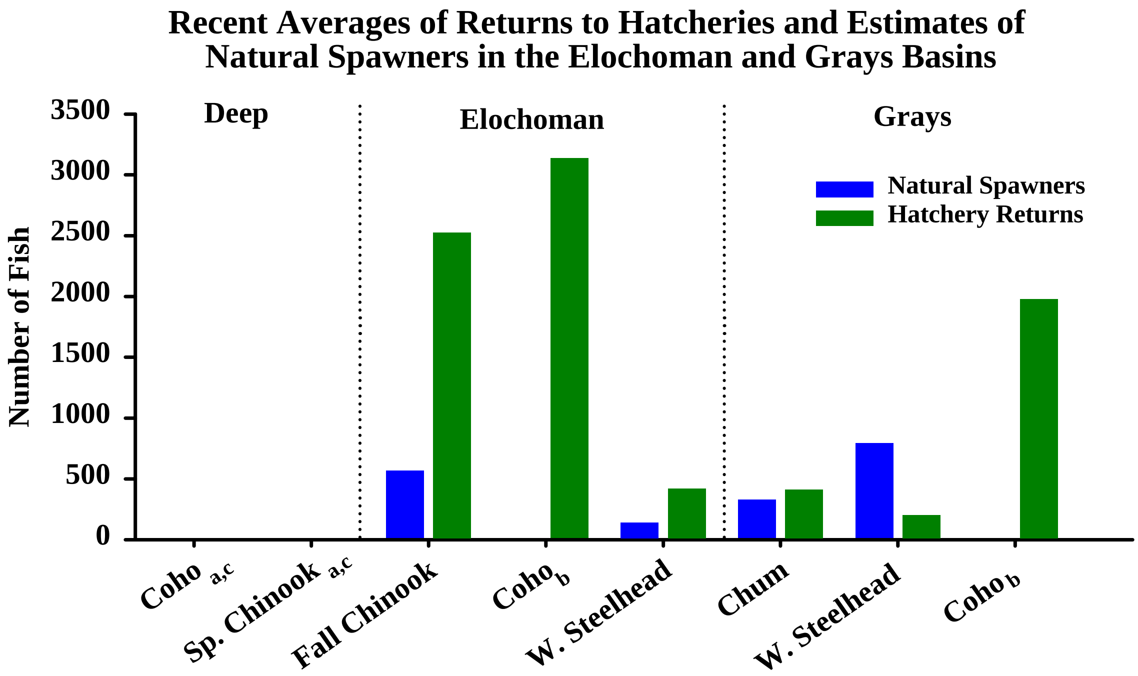


Figure 8. Recent average hatchery returns and estimates of natural spawning escapement in the Deep, Grays, and Elochoman River basins by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement for a particular species and basin were derived from the same years in all cases. All data were from 1992 to the present. Calculation of each average utilized a minimum of 5 years of data, except for Grays chum (1998–2000) and Grays winter steelhead (1998 and 2000).

Hatchery Effects

Genetics—The Deep River spring Chinook net pen program receives juvenile spring Chinook from the Cowlitz and Lewis salmon hatcheries. The WDFW management plan for the spring Chinook program precludes the use of other stocks (such as Willamette spring Chinook) to assure that outside stocks do not have the opportunity to spawn in Washington tributaries of the lower Columbia River. The Deep River coho net pen program receives juvenile coho salmon from the Grays River Hatchery; broodstock comprises adults returning to the hatchery. Specific information on broodstock development for these hatcheries can be found in the appropriate sections below describing hatchery activities in the Grays and Cowlitz River basins.

Interactions—The presence of wild spring Chinook and early run coho in the Deep River basin is nominal (Figure 8). Hatchery juvenile spring Chinook and coho are contained in net pens and released into the system as smolts. The Deep River is a short river basin and hatchery smolts are expected to migrate through the basin rapidly and disperse throughout the lower Columbia River mainstem. Interaction and competition between hatchery and wild adults or juveniles in the Deep River basin is expected to be minimal. To limit the potential for predation, surveys are conducted to determine when chum fry have emigrated from the area, prior to coho release from the net pens.

Water Quality/Disease—The Deep River Net Pens are located directly in the Deep River and the river supplies all water to these programs. Specific information on disease occurrence and treatment in the adult collection, incubation, and early rearing phases can be found in the

Cowlitz and Grays River sections below for the spring Chinook and coho programs, respectively.

Mixed Harvest—The purpose of each Deep River net pen program is to provide fish for isolated harvest opportunity in the Deep River basin. However, these hatchery programs benefit other fisheries as well. Spring Chinook are an important target species in Columbia River commercial and recreational fisheries and tributary recreational fisheries. All Deep River net pen spring Chinook and coho are adipose fin-clipped. Coho salmon are an important target species in ocean and Columbia River commercial and recreational fisheries, as well as tributary recreational fisheries. Wild fish release regulations are in place for commercial and recreational fisheries in the lower Columbia River, as well as some ocean fisheries. Specific hatchery-selective commercial and recreational fisheries in the lower Columbia target hatchery spring Chinook and coho. Therefore, recent exploitation rates by commercial and recreational fisheries are higher for Deep River Net Pen spring Chinook and coho compared to wild fish. However, recent commercial and sport harvest in the terminal areas has not been as high as desired so the programs are being reviewed.

Passage—Adult hatchery fish are not collected in the Deep River, so there are no adult passage concerns. Description of the adult collection facilities at the Grays River and Cowlitz Salmon hatcheries can be found in the sections on those basins.

Supplementation—Supplementation is not the purpose of the spring Chinook or coho net pen programs in Deep Creek; these fish are produced for harvest opportunities.

Biological Risk Assessment

The evaluation of hatchery programs and implementation of hatchery reform in the Lower Columbia is occurring through several processes. These include: 1) the LCFRB recovery planning process; 2) Hatchery Genetic Management Plan (HGMP) preparation for ESA permitting; 3) FERC related plans on the Cowlitz River and Lewis River; and 4) the federally mandated Artificial Production Review and Evaluation (APRE) process. Through each of these processes, WDFW is applying a consistent framework to identify the hatchery program enhancements that will maximize fishing-related economic benefits and promote attainment of regional recovery goals. Developing hatcheries into an integrated, productive, stock recovery tool requires a policy framework for considering the acceptable risks of artificial propagation, and a scientific assessment of the benefits and risks of each proposed hatchery program. WDFW developed the Benefit-Risk Assessment Procedure (BRAP) to provide that framework. The BRAP evaluates hatchery programs in the ecological context of the watershed, with integrated assessment and decisions for hatcheries, harvest, and habitat. The risk assessment procedure consists of five basic steps, grouped into two blocks:

Policy Framework

- Assess population status of wild populations
- Develop risk tolerance profiles for all stock conditions
- Assign risk tolerance profiles to all stocks

Risk Assessment

- Conduct risk assessments for all hatchery programs
- Identify appropriate management actions to reduce risk

Following the identification of risks through the assessment process, a strategy is developed to describe a general approach for addressing those risks. Building upon those strategies, program-specific actions and an adaptive management plan are developed as the final steps in the WDFW framework for hatchery reform.

Table 4 identifies hazards levels associated with risks involved with hatchery programs in the Columbia Estuary Tributaries / Grays River Basin. Table 5 identifies preliminary strategies proposed to address risks identified in the BRAP for the same populations.

The BRAP risk assessments and strategies to reduce risk have been key in providing the biological context to develop the hatchery recovery measures for lower Columbia River sub-basins.

Table 4. Preliminary BRAP for hatchery programs affecting populations in the Columbia Estuary Tributaries / Grays River Basin.

Symbol	Description
○	Risk of hazard consistent with current risk tolerance profile.
?	Magnitude of risk associated with hazard unknown.
●	Risk of hazard exceeds current risk tolerance profile.
░	Hazard not relevant to population

Grays/Chinook Population	Hatchery Program: Name	Release (millions)	Genetic: Effective Population Size	Genetic: Domestication	Genetic: Diversity	Ecological: Predation	Ecological: Competition	Ecological: Disease	Demographic: Survival Rate	Demographic: Reproductive Success	Facility: Catastrophic Loss	Facility: Passage	Facility: Screening	Facility: Water Quality
Fall Chinook	Sea Resources Fall Chinook	0.041	○	○	○	○	?	○	○	?	○	○	○	○
	Deep Net Pens Sp. Chinook 1+	0.330	░	░	░	?	?	○	░	░	░	○	○	○
	Grays Coho 1+	0.150	░	░	░	?	?	○	░	░	░	○	○	○
	Deep Net Pens Coho 1+	0.200	░	░	░	?	?	○	░	░	░	○	○	○
	Grays Winter Steelhead 1+	0.040	░	░	░	?	?	○	░	░	░	○	○	○
	Grays Chum	0.150	░	░	░	○	○	○	░	░	░	○	○	○
	Chinook Chum	0.050	░	░	░	○	○	○	░	░	░	○	○	○
Winter Steelhead	Sea Resources Fall Chinook	0.041	░	░	░	○	?	○	░	░	░	○	○	○
	Deep Net Pens Sp. Chinook 1+	0.330	░	░	░	?	?	○	░	░	░	○	○	○
	Grays Coho 1+	0.150	░	░	░	?	?	○	░	░	░	○	○	○
	Deep Net Pens Coho 1+	0.200	░	░	░	?	?	○	░	░	░	○	○	○
	Grays Winter Steelhead 1+	0.040	○	○	?	?	?	○	░	░	░	○	○	○
	Grays Chum	0.150	░	░	░	○	○	○	░	░	░	○	○	○
	Chinook Chum	0.050	░	░	░	○	○	○	░	░	░	○	○	○
Chum	Sea Resources Fall Chinook	0.041	░	░	░	?	○	○	░	░	░	○	○	○
	Deep Net Pens Sp. Chinook 1+	0.330	░	░	░	?	○	○	░	░	░	○	○	○
	Grays Coho 1+	0.150	░	░	░	?	○	○	░	░	░	○	○	○
	Deep Net Pens Coho 1+	0.200	░	░	░	?	○	○	░	░	░	○	○	○
	Grays Winter Steelhead 1+	0.040	░	░	░	?	○	○	░	░	░	○	○	○
	Grays Chum	0.150	○	○	○	○	○	○	○	?	○	○	○	○
	Chinook Chum	0.050	○	○	○	○	○	○	○	?	○	○	○	○

Table 5. Preliminary strategies proposed to address risks identified in the BRAP for Columbia Estuary Tributaries / Grays River Basin populations.

	Hatchery Program		Risk Assessment of Hazards														
			Address Genetic Risks					Address Ecological Risks				Address Demographic Risks		Address Facility Risks			
Grays/Chinook Population	Name	Release (millions)	Mating Procedure	Integrated Program	Segregated Program	Research/ Monitoring	Broodstock Source	Number Released	Release Procedure	Disease Containment	Research/ Monitoring	Culture Procedure	Research/ Monitoring	Reliability	Improve Passage	Improve Screening	Pollution Abateme
Fall Chinook	Sea Resources Fall Chinook	0.041															
	Deep Net Pens Sp. Chinook 1+	0.330									●						
	Grays Coho 1+	0.150						●	●		●						
	Deep Net Pens Coho 1+	0.200															
	Grays Winter Steelhead 1+	0.040						●	●		●						
	Grays Chum	0.150															
	Chinook Chum	0.050															

Impact Assessment

The potential significance of negative hatchery impacts within the basin on natural populations was estimated with a simple index based on: 1) intra-specific effects resulting from depression in wild population productivity that can result from interbreeding with less fit hatchery fish and 2) inter-specific effects resulting from predation of juvenile salmonids of other species. The index reflects only a portion of net hatchery effects but can provide some sense of the magnitude of key hatchery risks relative to other limiting factors. Fitness effects are among the most significant intra-specific hatchery risks and can also be realistically quantified based on hatchery fraction in the natural spawning population and assumed fitness of the hatchery fish relative to the native wild population. Predation is among the most significant inter-specific effects and can be estimated from hatchery release numbers by species. This index assumed that equilibrium conditions have been reached for the hatchery fraction in the wild and for relative fitness of hatchery and wild fish. This simplifying assumption was necessary because more detailed information is lacking on how far the current situation is from equilibrium. The index does not consider the numerical benefits of hatchery spawners to natural population numbers, ecological interactions between hatchery and wild fish other than predation, or out-of-basin interactions, all of which are difficult to quantify. Appendix E contains a detailed description of the method and rationale behind this index.

The indexed potential for negative impacts of hatchery spawners on wild population fitness in the Chinook River was extrapolated from from Grays River hatchery fractions. The estimated fitness effects is quite low (2.5%) for chum where broodstock are naturally-derived and the program is operated for conservation purposes. Fitness impact potential is estimated to be greater for the Chinook and coho reintroduction programs in the Chinook River, as broodstock is not as far removed from hatchery stock as the chum program. However, the high incidence of fall Chinook and coho hatchery spawners suggests that the fitness of natural and hatchery fish is now probably quite similar and natural populations might decline substantially without continued hatchery subsidy under current habitat conditions. Interspecific impacts from predation appear to be less than 1% for all species. Hatchery impacts to Grays River populations can be found in the Grays River Subbasin Plan.

Table 6. Presumed reductions in wild population fitness as a result of natural hatchery spawners and survival as a result of interactions with other hatchery species for Chinook River salmon and steelhead populations.

Population	Annual releases[a]	Hatchery fraction[b]	Fitness category[c]	Assumed fitness[d]	Fitness impact[e]	Interacting releases[f]	Interspecies impact[g]
Fall Chinook	107,500[h]	0.37	3	0.5	0.18	52,000	0.003
Chum	117,500,[i]	0.25	1	0.9	0.025	0	0.000
Coho	52,000[j]	0.95	3	0.5	0.48	52,000	0.0007

[a] Annual release goals.
[b] Proportion of natural spawners that are first generation hatchery fish. No information specific to Chinook River. Assumed same as Grays River fraction.
[c] Broodstock category: 1 = derived from native local stock, 2 = domesticated stock of native local origin, 3 = originates from same ESU but substantial divergence may have occurred, 4 = out-of-ESU origin or origin uncertain
[d] Productivity of naturally-spawning hatchery fish relative to native wild fish prior to significant hatchery influence. Because population-specific fitness estimates are not available for most lower Columbia River populations, we applied hypothetical rates comparable to those reported in the literature and the nature of local hatchery program practices.
[e] Index based on hatchery fraction and assumed fitness.
[f] Number of other hatchery releases with a potential to prey on the species of interest. Includes steelhead and coho for fall chinook and coho. Includes steelhead for chum.
[g] Predation impact based on interacting releases and assumed species-specific predation rates.

[h] Number refers to fall chinook hatchery program underway to restore a naturally producing population in the Chinook River. The Grays River fall chinook hatchery program stopped releasing smolts in 1998; hatchery returns were expected to significantly diminish starting with the 2002 return.
[i] Releases include 147,500 to restore a Chinook River population.
[j] Comprised of early coho (type S) released in the Grays, Deep, and Chinook Rivers from the Grays River and Sea Resources Hatcheries.

3.6.2 *Harvest*

Fishing generally affects salmon populations through directed and incidental harvest, catch and release mortality, and size, age, and run timing alterations because of uneven fishing on different run components. From a population biology perspective, this can result in fewer spawners and can alter age, size, run timing, fecundity, and genetic characteristics. Fewer spawners result in fewer eggs for future generations and diminish marine-derived nutrients delivered via dying adults, now known to be significant to the growth and survival of juvenile salmon in aquatic ecosystems. The degree to which harvest-related limiting factors influence productivity varies by species and location.

Most harvest of wild Columbia River salmon and steelhead occurs incidental to the harvest of hatchery fish and healthy wild stocks in the Columbia estuary, mainstem, and ocean. Fish are caught in the Canada/Alaska ocean, U.S. West Coast ocean, lower Columbia River commercial and recreational, tributary recreational, and in-river treaty Indian (including commercial, ceremonial, and subsistence) fisheries. Total exploitation rates have decreased for lower Columbia salmon and steelhead, especially since the 1970s as increasingly stringent protection measures were adopted for declining natural populations.

Current fishing impact rates on lower Columbia River naturally-spawning salmon populations ranges from 2.5% for chum salmon to 45% for tule fall Chinook (Table 7). These rates include estimates of direct harvest mortality as well as estimates of incidental mortality in catch and release fisheries. Fishery impact rates for hatchery produced coho are higher than for naturally-spawning fish of the same species because of selective fishing regulations. These rates generally reflect recent year (2001-2003) fishery regulations and quotas controlled by weak stock impact limits and annual abundance of healthy targeted fish. Actual harvest rates will vary for each year dependent on annual stock status of multiple west coast salmon populations, however, these rates generally reflect expected impacts of harvest on lower Columbia naturally-spawning and hatchery salmon under current harvest management plans.

Table 7. Approximate annual exploitation rates (% harvested) for naturally-spawning lower Columbia salmon and steelhead under current management controls (represents 2001-2003 fishing period).

	AK./Can. Ocean	West Coast Ocean	Col. R. Comm.	Col. R. Sport	Trib. Sport	**Wild Total**	Hatchery Total	Historic Highs
Fall Chinook (Tule)	15	15	5	5	5	**45**	45	80
Fall Chinook (Bright)	19	3	6	2	10	**40**	Na	65
Chum	0	0	1.5	0	1	**2.5**	2.5	60
Coho	<1	9	6	2	1	**18**	51	85

Columbia River fall Chinook are subject to freshwater and ocean fisheries from Alaska to their rivers of origin in fisheries targeting abundant Chinook stocks originating from Alaska, Canada, Washington, Oregon, and California. Columbia tule fall Chinook harvest is constrained by a Recovery Exploitation Rate (RER) developed by NOAA Fisheries for management of

Coweeman naturally-spawning fall Chinook. Some in-basin sport fisheries (like the Chinook and grays rivers) are closed to the retention of Chinook to protect naturally spawning populations. Harvest of lower Columbia bright fall Chinook is managed to achieve an escapement goal of 5,700 natural spawners in the North Fork Lewis.

Rates are very low for chum salmon, which are not encountered by ocean fisheries and return to freshwater in late fall when significant Columbia River commercial fisheries no longer occur. Chum are no longer targeted in Columbia commercial seasons and retention of chum is prohibited in Columbia River and Grays/Chinook River sport fisheries. Chum are impacted incidental to fisheries directed at coho and winter steelhead.

Harvest of estuary tributary coho occurs in the ocean commercial and recreational fisheries off the Washington and Oregon coasts and Columbia River. The Estuary Tributaries are closed to salmon fishing . Wild coho impacts are limited by fishery management to retain marked hatchery fish and release unmarked wild fish.

Access to harvestable surpluses of strong stocks in the Columbia River and ocean is regulated by impact limits on weak populations mixed with the strong. Weak stock management of Columbia River fisheries became increasingly prevalent in the 1960s and 1970s in response to continuing declines of upriver runs affected by mainstem dam construction. In the 1980s coordinated ocean and freshwater weak stock management commenced. More fishery restrictions followed ESA listings in the 1990s. Each fishery is controlled by a series of regulating factors. Many of the regulating factors that affect harvest impacts on Columbia River stocks are associated with treaties, laws, policies, or guidelines established for the management of other stocks or combined stocks, but indirectly control impacts of Columbia River fish as well. Listed fish generally comprise a small percentage of the total fish caught by any fishery. Every listed fish may correspond to tens, hundreds, or thousands of other stocks in the total catch. As a result of weak stock constraints, surpluses of hatchery and strong naturally-spawning runs often go unharvested. Small reductions in fishing rates on listed populations can translate to large reductions in catch of other stocks and recreational trips to communities which provide access to fishing, with significant economic consequences.

Selective fisheries for adipose fin-clipped hatchery spring Chinook (since 2001), coho (since 1999), and steelhead (since 1984) have substantially reduced fishing mortality rates for naturally-spawning populations and allowed concentration of fisheries on abundant hatchery fish. Selective fisheries occur in the Columbia River and tributaries, for spring Chinook and steelhead, and in the ocean, Columbia River, and tributaries for coho. Columbia River hatchery fall Chinook are not marked for selective fisheries, but likely will be in the future because of recent legislation enacted by Congress.

3.6.3 *Mainstem and Estuary Habitat*

Conditions in the Columbia River mainstem, estuary, and plume affect all anadromous salmonid populations within the Columbia Basin. Juvenile and adult salmon may be found in the mainstem and estuary at all times of the year, as different species, life history strategies and size classes continually rear or move through these waters. A variety of human activities in the mainstem and estuary have decreased both the quantity and quality of habitat used by juvenile salmonids. These include floodplain development; loss of side channel habitat, wetlands and marshes; and alteration of flows due to upstream hydro operations and irrigation withdrawals.

Effects on salmonids of habitat changes in the mainstem and estuary are complex and poorly understood. Effects are similar for populations in Columbia Estuary tributaries to those of most other subbasin salmonid populations. Effects are likely to be greater for chum and fall Chinook which rear for extended periods in the mainstem and estuary than for steelhead and coho which move through more quickly. Estimates of the impacts of human-caused changes in mainstem and estuary habitat conditions are available based on changes in river flow, temperature, and predation as represented by EDT analyses for the NPCC Multispecies Framework Approach (Marcot et al. 2002). These estimates generally translate into a 10-60% reduction in salmonid productivity depending on species (Appendix E). Estuary effects are described more fully in the estuary subbasin volume of this plan (Volume II-A).

3.6.4 *Hydropower Construction and Operation*

There are no hydro-electric dams in the Estuary Tributary Basin. However, Estuary Tributary species are affected by changes in Columbia River mainstem and estuary related to Columbia basin hydropower development and operation. The mainstem Columbia River and estuary provide important habitats for anadromous species during juvenile and adult migrations between spawning and rearing streams and the ocean where they grow and mature. These habitats are particularly important for fall Chinook and chum which rear extensively in the Columbia mainstem and estuary. Aquatic habitats have been fundamentally altered throughout the Columbia River basin by the construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control.

The hydropower infrastructure and flow regulation affects adult migration, juvenile migration, mainstem spawning success, estuarine rearing, water temperature, water clarity, gas supersaturation, and predation. Dams block or impede passage of anadromous juveniles and adults. Columbia River spring flows are greatly reduced from historical levels as water is stored for power generation and irrigation, while summer and winter flows have increased. These flow changes affect juvenile and adult migration, and have radically altered habitat forming processes. Flow regulation and reservoir construction have increased average water temperature in the Columbia River mainstem and summer temperatures regularly exceed optimums for salmon. Supersaturation of water with atmospheric gases, primarily nitrogen, when water is spilled over high dams causes gas bubble disease. Predation by fish, bird, and marine mammals has been exacerbated by habitat changes. The net effect of these direct and indirect effects is difficult to quantify but is expected to be less significant for populations originating from lower Columbia River subbasins than for upriver salmonid populations. Additional information on hydropower effects can be found in the Regional Recovery and Subbasin Plan Volume I.

3.6.5 *Ecological Interactions*

Ecological interactions focus on how salmon and steelhead, other fish species, and wildlife interact with each other and the subbasin ecosystem. Salmon and steelhead are affected throughout their lifecycle by ecological interactions with non native species, food web components, and predators. Each of these factors can be exacerbated by human activities either by direct actions or indirect effects of habitat alternation. Effects of non-native species on salmon, effects of salmon on system productivity, and effects of native predators on salmon are difficult to quantify. Strong evidence exists in the scientific literature on the potential for significant interactions but effects are often context- or case-specific.

Predation is one interaction where effects can be estimated although interpretation can be complicated. In the lower Columbia River, northern pikeminnow, Caspian tern, and marine mammal predation on salmon has been estimated at approximately 5%, 10-30%, and 3-12%, respectively of total salmon numbers (see Appendix E for additional details). Predation has always been a source of salmon mortality but predation rates by some species have been exacerbated by human activities.

3.6.6 *Ocean Conditions*

Salmonid numbers and survival rates in the ocean vary with ocean conditions and low productivity periods increase extinction risks of populations stressed by human impacts. The ocean is subject to annual and longer-term climate cycles just as the land is subject to periodic droughts and floods. The El Niño weather pattern produces warm ocean temperatures and warm, dry conditions throughout the Pacific Northwest. The La Niña weather patterns is typified by cool ocean temperatures and cool/wet weather patterns on land. Recent history is dominated by a high frequency of warm dry years, along with some of the largest El Niños on record—particularly in 1982-83 and 1997-98. In contrast, the 1960s and early 1970s were dominated by a cool, wet regime. Many climatologists suspect that the conditions observed since 1998 may herald a return to the cool wet regime that prevailed during the 1960s and early 1970s.

Abrupt declines in salmon populations throughout the Pacific Northwest coincided with a regime shift to predominantly warm dry conditions from 1975 to 1998 (Beamish and Bouillon 1993, Hare et al 1999, McKinnell et al. 2001, Pyper et al. 2001). Warm dry regimes result in generally lower survival rates and abundance, and they also increase variability in survival and wide swings in salmon abundance. Some of the largest Columbia River fish runs in recorded history occurred during 1985–1987 and 2001–2002 after strong El Niño conditions in 1982–83 and 1997–98 were followed by several years of cool wet conditions.

The reduced productivity that accompanied an extended series of warm dry conditions after 1975 has, together with numerous anthropogenic impacts, brought many weak Pacific Northwest salmon stocks to the brink of extinction and precipitated widespread ESA listings. Salmon numbers naturally ebb and flow as ocean conditions vary. Healthy salmon populations are productive enough to withstand these natural fluctuations. Weak salmon populations may disappear or lose the genetic diversity needed to withstand the next cycle of low ocean productivity (Lawson 1993).

Recent improvements in ocean survival may portend a regime shift to generally more favorable conditions for salmon. The large spike in recent runs and a cool, wet climate would provide a respite for many salmon populations driven to critical low levels by recent conditions. The National Research Council (1996) concluded: *"Any favorable changes in ocean conditions—which could occur and could increase the productivity of some salmon populations for a time—should be regarded as opportunities for improving management techniques. They should not be regarded as reasons to abandon or reduce rehabilitation efforts, because conditions will change again"*. Additional details on the nature and effects of variable ocean conditions on salmonids can be found in the Regional Recovery and Subbasin Plan Volume I.

4.0 Key Programs and Projects

This section provides brief summaries of current federal, state, local, and non-governmental programs and projects pertinent to recovery, management, and mitigation measures and actions in this basin. These descriptions provide a context for descriptions of specific actions and responsibilities in the management plan portion of this subbasin plan. More detailed descriptions of these programs and projects can be found in the Comprehensive Program Directory (Appendix C).

4.1 Federal Programs

4.1.1 *NOAA Fisheries*

NOAA Fisheries is responsible for conserving, protecting and managing pacific salmon, ground fish, halibut, marine mammals and habitats under the Endangered Species Act, the Marine Mammal Protection Act, the Magnuson-Stevens Act, and enforcement authorities. NOAA administers the ESA under Section 4 (listing requirements), Section 7 (federal actions), and Section 10 (non-federal actions).

4.1.2 *US Army Corps of Engineers*

The U.S. Army Corps of Engineers (USACE) is the Federal government's largest water resources development and management agency. USACE programs applicable to Lower Columbia Fish & Wildlife include: 1) Section 1135 – provides for the modification of the structure or operation of a past USACE project, 2) Section 206 – authorizes the implementation of aquatic ecosystem restoration and protection projects, 3) Hydroelectric Program – applies to the construction and operation of power facilities and their environmental impact, 4) Regulatory Program – administration of Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act.

4.1.3 *Environmental Protection Agency*

The Environmental Protection Agency (EPA) is responsible for the implementation of the Clean Water Act (CWA). The broad goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters so that they can support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water. The CWA requires that water quality standards (WQS) be set for surface waters. WQS are aimed at translating the broad goals of the CWA into waterbody-specific objectives and apply only to the surface waters (rivers, lakes, estuaries, coastal waters, and wetlands) of the United States.

4.1.4 *Natural Resources Conservation Service*

Formerly the Soil Conservation Service, the USDA Natural Resources Conservation Service (NRCS) works with landowners to conserve natural resources on private lands. The NRCS accomplishes this through various programs including, but not limited to, the Conservation Technical Assistance Program, Soil Survey Program, Conservation Reserve Enhancement Program, and the Wetlands Reserve Program. The NRCS works closely with local Conservation Districts; providing technical assistance and support.

4.1.5 *Northwest Power and Conservation Council*

The Northwest Power and Conservation Council, an interstate compact of Idaho, Montana, Oregon, and Washington, has specific responsibility in the Northwest Power Act of 1980 to mitigate the effects of the hydropower system on fish and wildlife of the Columbia River

Basin. The Council does this through its Columbia River Basin Fish and Wildlife Program, which is funded by the Bonneville Power Administration. Beginning in Fiscal Year 2006, funding is guided by locally developed subbasin plans that are expected to be formally adopted in the Council's Fish and Wildlife Program in December 2004.

4.2 State Programs

4.2.1 *Washington Department of Natural Resources*

The Washington Department of Natural Resources governs forest practices on non-federal lands and is steward to state owned aquatic lands. Management of DNR public forest lands is governed by tenets of their proposed Habitat Conservation Plan (HCP). Management of private industrial forestlands is subject to Forest Practices regulations that include both protective and restorative measures.

4.2.2 *Washington Department of Fish & Wildlife*

WDFW's Habitat Division supports a variety of programs that address salmonids and other wildlife and resident fish species. These programs are organized around habitat conditions (Science Division, Priority Habitats and Species, and the Salmon and Steelhead Habitat Inventory and Assessment Program); habitat restoration (Landowner Incentive Program, Lead Entity Program, and the Conservation and Reinvestment Act Program, as well as technical assistance in the form of publications and technical resources); and habitat protection (Landowner Assistance, GMA, SEPA planning, Hydraulic Project Approval, and Joint Aquatic Resource Permit Applications).

4.2.3 *Washington Department of Ecology*

The Department of Ecology (DOE) oversees: the Water Resources program to manage water resources to meet current and future needs of the natural environment and Washington's communities; the Water Quality program to restore and protect Washington's water supplies by preventing and reducing pollution; and Shoreline and the Environmental Assistance program for implementing the Shorelines Management Act, the State Environmental Protection Act, the Watershed Planning Act, and 401 Certification of ACOE Permits.

4.2.4 *Washington Department of Transportation*

The Washington State Department of Transportation (WSDOT) must ensure compliance with environmental laws and statutes when designing and executing transportation projects. Programs that consider and mitigate for impacts to salmonid habitat include: the Fish Passage Barrier Removal program; the Regional Road Maintenance ESA Section 4d Program, the Integrated Vegetation Management & Roadside Development Program; Environmental Mitigation Program; the Stormwater Retrofit Program; and the Chronic Environmental Deficiency Program.

4.2.5 *Interagency Committee for Outdoor Recreation*

Created through the enactment of the Salmon Recovery Act (Washington State Legislature, 1999), the Salmon Recovery Funding Board provides grant funds to protect or restore salmon habitat and assist related activities with local watershed groups known as lead entities. SRFB has helped finance over 500 salmon recovery projects statewide. The Aquatic Lands Enhancement Account (ALEA) was established in 1984 and is used to provide grant support for the purchase, improvement, or protection of aquatic lands for public purposes, and for providing and improving access to such lands. The Washington Wildlife and Recreation

Program (WWRP), established in 1990 and administered by the Interagency Committee for Outdoor Recreation, provides funding assistance for a broad range of land protection, park development, preservation/conservation, and outdoor recreation facilities.

4.2.6 *Lower Columbia Fish Recovery Board*

The Lower Columbia Fish Recovery Board encompasses five counties in the Lower Columbia River Region. The 15-member board has four main programs, including habitat protection and restoration activities, watershed planning for water quantity, quality, habitat, and instream flows, facilitating the development of an integrated recovery plan for the Washington portion of the lower Columbia Evolutionarily Significant Units, and conducting public outreach activities.

4.3 Local Government Programs

4.3.1 *Pacific County*

Pacific County has been conducting Comprehensive Planning under the State's Growth Management Act since 1998. Pacific County manages natural resources primarily through its Critical Areas Ordinance.

4.4 Non-governmental Programs

4.4.1 *Columbia Land Trust*

The Columbia Land Trust is a private, non-profit organization founded in 1990 to work exclusively with willing landowners to find ways to conserve the scenic and natural values of the land and water. Landowners donate the development rights or full ownership of their land to the Land Trust. CLT manages the land under a stewardship plan and, if necessary, will legally defend its conservation values.

4.4.2 *Columbia River Estuary Study Taskforce*

The Columbia River Estuary Study Taskforce (CREST) is a council of local governments. CREST developed the Columbia River Estuary Regional Management Plan, which was adopted in local comprehensive plans and shoreline master programs. This plan contains an inventory of physical, biological and cultural characteristics of the estuary. Based on data needs identified during the development of the plan, Congress authorized and funded the Columbia River Estuary Data Development Program (CREDDP). This program provided a wealth of information that is still used by the local governments and by state and federal agencies in resource planning.

4.4.3 *Lower Columbia Fish Enhancement Group*

The Washington State Legislature created the Regional Fisheries Enhancement Group Program in 1990 to involve local communities, citizen volunteers, and landowners in the state's salmon recovery efforts. RFEGs help lead their communities in successful restoration, education and monitoring projects. Every group is a separate, nonprofit organization led by their own board of directors and operational funding from a portion of commercial and recreational fishing license fees administered by the WDFW, and other sources. The mission of the Lower Columbia RFEG (LCFEG) is to restore salmon runs in the lower Columbia River region through habitat restoration, education and outreach, and developing regional and local partnerships.

4.5 NPCC Fish & Wildlife Program Projects

There are no NPCC Fish & Wildlife Program projects within the Estuary Tributaries; however, there are several projects within the Columbia River Estuary, which encompasses the lower portions of estuary tributaries. These are discussed in the Columbia Estuary Subbasin Volume.

4.6 Washington Salmon Recovery Funding Board Projects

Type	Project Name	Subbasin
Acquisition	L. Columbia River Estuary-Grays River Phase 4	Grays/Chinook
Preservation	Columbia Estuary: Grays Bay Phase III	Grays/Chinook
Restoration	Lower Columbia River Estuary: Chinook	Grays/Chinook
Restoration	Grays River Estuary Phase 2	Grays/Chinook
Restoration	Chinook River Estuary	Grays/Chinook
Restoration	Columbia Estuary: Deep River	Grays/Chinook
	Lower Columbia River Estuary Grays River	Grays/Chinook

5.0 Management Plan

5.1 Vision

Washington lower Columbia salmon, steelhead, and bull trout are recovered to healthy, harvestable levels that will sustain productive sport, commercial, and tribal fisheries through the restoration and protection of the ecosystems upon which they depend and the implementation of supportive hatchery and harvest practices.

The health of other native fish and wildlife species in the lower Columbia will be enhanced and sustained through the protection of the ecosystems upon which they depend, the control of non-native species, and the restoration of balanced predator/prey relationships.

The Estuary Tributary Basin will play a key role in the regional recovery of salmon and steelhead. Natural populations of fall Chinook, chum, and coho will be restored to high levels of viability by significant reductions in human impacts throughout the lifecycle. Salmonid recovery efforts will provide broad ecosystem benefits to a variety of fish and wildlife species. Recovery will be accomplished through a combination of improvements in subbasin, Columbia River mainstem, and estuary habitat conditions as well as careful management of hatcheries, fisheries, and ecological interactions among species.

Habitat protection or restoration will involve a wide range of Federal, State, Local, and non-governmental programs and projects. Success will depend on effective programs as well as a dedicated commitment to salmon recovery across a broad section of society.

Some hatchery programs will be realigned to focus on protection, conservation, and recovery of native fish. The need for hatchery measures will decrease as productive natural habitats are restored. Where consistent with recovery, other hatchery programs will continue to provide fish for fishery benefits for mitigation purposes in the interim until habitat conditions are restored to levels adequate to sustain healthy, harvestable natural populations.

Directed fishing on sensitive wild populations will be eliminated and incidental impacts of mixed stock fisheries in the Columbia River and ocean will be regulated and limited consistent with wild fish recovery needs. Until recovery is achieved, fishery opportunities will be focused on hatchery fish and harvestable surpluses of healthy wild stocks.

Columbia basin hydropower effects on Estuary Tributary Basin salmonids will be addressed by mainstem Columbia and estuary habitat restoration measures. Hatchery facilities in the Estuary Tributaries Basin will also be called upon to produce fish to help mitigate for hydropower impacts on upriver stocks where compatible with wild fish recovery.

This plan uses a planning period or horizon of 25 years. The goal is to achieve recovery of the listed salmon species and the biological objectives for other fish and wildlife species of interest within this time period. It is recognized, however, that sufficient restoration of habitat conditions and watershed processes for all species of interest will likely take 75 years or more.

5.2 Biological Objectives

Biological objectives for Estuary Tributary Basin salmonid populations are based on recovery criteria developed by scientists on the Willamette/Lower Columbia Technical Recovery Team convened by NOAA Fisheries. Criteria involve a hierarchy of ESU, Strata (i.e. ecosystem areas within the ESU – Coast, Cascade, Gorge), and Population standards. A recovery scenario describing population-scale biological objectives for all species in all three strata in the lower Columbia ESUs was developed through a collaborative process with stakeholders based on biological significance, expected progress as a result of existing programs, the absence of apparent impediments, and the existence of other management opportunities. Under the preferred alternative, individual populations will variously contribute to recovery according to habitat quality and the population's perceived capacity to rebuild. Criteria, objectives, and the regional recovery scenario are described in greater detail in the Regional Recovery and Subbasin Plan Volume I.

Focal populations in the Estuary Tributaries Basin are combined with Grays River populations to derive a targeted improvement level that contributes to recovery of the species. The scenario differentiates the role of populations by designating primary, contributing, and stabilizing categories. *Primary populations* are those that would be restored to high or better probabilities of persistence. *Contributing populations* are those where low to medium improvements will be needed to achieve stratum-wide average of moderate persistence probability. *Stabilizing populations* are those maintained at current levels.

The Grays/Chinook Basin was identified as one of the most significant areas for salmon recovery among Washington coastal subbasins based on fish population significance and realistic prospects for restoration. Recovery goals call for restoring salmon and winter steelhead populations in the Grays/Chinook subbasin to a high or very high viability level. Winter Steelhead populations are not included in the Chinook River. This level will provide for a 95% or better probability of population survival over 100 years. Cutthroat will benefit from improvements in stream habitat conditions for anadromous species. Lamprey are also expected to benefit from habitat improvements in the estuary, Columbia River mainstem, and Estuary Tributary Basin although specific spawning and rearing habitat requirements are not well known. Bull trout do not occur in the basin.

Table 8. Current viability status of Grays/Chinook tributary salmon populations and the biological objective status that is necessary to meet the recovery criteria for the Coastal strata and the lower Columbia ESU.

	ESA	Hatchery	Current		Objective	
Species	Status	Component	Viability	Numbers	Viability	Numbers
Fall Chinook	Threatened	Yes	Low+	100-300	High[P]	1,400
Chum	Threatened	Yes	Low+	500-10,000	High+[P]	4,300-7,800
Coho	Candidate	Yes	Low+	unknown	High[P]	unknown

P = primary population in recovery scenario
C = contributing population in recovery scenario
S = stabilizing population in recovery scenario

5.3 Integrated Strategy

An Integrated Regional Strategy for recovery emphasizes that: 1) it is feasible to recover Washington lower Columbia natural salmon and steelhead to healthy and harvestable levels; 2) substantial improvements in salmon and steelhead numbers, productivity, distribution, and diversity will be required; 3) recovery cannot be achieved based solely on improvements in any one factor; 4) existing programs are insufficient to reach recovery goals, 5) all manageable effects on fish and habitat conditions must contribute to recovery, 6) actions needed for salmon recovery will have broader ecosystem benefits for all fish and wildlife species of interest, and 7) strategies and measures likely to contribute to recovery can be identified but estimates of the incremental improvements resulting from each specific action are highly uncertain. The strategy is described in greater detail in the Regional Recovery and Subbasin Plan Volume I.

The Integrated Strategy recognizes the importance of implementing measures and actions that address each limiting factor and risk category, prescribing improvements in each factor/threat category in proportion to its magnitude of contribution to salmon declines, identifying an appropriate balance of strategies and measures that address regional, upstream, and downstream threats, and focusing near term actions on species at-risk of extinction while also ensuring a long term balance with other species and the ecosystem.

Population productivity improvement increments identify proportional improvements in productivity needed to recover populations from current status to medium, high, and very high levels of population viability consistent with the recovery scenario. Productivity is defined as the inherent population replacement rate and is typically expressed by models as a median rate of population increase (PCC model) or a recruit per spawner rate (EDT model). Corresponding improvements in spawner numbers, juvenile outmigrants, population spatial structure, genetic and life history diversity, and habitat are implicit in productivity improvements.

Improvement targets were developed for each impact factor based on desired population productivity improvements and estimates of potentially manageable impacts (see Section 3.7). Impacts are estimates of the proportional reduction in population productivity associated with human-caused and other potentially manageable impacts from stream habitats, estuary/mainstem habitats, hydropower, harvest, hatcheries, and selected predators. Reduction targets were driven by the regional strategy of equitably allocating recovery responsibilities among the six manageable impact factors. Given the ultimate uncertainty in the effects of recovery actions and the need to implement an adaptive recovery program, this approximation should be adequate for developing order-of-magnitude estimates to which recovery actions can be scaled consistent with the current best available science and data. Objectives and targets will need to be confirmed or refined during plan implementation based on new information and refinements in methodology.

The following table (Table 9) identifies population and factor-specific improvements consistent with the biological objectives for the Grays River subbasin. The Grays River population is combined with Chinook River populations for assessing biological recovery objectives. These data are not available specific to the Chinook River or other estuary tributaries. Per factor increments are less than the population net because factor affects are compounded at different life stages and density dependence is largely limited to freshwater tributary habitat. For example, productivity of Grays River fall Chinook must increase by 30% to reach population viability goals which requires impact reductions equivalent to a 9% improvement in productivity or survival for each of six factor categories. Thus, tributary habitat impacts on fall Chinook must decrease from a 37% to a 32% impact in order to achieve the required 9% increase in tributary habitat potential from the current 63% of the historical potential to 68% of the historical potential.

Table 9. Productivity improvements consistent with biological objectives the Columbia Estuary Tributaries Basin.

Species	Net increase	Per factor	Baseline impacts					
			Trib.	Estuary	Hydro.	Pred.	Harvest	Hatch.
Fall Chinook	30%	9%	0.37	0.35	0	0.22	0.65	0.19
Chum	90%	14%	0.85	0.28	0	0.22	0.05	0.03
Coho	na	na	na	na	na	na	na	na

5.4 Tributary Habitat

Due to the small size of the Estuary Tributaries Basin, an in-depth stream habitat assessment was not conducted using EDT. Development of prioritized measures and actions in this basin relied upon existing information on salmonid habitat and on the results of the watershed process assessment (IWA). As a first step toward measure and action development, existing habitat information and watershed assessment results were integrated to develop a multi-species view of 1) priority areas, 2) factors limiting recovery, and 3) contributing land-use threats. For the purpose of this assessment, limiting factors are defined as the biological and physical conditions serving to suppress salmonid population performance, whereas threats are the land-use activities contributing to those factors. Limiting Factors refer to local (reach-scale) conditions believed to be directly impacting fish. Threats, on the other hand, may be local or non-local. Non-local threats may impact instream limiting factors in a number of ways, including: 1) through their effects on habitat-forming processes – such as the case of forest road impacts on reach-scale fine sediment loads, 2) due to an impact in a contributing stream reach – such as riparian degradation reducing wood recruitment to a downstream reach, or 3) by blocking fish passage to an upstream reach.

Priority areas, limiting factors, and land-use threats were determined from a variety of sources including Washington Conservation Commission Limiting Factors Analyses, the IWA, the State 303(d) list, air photo analysis, the Barrier Assessment, personal knowledge of investigators, or known cause-effect relationships between stream conditions and land-uses.

Priority areas, limiting factors and threats were used to develop a prioritized suite of habitat measures. Measures are based solely on biological and physical conditions. For each measure, the key programs that address the measure are identified and the sufficiency of existing programs to satisfy the measure is discussed. The measures, in conjunction with the program sufficiency considerations, were then used to identify specific actions necessary to fill gaps in measure implementation. Actions differ from measures in that they address program deficiencies as well as biophysical habitat conditions. The process for developing measures and actions is illustrated in Figure 9 and each component is presented in detail in the sections that follow.

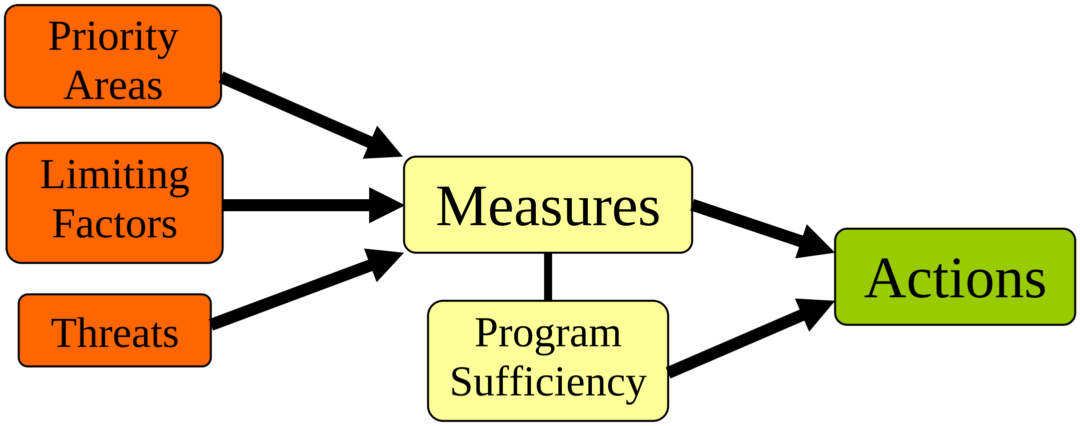


Figure 9. Flow chart illustrating the development of subbasin measures and actions.

5.4.1 *Priority Areas, Limiting Factors and Threats*

Decades of human activity in the Estuary Tributaries Basin have significantly altered watershed processes and reduced both the quality and quantity of habitat needed to sustain viable populations of salmon and steelhead. Moreover, with the exception of fall Chinook, stream habitat conditions within the Estuary Tributaries Basin have a high impact on the health and viability of salmon and steelhead relative to other limiting factors. The following bullets provide an overview of each of the priority areas in the basin. These descriptions summarize the species most affected, the primary limiting factors, the contributing land-use threats, and the general type of measures that will be necessary for recovery. A tabular summary of the key limiting factors and land-use threats can be found in Table 10.

- **Chinook River** – The mainstem Chinook between tidal influence (RM 2.5) and the Sea Resources Hatchery (RM 4) currently contains habitats that are important for Chinook River salmon populations. Potential production in this reach is limited by riparian degradation, loss of floodplain function, loss of backwater habitats, and sedimentation of stream channels. Adjacent agricultural uses have resulted in channels confined by dikes and under-vegetated riparian areas. Sedimentation originates from upper basin sediment delivery and local agriculture/grazing practices.
- **Wallacut River and other small Columbia River tributaries** – The Wallacut River is affected by many of the same attributes as the Chinook River. The estuarine portion of the lower Wallacut River has been channelized and diked to create crop and pasture lands. Fish passage is currently limited at certain times by tidegates. Other potentially productive small tributaries to the Columbia River are located between the communities of Chinook and Megler. Some of these streams have fish passage issues associated with culverts under Highways 401 and 101.

Table 10. Salmonid habitat limiting factors and threats in priority areas. Priority areas include the Chinook River (CH) and the Wallacut River plus other small tributaries (WA). Linkages between each threat and limiting factor are not displayed – each threat directly and indirectly affects a variety of habitat factors.

Limiting Factors			Threats		
	CH	WA		CH	WA
Habitat connectivity			***Agriculture / grazing***		
Blockages to off-channel habitats	✓	✓	Clearing of vegetation	✓	✓
Blockages to stream habitats due to structures	✓	✓	Riparian grazing	✓	✓
Habitat diversity			Floodplain filling	✓	✓
Lack of stable instream woody debris	✓	✓	***Rural development***		
Altered habitat unit composition	✓	✓	Clearing of vegetation	✓	✓
Loss of off-channel or side-channel habitats	✓	✓	Floodplain filling	✓	✓
Channel stability			Roads – riparian/floodplain impacts	✓	✓
Bed and bank erosion	✓	✓	***Forest practices***		
Riparian function			Timber harvests: sediment supply impacts	✓	✓
Reduced stream canopy cover	✓	✓	Timber harvests: impacts to runoff	✓	✓
Reduced bank/soil stability	✓	✓	Riparian harvests	✓	✓
Exotic and/or noxious species	✓	✓	Forest roads: impacts to sediment supply	✓	✓
Reduced wood recruitment	✓	✓	Forest roads: impacts to runoff	✓	✓
Floodplain function			Forest roads: riparian/floodplain impacts	✓	✓
Altered nutrient exchange processes	✓	✓	***Channel manipulations***		
Reduced flood flow dampening	✓	✓	Bank hardening	✓	✓
Restricted channel migration	✓	✓	Channel straightening	✓	✓
Disrupted hyporheic processes	✓	✓	Artificial confinement	✓	✓
Stream flow			Passage obstruction (tidegates, culverts)	✓	✓
Altered magnitude, duration, or rate of change	✓	✓			
Water quality					
Altered stream temperature regime	✓	✓			
Substrate and sediment					
Embedded substrates	✓	✓			
Excessive fine sediment	✓	✓			

5.4.2 *Habitat Measures*

Measures are means to achieve the regional strategies that are applicable to the Estuary Tributaries Basin and are necessary to accomplish the biological objectives for focal fish species. Measures are based on the technical assessments for this basin (Section 3.0) as well as on the synthesis of priority areas, limiting factors, and threats presented earlier in this section. The measures applicable to the Estuary Tributaries Basin are presented in priority order in Table 11. Each measure has a set of submeasures that define the measure in greater detail and add specificity to the particular circumstances occurring within the basin. The table for each measure and associated submeasures indicates the limiting factors that are addressed, the contributing threats that are addressed, the species that would be most affected, and a short discussion. Priority locations are given for some measures. Priority locations typically refer to either stream reaches or subwatersheds, depending on the measure. Addressing measures in the highest priority areas first will provide the greatest opportunity for effectively accomplishing the biological objectives.

Following the list of priority locations is a list of the programs that are the most relevant to the measure. Each program is qualitatively evaluated as to whether it is sufficient or needs expansion with respect to the measure. This exercise provides an indication of how effectively the measure is already covered by existing programs, policy, or projects; and therefore indicates where there is a gap in measure implementation. This information is summarized in a discussion of Program Sufficiency and Gaps.

The measures themselves are prioritized based on the results of the technical assessment and in consideration of principles of ecosystem restoration (e.g. NRC 1992, Roni et al. 2002). These principles include the hypothesis that the most efficient way to achieve ecosystem recovery in the face of uncertainty is to focus on the following prioritized approaches: 1) protect existing functional habitats and the processes that sustain them, 2) allow no further degradation of habitat or supporting processes. 3) re-connect isolated habitat, 4) restore watershed processes (ecosystem function), 5) restore habitat structure, and 6) create new habitat where it is not recoverable. These priorities are adjusted depending on the results of the technical assessment and on the specific circumstances occurring in the basin. For example, re-connecting isolated habitat could be adjusted to a lower priority if there is little impact to the population created from passage barriers.

5.4.3 *Habitat Actions*

The prioritized measures and associated gaps are used to develop specific Actions for the basin. These are presented in Table 12. Actions are different than the measures in a number of ways: 1) actions have a greater degree of specificity than measures, 2) actions consider existing programs and are therefore not based strictly on biophysical conditions, 3) actions refer to the agency or entity that would be responsible for carrying out the action, and 4) actions are related to an expected outcome with respect to the biological objectives. Actions are not presented in priority order but instead represent the suite of activities that are all necessary for recovery of listed species. The priority for implementation of these actions will consider the priority of the measures they relate to, the “size” of the gap they are intended to fill, and feasibility considerations.

Table 11. Prioritized measures for the Estuary Tributaries Basin.

#1 – Protect stream corridor structure and function

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect floodplain function and channel migration processes B. Protect riparian function C. Protect access to habitats D. Protect instream flows through management of water withdrawals E. Protect channel structure and stability F. Protect water quality G. Protect the natural stream flow regime	Potentially addresses many limiting factors	Potentially addresses many limiting factors	All Species	The lower Wallacut and Chinook Rivers historically flowed through wide lowland marshes with interconnected side channels and backwater habitats important for salmonid rearing. These reaches have been simplified, straightened, and confined to facilitate agriculture and residential development. Other stream reaches have been impacted by past riparian timber harvests. Preventing further degradation of stream channel structure, riparian function, and floodplain function will be an important component of recovery.

Priority Locations

1st- Chinook River between tidal influence (RM 2.5) and Sea Resources Hatchery (RM 4)
2nd- Wallacut River and other small Columbia River tributaries

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NOAA Fisheries	ESA Section 7 and Section 10	✓	
US Army Corps of Engineers (USACE)	Dredge & fill permitting (Clean Water Act sect. 404); Navigable waterways protection (Rivers & Harbors Act Sect, 10)	✓	
WA Department of Natural Resources (WDNR)	Forest Practices Rules, Riparian Easement Program	✓	
WA Department of Fish and Wildlife (WDFW)	Hydraulics Projects Approval	✓	
Pacific County	Comprehensive Planning		✓
Pacific Conservation District / NRCS	Agricultural land habitat protection programs		✓
Noxious Weed Control Boards (State and County level)	Noxious Weed Education, Enforcement, Control		✓
Non-Governmental Organizations (NGOs) (e.g. Columbia Land Trust) and public agencies	Land acquisition and easements		✓

Program Sufficiency and Gaps

Alterations to stream corridor structure that may impact aquatic habitats are regulated through the WDFW Hydraulics Project Approval (HPA) permitting program. Other regulatory protections are provided through USACE permitting, ESA consultations, and County regulations. Riparian areas within private timberlands are protected through the Forest Practices Rules (FPR) administered by WDNR. The FPRs came out of an extensive review process and are believed to adequately protect riparian areas with respect to stream shading, bank stability, and LWD recruitment. The program is new, however, and careful monitoring of the effect of the regulations is necessary, particularly with respect to effects on watershed hydrology and sediment delivery. Conversion of land-use from forest or agriculture to residential use has the potential to increase impairment of aquatic habitat, particularly when residential development is paired with flood control measures. Counties can limit potentially harmful land-use conversions by thoughtfully directing growth through comprehensive planning and tax incentives, by providing consistent protection of critical areas across jurisdictions, and by preventing development in floodplains. In cases where existing programs are unable to protect critical habitats due to inherent limitations of regulatory mechanisms, conservation easements and land acquisition may be necessary.

#2 – Protect hillslope processes

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Manage forest practices to minimize impacts to sediment supply processes, runoff regime, and water quality B. Manage agricultural practices to minimize impacts to sediment supply processes, runoff regime, and water quality C. Manage growth and development to minimize impacts to sediment supply processes, runoff regime, and water quality	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Agricultural practices – impacts to sediment supply, water quality, and runoff processes • Development – impacts to sediment supply, water quality, and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded due to past intensive timber harvest and road building, particularly from heavy timber harvesting in the 1970s. Lowland hillslope processes have been impacted by agriculture and development. Limiting additional degradation will be necessary to prevent further habitat impairment.

Priority Locations

1st- Functional subwatersheds (functional for sediment *or* flow according to the IWA – local rating)
Subwatersheds: 30503
2nd- Moderately Impaired subwatersheds
Subwatersheds: 30501, 30502, 30504

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules	✓	
Pacific County	Comprehensive Planning		✓
Pacific Conservation District / NRCS	Agricultural land habitat protection programs		✓

Program Sufficiency and Gaps

Hillslope processes on private forest lands are protected through Forest Practices Rules administered by the WDNR. These rules, developed as part of the Forests & Fish Agreement, are believed to be adequate for protecting watershed sediment supply, runoff processes, and water quality on private forest lands. Small private landowners may be unable to meet some of the requirements on a timeline commensurate with large industrial landowners. Financial assistance to small owners would enable greater and quicker compliance. On non-forest lands (agriculture and developed), County Comprehensive Planning is the primary nexus for protection of hillslope processes. Counties can control impacts through zoning that protects existing uses, through stormwater management ordinances, and through tax incentives to prevent agricultural and forest lands from becoming developed. There are few to no regulatory protections of hillslope processes that relate to agricultural practices; such deficiencies need to be addressed through local or state authorities. Protecting hillslope processes on agricultural lands would also benefit from the expansion of technical assistance and landowner incentive programs (NRCS, Conservation Districts).

#3 – Restore access to habitat blocked by artificial barriers

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore access to isolated habitats blocked by culverts, dams, or other barriers	• Blockages to channel habitats • Blockages to off-channel habitats	• Dams, culverts, in-stream structures	All species	Passage obstructions include tidegates, culverts, and water intake facilities. Passage restoration projects should focus only on cases where it can be demonstrated that there is good potential benefit and reasonable project costs.

Priority Locations

1st- Chinook River tidegate; Freshwater Creek (City of Chinook water supply); Tidegates on the Wallacut River; Culverts on streams at highway 401 & 101 crossings
2nd- Other small tributaries with blockages

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules, Family Forest Fish Passage		✓
WDFW	Habitat Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Washington Department of Transportation / WDFW	Fish Passage Program		✓
Pacific County	Roads		✓

Program Sufficiency and Gaps

There are efforts currently underway to remove the tidegate at the mouth of the Chinook River and to upgrade culverts under Highways 401 and 101 that may be restricting passage to several small streams. The Forest Practices Rules require forest landowners to restore fish passage at artificial barriers by 2016. Small forest landowners are given the option to enroll in the Family Forest Fish Program in order to receive financial assistance to fix blockages. The Washington State Department of Transportation, in a cooperative program with WDFW, manages a program to inventory and correct blockages associated with state highways. The Salmon Recovery Funding Board, through the Lower Columbia Fish Recovery Board, funds barrier removal projects. Past efforts have corrected major blockages and have identified others in need of repair. Additional funding is needed to correct remaining blockages. Further monitoring and assessment is needed to ensure that all potential blockages have been identified and prioritized.

#4 - Restore floodplain and estuarine function in the Chinook and Wallacut Rivers

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Set back, breach, or remove artificial confinement structures B. Remove or re-configure tidegates to allow for natural hydrologic processes	• Bed and bank erosion • Altered habitat unit composition • Restricted channel migration • Disrupted hyporheic processes • Reduced flood flow dampening • Altered nutrient exchange processes • Channel incision • Loss of off-channel and/or side-channel habitat • Blockages to off-channel habitats	• Floodplain filling • Channel straightening • Artificial confinement	chum, fall chinook, coho	There has been significant degradation of floodplain and estuary connectivity along the lower mainstem Chinook and Wallacut Rivers. The installation of a tidegate at the mouth of the Chinook River in the 1920s and subsequent diking, dredging, and removal of log jams has degraded floodplain connectivity in the lower river. Before these activities, the lower river consisted of a wide lowland marsh. In some headwater stream channels, channel incision has disconnected streams from their floodplains. In the lower river, selective breaching, setting back, or removing confining structures would help to restore floodplain function as well as restore off-channel and side channel habitats. Connectivity could also be improved by removing tide-gates or altering their operation. There are challenges with implementation due to private lands, existing infrastructure already in place, potential flood risk to property, and large expense.

Priority Locations

1st- Lower Chinook and Wallacut Rivers

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDFW	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Sea Resources	Habitat Projects		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓

Program Sufficiency and Gaps

There currently are no programs that set forth strategies for restoring floodplain function in the Estuary Tributaries Basin. Without programmatic changes, projects are likely to occur only seldom as opportunities arise and only if financing is made available. The level of estuarine and floodplain impairment in the Chinook and Wallacut Rivers put an increased emphasis on restoration. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs and government entities to conduct projects. Floodplain restoration projects are often expensive, large-scale efforts that require partnerships among many agencies, NGOs, and landowners. Building partnerships is a necessary first step toward floodplain restoration.

#5- Restore degraded hillslope processes on forest and agricultural lands

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Upgrade or remove problem forest roads B. Reforest heavily cut areas not recovering naturally C. Employ agricultural Best Management Practices with respect to contaminant use, erosion, and runoff D. Reduce watershed imperviousness E. Reduce effective stormwater runoff from developed areas	• Excessive fine sediment • Excessive turbidity • Embedded substrates • Stream flow – altered magnitude, duration, or rate of change of flows • Water quality impairment	• Timber harvest – impacts to sediment supply, water quality, and runoff processes • Forest roads – impacts to sediment supply, water quality, and runoff processes • Agricultural practices – impacts to sediment supply, water quality, and runoff processes • Development – impacts to water quality and runoff processes	All species	Hillslope runoff and sediment delivery processes have been degraded due to past intensive timber harvest, road building, agriculture, and development. These processes must be addressed for reach-level habitat recovery to be successful.

Priority Locations

1st- Moderately impaired or impaired subwatersheds (mod. impaired or impaired for sediment *or* flow according to IWA – local rating)
Subwatersheds: Entire Basin

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules	✓	
WDFW	Habitat Program	✓	
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Pacific Conservation District / NRCS	Agricultural land habitat restoration programs		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓

Program Sufficiency and Gaps

Forest management programs including the new Forest Practices Rules (private timber lands) are expected to afford protections that will passively and actively restore degraded hillslope conditions. Timber harvest rules are expected to passively restore sediment and runoff processes. The road maintenance and abandonment requirements for private timber lands are expected to actively address road-related impairments within a 15 year time-frame. While these strategies are believed to be largely adequate to protect watershed processes, the degree of implementation and the effectiveness of the prescriptions will not be fully known for at least another 15 or 20 years. Of particular concern is the capacity of some forest land owners, especially small forest owners, to conduct the necessary road improvements (or removal) in the required timeframe. Additional financial and technical assistance would enable small forest landowners to conduct the necessary improvements in a timeline parallel to large industrial timber land owners. Ecological restoration of existing developed and agricultural lands occurs relatively infrequently and there are no programs that specifically require restoration in these areas. Restoring existing developed and farmed lands can involve retrofitting facilities with new materials, replacing existing systems, adopting new management practices, and creating or re-configuring landscaping. Means of increasing restoration activity include increasing landowner participation through education and incentive programs, building support for projects on public lands/facilities, requiring Best Management Practices through permitting and ordinances, and increasing available funding for entities to conduct restoration projects.

#6 - Restore riparian conditions throughout the basin

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore the natural riparian plant community B. Exclude livestock from riparian areas C. Eradicate invasive plant species from riparian areas	• Reduced stream canopy cover • Altered stream temperature regime • Reduced bank/soil stability • Reduced wood recruitment • Lack of stable instream woody debris • Exotic and/or invasive species • Bacteria	• Timber harvest – riparian harvests • Riparian grazing • Clearing of vegetation due to agriculture and residential development	All species	Degradation of riparian forests in the subbasin has contributed to loss of large woody debris recruitment potential, loss of stream shading, loss of streambank stability, loss of floodplain function, and disruption of nutrient exchange and hyporheic flow processes; all of which have potentially deleterious effects to aquatic and terrestrial species. Riparian forest degradation in the upper elevation subwatersheds are primarily related to past forest harvest and road building. Riparian impacts in the lower elevations are related primarily to agricultural development. The increasing abundance of exotic and invasive species is of particular concern. Riparian restoration projects are relatively inexpensive and are often supported by landowners.

Priority Locations

1st- Chinook River between tidal influence (RM 2.5) and Sea Resources Hatchery (RM 4)
2nd- Wallacut River and other small Columbia River tributaries

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDNR	Forest Practices Rules	✓	
WDFW	Habitat Program		✓
Pacific Conservation District / NRCS	Agricultural land habitat restoration programs		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
Noxious Weed Control Boards (State and County level)	Noxious weed control		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring riparian conditions; however, existing programs will afford protections that will allow for the *passive* restoration of riparian forests. These protections are believed to be adequate for riparian areas on forest lands that are subject to Forest Practices Rules. Other lands receive variable levels of protection and passive restoration through the Pacific County Comprehensive Plan. Many degraded riparian zones in agricultural, rural residential, or transportation corridor uses will not passively restore with existing regulatory protections and will require active measures that are not called for in any existing policy. Riparian restoration in these areas may entail livestock exclusion, tree planting, road relocation, invasive species eradication, and adjusting current land-use in the riparian zone. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

#7 – Provide for adequate instream flows during critical periods

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Protect instream flows through water rights closures and enforcement B. Restore instream flows through acquisition of existing water rights C. Restore instream flows through implementation of water conservation measures	• Stream flow – maintain or improve Summer low-flows	• Water withdrawals	All species	There is little information on instream flows in the Estuary Tributaries Basin. The impacts of flow diversions at the Sea Resources Hatchery and at the City of Chinook water supply intake are largely unknown (Wade 2002). This measure applies to instream flows associated with water withdrawals and diversions, generally a concern only during low flow periods. Hillslope processes also affect low flows but these issues are addressed in separate measures.

Priority Locations

Entire Basin

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Resources Program		✓
City of Chinook	Water Supply Program		✓

Program Sufficiency and Gaps

WRIA 24 is not planning under the State's Watershed Planning Act (HB 2514), which sets a framework for local planning units to recommend instream flow rules. The WA State Dept. of Ecology will therefore be responsible for setting instream flow rules if it is deemed necessary.

#8 – Restore degraded water quality

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Exclude livestock from riparian areas B. Increase riparian shading C. Decrease channel width-to-depth ratios D. Reduce delivery of chemical contaminants to streams E. Address leaking septic systems	• Altered stream temperature regime • Bacteria • Chemical contaminants	• Timber harvest – riparian harvests • Riparian grazing • Clearing of vegetation due to rural development and agriculture • Leaking septic systems • Chemical contaminants from agricultural and developed lands	• All species	Little information exists with respect to water quality impairments in the basin. High temperatures have been recorded in the lower Chinook River above the Tidegate (Wade 2002). Rural residential development and agricultural practices suggest that bacteria impairment and contaminant runoff may be a concern, although these impairments may be more pertinent to human health than fish health. The condition of water quality in the basin warrants further investigation.

Priority Locations

1st- Lower Chinook River (temperature)
2nd- All remaining reaches

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
Washington Department of Ecology	Water Quality Program		✓
WDNR	Forest Practices Rules	✓	
WDFW	Habitat Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Pacific Conservation District / NRCS	Agricultural land habitat restoration programs		✓
NGOs, tribes, agencies, landowners	Habitat Projects		✓
Pacific County Health Department	Septic System Program		✓

Program Sufficiency and Gaps

The WDOE Water Quality Program manages the State 303(d) list of impaired water bodies. There are no listings in the Estuary Tributaries Basin (WDOE 2004). The 303(d) listings are believed to address the primary water quality concerns; however, other impairments may exist that the current monitoring effort is unable to detect. Additional monitoring is needed to fully understand the degree of water quality impairment in the basin, especially regarding agricultural pollutants.

#9 - Restore channel structure and stability

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Place stable woody debris in streams to enhance cover, pool formation, bank stability, and sediment sorting B. Structurally modify channel morphology to create suitable habitat C. Restore natural rates of erosion and mass wasting within river corridors	• Lack of stable instream woody debris • Altered habitat unit composition • Reduced bank/soil stability • Excessive fine sediment • Excessive turbidity • Embedded substrates	• None (symptom-focused restoration strategy)	All species	Large wood installation projects could benefit habitat conditions in many areas although watershed processes contributing to wood deficiencies should be considered and addressed prior to placing wood in streams. Other structural enhancements to stream channels may be warranted in some places, especially in lowland alluvial reaches that have been simplified through channel straightening and confinement.

Priority Locations

1st- Chinook River between tidal influence (RM 2.5) and Sea Resources Hatchery (RM 4)
2nd- Wallacut River and other small Columbia River tributaries

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
NGOs, tribes, agencies, landowners	Habitat Projects		✓
WDFW	Habitat Program		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
Pacific Conservation District / NRCS	Agricultural land habitat restoration programs		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for actively restoring channel stability and structure. Passive restoration is expected to slowly occur as a result of protections afforded to riparian areas and hillslope processes. Past projects have largely been opportunistic and have been completed due to the efforts of local NGOs, landowners, and government agencies; such projects are likely to continue in a piecemeal fashion as opportunities arise and if financing is made available. The lack of LWD in stream channels, and the importance of wood for habitat of listed species, places an emphasis on LWD supplementation projects. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

#10 – Create/restore off-channel and side-channel habitat

Submeasures	Factors Addressed	Threats Addressed	Target Species	Discussion
A. Restore historical off-channel and side-channel habitats where they have been eliminated B. Create new channel or off-channel habitats (i.e. spawning channels)	• Loss of off-channel and/or side-channel habitat	• Floodplain filling • Channel straightening • Artificial confinement	chum coho	There has been significant loss of off-channel and side-channel habitats, especially along the lower Chinook and Wallacut Rivers that have been extensively channelized. This has severely limited chum spawning habitat and coho overwintering habitat. Targeted restoration or creation of habitats would increase available habitat where full floodplain and estuary restoration is not possible.

Priority Locations

1st- Lower Chinook and Wallacut Rivers
2nd- Other reaches that may have potential for off-channel and side-channel habitat restoration or creation

Key Programs

Agency	Program Name	Sufficient	Needs Expansion
WDFW	Habitat Program		✓
Lower Columbia Fish Enhancement Group	Habitat Projects		✓
NGOs, tribes, Conservation Districts, agencies, landowners	Habitat Projects		✓
USACE	Water Resources Development Act (Sect. 1135 & Sect. 206)		✓

Program Sufficiency and Gaps

There are no regulatory mechanisms for creating or restoring off-channel and side-channel habitat. Means of increasing restoration activity include building partnerships with landowners, increasing landowner participation in conservation programs, allowing restoration projects to serve as mitigation for other activities, and increasing funding for NGOs, government entities, and landowners to conduct restoration projects.

Table 12. Habitat actions for the Estuary Tributaries Basin.

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
Est-tribs 1. Fully implement and enforce the Forest Practices Rules (FPRs) on private timber lands in order to afford protections to riparian areas, sediment processes, runoff processes, water quality, and access to habitats	Activity is currently in place	WDNR	1, 2, 3, 5, 6 & 8	High: Private commercial timber lands	High: Increase in instream LWD; reduced stream temperature extremes; greater streambank stability; reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
Est-tribs 2. Expand standards in local government comprehensive plans to afford adequate protections of ecologically important areas (i.e. stream channels, riparian zones, floodplains, CMZs, wetlands, unstable geology)	Expansion of existing program or activity	Pacific County, Chinook	1 & 2	Medium: Applies primarily to lands in agriculture, rural residential, and forestland uses with development activity	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High
Est-tribs 3. Prevent floodplain impacts from new development through land use controls and Best Management Practices	New program or activity	Pacific County, WDOE, Chinook	1	Medium: Private lands currently in agriculture or timber production in lowland areas	High: Protection of floodplain function, CMZ processes, and off-channel/side-channel habitat. Prevention of reduced habitat diversity and key habitat availability	High
Est-tribs 4. Create and/or restore lost side-channel/off-channel habitat for chum spawning and coho overwintering	New program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Pacific CD, LCFEG	10	Medium: Lower Chinook and lower Wallacut Rivers	High: Increased habitat availability for spawning and rearing	High
Est-tribs 5. Seize opportunities to conduct voluntary floodplain restoration, where feasible, on lands being phased out of agricultural production. Survey landowners, build partnerships, and provide financial incentives	New program or activity	NRCS, Pacific CD, NGOs, WDFW, LCFRB, USACE, LCFEG	3, 4, 6, 8 & 9	Medium: Chinook and Wallacut Rivers	Medium: Restoration of floodplain function, habitat diversity, and habitat availability.	High
Est-tribs 6. Review and adjust operations to ensure compliance with the Endangered Species Act; examples include roads, parks, and weed management	Expansion of existing program or activity	Pacific County, Chinook	1, 5, 6, & 8	Low: Applies to lands under public jurisdiction	Medium: Protection of water quality, greater streambank stability, reduction in road-related fine sediment delivery, restoration and preservation of fish access to habitats	High
Est-tribs 7. Manage future growth and development patterns to ensure the protection of watershed processes. This includes limiting the conversion of agriculture and timber lands to developed uses through zoning regulations and	Expansion of existing program or activity	Pacific County	1 & 2	Medium: Applies primarily to lands in agriculture, rural residential, and forestland uses with development	High: Protection of water quality, riparian function, stream channel structure (e.g. LWD), floodplain function, CMZs, wetland function, runoff processes, and sediment supply processes	High

[1] Relative amount of basin affected by action
[2] Expected response of action implementation
[3] Relative certainty that expected results will occur as a result of full implementation of action

Action	Status	Responsible Entity	Measures Addressed	Spatial Coverage of Target Area[1]	Expected Biophysical Response[2]	Certainty of Outcome[3]
tax incentives				activity		
Est-tribs 8. Assess instream flows and set instream flow requirements if necessary	Activity is currently in place	WDOE, WDFW, Chinook	7	High: Entire basin	Medium: Adequate instream flows to support life stages of salmonids and other aquatic biota.	Medium
Est-tribs 9. Increase funding available to purchase easements or property in sensitive areas in order to protect watershed function where existing programs are inadequate	Expansion of existing program or activity	LCFRB, NGOs, WDFW, USFWS, BPA (NPCC)	1 & 2	Low: Mixed-use lands at risk of degradation	High: Protection of riparian function, floodplain function, water quality, wetland function, and runoff and sediment supply processes	High
Est-tribs 10. Increase technical assistance to landowners and increase landowner participation in conservation programs that protect and restore habitat and habitat-forming processes. Includes increasing the incentives (financial or otherwise) and increasing program marketing and outreach	Expansion of existing program or activity	NRCS, Pacific CD, WDNR, WDFW, LCFEG, Pacific County	All measures	Medium: Private lands. Applies primarily to lands in agriculture, rural residential, and forestland uses near streams or estuaries	High: Increased landowner stewardship of habitat. Potential improvement in all factors	Medium
Est-tribs 11. Assess the impact of fish passage barriers throughout the basin and restore access to potentially productive habitats	Expansion of existing program or activity	WDFW, WDNR, Pacific County, WSDOT, LCFEG	3	Medium: Passage obstructions include tidegates and culverts	Medium: Increased spawning and rearing capacity due to access to blocked habitat. Habitat is marginal in most cases	High
Est-tribs 12. Increase the level of implementation of voluntary habitat enhancement projects in high priority reaches and subwatersheds. This includes building partnerships, providing incentives to landowners, and increasing funding	Expansion of existing program or activity	LCFRB, BPA (NPCC), NGOs, WDFW, NRCS, Pacific CD, LCFEG	3, 4, 5, 6, 8, 9, & 10	Low: Priority stream reaches and subwatersheds throughout the basin	Medium: Improved conditions related to water quality (temperature and bacteria), LWD quantities, bank stability, key habitat availability, habitat diversity, riparian function, floodplain function, sediment availability, & channel migration processes	Medium
Est-tribs 13. Increase technical support and funding to small forest landowners faced with implementation of Forest and Fish requirements for fixing roads and barriers to ensure full and timely compliance with regulations	Expansion of existing program or activity	WDNR	1, 2, 3, 5, 6 & 8	Low: Small private timberland owners	Medium: Reduction in road-related fine sediment delivery; decreased peak flow volumes; restoration and preservation of fish access to habitats	Medium
Est-tribs 14. Protect and restore native plant communities from the effects of invasive species	Expansion of existing program or activity	Weed Control Boards (local and state); NRCS, Pacific CD, LCFEG	1 & 6	Medium: Greatest risk is in agriculture and residential use areas	Medium: restoration and protection of native plant communities necessary to support watershed and riparian function	Low
Est-tribs 15. Assess, upgrade, and replace on-site sewage systems that may be contributing to water quality impairment	Expansion of existing program or activity	Pacific County, WDOE, Pacific CD	8	Low: Private agricultural and rural residential lands	Medium: Protection and restoration of water quality (bacteria)	Medium

5.5 Hatcheries

5.5.1 *Subbasin Hatchery Strategy*

The desired future state of fish production within the Estuary Tributary Basin includes natural salmon and steelhead populations that are improving on a trajectory to recovery and hatchery programs that either enhance the natural fish recovery trajectory or are operated to not impede progress towards recovery. Hatchery recovery actions in each subbasin are tailored to the specific ecological and biological circumstances for each species in the subbasin. This may involves substantial changes in some hatchery programs from their historical focus on production for mitigation for lost fishing benefits. The recovery strategy includes a mixture of conservation programs and mitigation programs. Mitigation programs involve areas or practices selected for consistency with natural population conservation and recovery objectives. A summary of the types of natural production enhancement strategies and fishery enhancement strategies to be implemented in the Chinook River and Deep River are displayed by species in Table 13. More detailed descriptions and discussion of the regional hatchery strategy can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 13. Summary of natural production and fishery enhancement strategies to be implemented in the Estuary Tributary Basin.

		Species				
		Fall Chinook	**Spring Chinook**	**Coho**	**Chum**	**Winter Steelhead**
Natural Production Enhancement	**Supplementation**	✓		✓	✓	
	Hatchery/Natural Conservation 1/					
	Isolation					
	Refuge					
Fishery Enhancement (Deep River)	**Hatchery Production**		✓	✓		

1/ Hatchery and natural population management strategy coordinated to meet biological recovery objectives. Strategy may include integration and/or isolation strategy over time. Strategy will be unique to biological and ecological circumstances in each watershed.

Conservation-based hatchery programs include strategies and actions which are specifically intended to enhance or protect production of a particular wild fish population within the basin. A unique conservation strategy is developed for each species and watershed depending on the status of the natural population, the biological relationship between the hatchery and natural populations, ecological attributes of the watershed, and logistical opportunities to jointly manage the populations. Four types of hatchery conservation strategies may be employed:

Natural Refuge Watersheds: In this strategy, certain sub-basins are designated as wild-fish-only areas for a particular species. The refuge areas include watersheds where populations have persisted with minimum hatchery influence and areas that may have a history of hatchery production but would not be subjected to future hatchery influence as part of the recovery strategy. More refuge areas may be added over time as wild populations recover. These refugia provide an opportunity to monitor population trends independent of the confounding influence of hatchery fish natural population on fitness and the ability to monitor natural fish and will be key indicators of natural population status within the ESU. This strategy is not currently planned for the Estuary Tributary Basin.

Hatchery Supplementation: This strategy utilizes hatchery production as a tool to assist in rebuilding depressed natural populations. Supplementation would occur in selected areas that are producing natural fish at levels significantly below current capacity or capacity is expected to increase as a result of immediate benefits of habitat or passage improvements. This is intended to be a temporary measure to jump start critically low populations and to bolster natural fish numbers above critical levels in selected areas until habitat is restored to levels where a population can be self sustaining. This strategy would include fall Chinook, coho and chum in the Estuary Tributary Basin.

Hatchery/Natural Isolation: This strategy is focused on physically separating hatchery adult fish from naturally-produced adult fish to avoid or minimize spawning interactions to allow natural adaptive processes to restore native population diversity and productivity. The strategy may be implemented in the entire watershed or more often in a section of the watershed upstream of a barrier or trap where the hatchery fish can be removed. This strategy is currently aimed at hatchery steelhead in watersheds with trapping capabilities. The strategy may also become part of spring and fall Chinook as well as coho strategy in certain watersheds in the future as unique wild runs develop. This strategy would not be included in near-term actions for the Estuary Tributary Basin but could be considered in the future for coho. This definition refers only to programs where fish are physically sorted using a barrier or trap. Some fishery mitigation programs, particularly for steelhead, are managed to isolate hatchery and wild stocks based on run timing and release locations.

Hatchery/Natural Merged Conservation Strategy: This strategy addresses the case where natural and hatchery fish have been homogenized over time such that they are principally all one stock that includes the native genetic material for the basin. Many spring Chinook, fall Chinook, and coho populations in the lower Columbia currently fall into this category. In many cases, the composite stock productivity is no longer sufficient to support a self-sustaining natural population especially in the face of habitat degradation. The hatchery program will be critical to maintaining any population until habitat can be improved and a strictly natural population can be re-established. This merged strategy is intended to transition these mixed populations to a self-supporting natural population that is not subsidized by hatchery production or subject to deleterious hatchery impacts. Elements include separate management of hatchery and natural subpopulations, regulation of hatchery fish in natural areas, incorporation of natural fish into hatchery broodstock, and annual abundance-driven distribution. Corresponding programs are expected to evolve over time dependent on changes in the populations and in the habitat productivity. This strategy is primarily aimed at Chinook salmon in areas where harvest production occurs. There is not a Chinook harvest program in the Estuary Tributary Basin.

Not every lower Columbia River hatchery program will be turned into a conservation program. The majority of funding for lower Columbia basin hatchery operations is for producing salmon and steelhead for harvest to mitigate for lost harvest of natural production due to hydro development and habitat degradation. Programs for fishery enhancement will continue during the recovery period, but will be managed to minimize risks and ensure they do not compromise recovery objectives for natural populations. It is expected that the need to produce compensatory fish for harvest through artificial production will reduce in the future as natural populations recover and become harvestable.

The Sea Resources Hatchery will be operated to include natural production enhancement strategies for Chinook River fall Chinook, chum and coho. There is no fishery enhancement programs at Sea Resources Hatchery. There is Select Area harvest programs for spring chinook and coho in Deep River net pens (Table 14).

Table 14. A summary of conservation and harvest strategies to be implemented through Sea Resources and Deep River Hatchery programs.

		Stock
Natural Production Enhancement	Supplementation	Chinook River Coho Chinook River Fall Chinook Grays River Chum
	Hatch/Nat Conservation [1/]	
	Isolation	
	Broodstock Development	Chinook River Coho Chinook River Fall Chinook
Fishery Enhancement	In-basin releases	Cowlitz/Lewis spring Chinook
	(Final Rearing in Deep River net pens)	Grays River early coho

1/ May include integrated and/or isolated strategy over time.
√ Denotes new program

5.5.2 *Hatchery Actions*

Hatchery strategies and actions are focused on evaluating and reducing biological risks consistent with the conservation strategies identified for each natural population. Artificial production programs within Estuary Tributary facilities have been evaluated in detail through the WDFW Benefit-Risk Assessment Procedure (BRAP) relative to risks to natural populations. The BRAP results were utilized to inform the development of these program actions specific to the Estuary Tributary Basin (Table 15). The Sub-Basin plan hatchery recovery actions were developed in coordination with WDFW and at the same time as the Hatchery and Genetic Management Plans (HGMP) were developed by WDFW for each hatchery program. As a result, the hatchery actions represented in this document will provide direction for specific actions which will be detailed in the HGMPs submitted by WDFW for public review and for NOAA fisheries approval. It is expected that the HGMPs and these recovery actions will be complimentary and provide a coordinated strategy for the Estuary Tributary Basin hatchery programs. Further explanation of specific strategies and actions for hatcheries can be found in the Regional Recovery and Subbasin Plan Volume I.

Table 15. Hatchery program actions to be implemented in the Estuary Tributary Basin.

Activitiy	Action	Hatchery Program Addressed	Natural Populations Addressed	Limiting Factors Addressed	Threats Addressed	Expected Outcome
• Continue to mass mark spring Chinook and coho hatchery releases from Deep River net-pens to provide the means to identify hatchery fish for selective fisheries and to distinguish between hatchery and wild fish in basins where non harvested adults may stray.	*Adipose fin-clip mark hatchery released coho and spring Chinook	Deep River net-pen coho and spring Chinook.	Grays River,Chinook, and Elochoman coho. Cowlitz, Kalama, Lewis Spring Chinook.	Domestication, Diversity, Abundance	• In-breeding • Harvest	• Maximize harvest of net pen releases while minimizing impacts to natural produced coho and spring Chinook. • Enable visual identification of hatchery and wild returns to provide the means to account for and manage the natural and wild escapement of steehead and coho consistent with biological objectives
• Continue chum brood stock program utilizing Grays River natural stock for supplementation and risk management of the Chinook chum population. • Continue and further develop the Sea Resources fall Chinook and coho enhancement programs aimed at the Chinook River natural populations	*Sea Resources Hatchery facility utilized for supplementation and enhancement of: natural chum, fall Chinook, and coho populations.	Grays River Hatchery chum, Sea Resources Hatchery coho and fall Chinook.	Chinook River chum, coho, and fall Chinook	Abundance, Spatial distribution	• Low numbers of natural spawners • Ecologically appropriate natural brood stock	• Continue propagation of Grays River chum brood stock to supplement and manage risks to Grays River, Chinook River and other local coastal populations. Increase abundance and distribution of coastal chum populations. • Rebuild ecologically adapted populations of coho and chum in the Chinook River Basin.
• Hatchery effluent discharge complies with NPDES permit monitoring requirements. Fish health monitored and treated as per co-managers fish health policy.	*Evaluate facility operations	All species	All species	Habitat quality	• Water Quality	• Hatchery fish disease controlled and water quality standards upheld to avoid impact to habitat quality in the Chinook River downstream of the Sea Resources Hatchery.
• Research, monitoring , and evaluation of performance of the above actions in relation to expected outcomes • Performance standards developed for each actions with measurable criteria to determine success or failure • Adaptive Management applied to adjust or change actions as necessary	** Monitoring and evaluation, adaptive management	All species	All species	Hatchery production performance, Natural production performance	• All of above	• Clear standards for performance and adequate monitoring programs to evaluate actions. • Adaptive management strategy reacts to information and provides clear path for adjustment or change to meet performance standard

** Extension or improvement of existing actions-may require additional funding*
*** New action-will likely require additional funding*

5.6 Harvest

Fisheries are both an impact that reduces fish numbers and an objective of recovery. The long-term vision is to restore healthy, harvestable natural salmonid populations in many areas of the lower Columbia basin. The near-term strategy involves reducing fishery impacts on natural populations to ameliorate extinction risks until a combination of actions can restore natural population productivity to levels where increased fishing may resume. The regional strategy for interim reductions in fishery impacts involves: 1) elimination of directed fisheries on natural populations, 2) regulation of mixed stock fisheries for healthy hatchery and natural populations to limit and minimize indirect impacts on natural populations, 3) scaling of allowable indirect impacts for consistency with recovery, 4) annual abundance-based management to provide added protection in years of low abundance, while allowing greater fishing opportunity consistent with recovery in years with much higher abundance, and 5) mass marking of hatchery fish for identification and selective fisheries.

Actions to address harvest impacts are generally focused at a regional level to cover fishery impacts accrued to lower Columbia salmon as they migrate along the Pacific Coast and through the mainstem Columbia River. Fisheries are no longer directed at weak natural populations but incidentally catch these fish while targeting healthy wild and hatchery stocks. Subbasin fisheries affecting natural populations have been largely eliminated. Fishery management has shifted from a focus on maximum sustainable harvest of the strong stocks to ensuring protection of the weak stocks. Weak stock protections often preclude access to large numbers of otherwise harvestable fish in strong stocks.

Fishery impact limits to protect ESA-listed weak populations are generally based on risk assessments that identify points where fisheries do not pose jeopardy to the continued persistence of a listed group of fish. In many cases, these assessments identify the point where additional fishery reductions provide little reduction in extinction risks. A population may continue to be at significant risk of extinction but those risks are no longer substantially affected by the specified fishing levels. Often, no level of fishery reduction will be adequate to meet naturally-spawning population escapement goals related to population viability. The elimination of harvest will not in itself lead to the recovery of a population. However, prudent and careful management of harvest can help close the gap in a coordinated effort to achieve recovery.

Fishery actions specific to the subbasins are addressed through the Washington State Fish and Wildlife sport fishing regulatory process. This public process includes an annual review focused on emergency type regulatory changes and a comprehensive review of sport fishing regulations which occurs every two years. This regulatory process includes development of fishing rules through the Washington Administrative Code (WAC) which are focused on protecting weak stock populations while providing appropriate access to harvestable populations. The actions consider the specific circumstances in each area of each subbasin and respond with rules that fit the relative risk to the weak populations in a given time and area of the subbasin. There are no tributary salmon or steelhead fisheries in the Chinook River or other small estuary tributaries. There is salmon and trout sport fishing and salmon commercial fishing in Deep River. Following is a general summary of the regulatory and protective sport fishery actions specific to Deep and Chinook rivers. Grays River tributary fishery actions can be found in the Grays River Subbasin Plan.

Table 16. Summary of regulatory and protective fishery actions in the Estuary tributaries.

Species	General Fishing Actions	Explanation	Other Protective Fishing Actions	Explanation
Fall Chinook	Closed in Chinook River.	Protects wild fall Chinook. No hatchery produced fall Chinook for harvest in Chinook River or Deep River	All salmon and trout fishing closed in Chinook River	Further protection of wild fall Chinook spawners
chum	Closed in Chinook and to retention in Deep River	Protects natural chum. Hatchery chum are not produced for harvest	Coho commercial seasons occur in Deep River boundaries	Minimizes potential for interception of Grays or Chinook River chum salmon
coho	Retain only adipose fin-clip marked coho in Deep River sport fishery. Season closed in Chinook River	Selective fishery for hatchery coho, unmarked wild coho must be released	Commercial fishery within Deep River boundary	Protects wild coho destined for Grays, Chinook, or other Estuary tributaries

Regional actions cover species from multiple watersheds which share the same migration routes and timing, resulting in similar fishery exposure. Regional strategies and actions for harvest are detailed in the Regional Recovery and Subbasin Plan Volume I. A number of regional strategies for harvest involve implementation of actions within specific subbasins. In-basin fishery management is generally applicable to steelhead and salmon while regional management is more applicable to salmon. Harvest actions with significant application to the Grays/Estuary Subbasin populations are summarized in Table 17.

Table 17. Regional harvest actions from Volume I, Chapter 7 with significant application to the Columbia Estuary Tributaries Subbasin populations.

Action	Description	Responsible Parties	Programs	Comments
**F.A8	Develop a regional mass marking program for tule fall Chinook	WDFW, NOAA, USFWS, Col. Tribes	U.S. Congress, Washington Fish and Wildlife Commission, U.S. v. Oregon, PSC	Retention of salmon is prohibited in Grays River sport fisheries, however marking of other hatchery tule Chinook would provide regional selective fishing options.
**F.A12	Monitor chum handle rate in winter steelhead and late coho tributary sport fisheries.	WDFW	WDFW Creel Program	State agencies would include chum incidental handle assessments as part of their annual tributary sport fishery sampling plan.
*F.A13	Monitor and evaluate commercial and sport impacts to naturally-spawning steelhead in salmon and hatchery steelhead target fisheries.	WDFW, ODFW	Columbia River Compact, BPA Fish and Wildlife Program, PFMC	Includes monitoring of naturally-spawning steelhead encounter rates in fisheries and refinement of long-term catch and release handling mortality estimates. Would include assessment of the current monitoring programs and determine their adequacy in formulating naturally-spawning steelhead incidental mortality estimates.
*F.A14	Continue to improve gear and regulations to minimize incidental impacts to naturally-spawning steelhead.	WDFW, ODFW	Columbia River Compact, BPA Fish and Wildlife Program	Regulatory agencies should continue to refine gear, handle and release methods, and seasonal options to minimize mortality of naturally-spawning steelhead in commercial and sport fisheries.
*F.A20	Maintain selective sport fisheries in ocean, Columbia River, and tributaries and monitor naturally-spawning stock impacts.	WDFW, NOAA, ODFW, USFWS	Columbia River Compact, PFMC	Mass marking of lower Columbia River coho and steelhead has enabled successful ocean and freshwater selective fisheries to be implemented since 1998. Marking programs should be continued and fisheries monitored to provide improved estimates of naturally-spawning salmon and steelhead release mortality.

* Extension or improvement of existing action
** New action

5.7 Hydropower

No dams or hydropower facilities exist in the Estuary Tributaries Basin, hence, no in-basin hydropower actions are identified. Estuary tributary anadromous fish populations will benefit from regional hydropower actions recovery actions and actions identified in regional plans to address habitat effects in the mainstem and estuary.

5.8 Mainstem and Estuary Habitat

Estuary tributary anadromous fish populations will also benefit from regional recovery strategies and actions identified to address habitat conditions and threats in the Columbia River mainstem and estuary. Regional recovery plan strategies involve: 1) avoiding large scale habitat changes where risks are known or uncertain, 2) mitigating small-scale local habitat impacts to ensure no net loss, 3) protecting functioning habitats while restoring impaired habitats to functional conditions, 4) striving to understand, protect, and restore habitat-forming processes, 5) moving habitat conditions in the direction of the historical template which is presumed to be more consistent with restoring viable populations, and 6) improving understanding of salmonids habitats use in the Columbia River mainstem and estuary and their response to habitat changes. A series of specific actions are detailed in the regional plan for each of these strategies.

5.9 Ecological Interactions

For the purposes of this plan, ecological interactions refer to the relationships of salmon anadromous steelhead with other elements of the ecosystem. Regional strategies and actions pertaining to exotic or non-native species, effects of salmon on system productivity, and native predators of salmon are detailed and discussed at length in the Regional Recovery and Subbasin Plan Volume I and are not revised at length in each subbasin plan. Strategies include 1) avoiding, eliminating introductions of new exotic species and managing effects of existing exotic species, 2) recognizing the significance of salmon to the productivity of other species and the salmon themselves, and 3) managing predation by selected species while also maintaining a viable balance of predator populations. A series of specific actions are detailed in the regional plan for each of these strategies. Implementation will occur at the regional and subbasin scale.

5.10 Monitoring, Research, & Evaluation

Biological status monitoring quantifies progress toward ESU recovery objectives and also establishes a baseline for evaluating causal relationships between limiting factors and a population response. Status monitoring involves routine and intensive efforts. Routine monitoring of biological data consists of adult spawning escapement estimates, whereas routine monitoring for habitat data consists of a suite of water quality and quantity measurements.

Intensive monitoring supplements routine monitoring for populations and basins requiring additional information. Intensive monitoring for biological data consists of life-cycle population assessments, juvenile and adult abundance estimates and adult run-reconstruction. Intensive monitoring for habitat data includes stream/riparian surveys, and continuous stream flow assessment. The need for additional water quality sampling may be identified. Rather than prescribing one monitoring strategy, three scenarios are proposed ranging in level of effort and cost from high to low (Level 1-3 respectively). Given the fact that routine monitoring is ongoing, only intensive monitoring varies between each level.

An in-depth discussion of the monitoring, research and evaluation (M, R & E) approach for the Lower Columbia Region is presented in the Regional Recovery and Management Plan. It includes site selection rationale, cost considerations and potential funding sources. The following table (Table 18) summarizes the biological monitoring efforts specific to the Estuary Tributaries.

Table 18. Summary of the biological monitoring plan for the estuary tributaries populations.

Estuary Tributary: Lower Columbia Biological Monitoring Plan						
Monitoring Type	Fall Chinook	Chum	Coho			
Routine	AA	AA	AA			
Intensive						
Level 1						
Level 2						
Level 3						

AA Annual adult abundance estimates
✓ Adult and juvenile intensive biological monitoring occurs periodically on a rotation schedule (every 9 years for 3-year duration)
× Adult and juvenile intensive biological monitoring occurs annually

6.0 References

Arp, A.H., J.H. Rose, S.K. Olhausen. 1971. Contribution of Columbia River hatcheries to harvest of 1963 brood fall chinook salmon. Nation Marine Fisheries Service (NMFS), Portland, OR.

Beamish, R.J. and D.R. Bouillon. 1993. Pacific salmon production trends in relation to climate. Canadian Journal of Fisheries and Aquatic Science 50:1002-1016.

Bryant, F.G. 1949. A survey of the Columbia River and its tributaries with special reference to its fishery resources--Part II Washington streams from the mouth of the Columbia to and including the Klickitat River (Area I). U.S. Fish and Wildlife Service (USFWS). Special Science Report 62:110.

Bureau of Commercial Fisheries. 1970. Contribution of Columbia River hatcheries to harvest of 1962 brood fall chinook salmon (Oncorhynchus tshawytscha). Bureau of Commercial Fisheries, Portland, OR.

Fiscus, H. 1991. 1990 chum escapement to Columbia River tributaries. Washington Department of Fisheries (WDF).

Grant, S., J. Hard, R. Iwamoto, R., O. Johnson, R. Kope, C. Mahnken, M. Schiewe, W. Waknitz, R. Waples, J. Williams. 1999. Status review update for chum salmon from Hood Canal summer-run and Columbia River ESU's. National Marine Fisheries Service (NMFS).

Hare, S.R., N.J. Mantua and R.C. Francis. 1999. Inverse production regimes: Alaska and West Coast Pacific salmon. Fisheries 24(1):6-14.

Harlan, K. 1999. Washington Columbia River and tributary stream survey sampling results, 1998. Washington Department of fish and Wildlife (WDFW). Columbia River Progress Report 99-15, Vancouver, WA.

Hopley, C. Jr. 1980. Cowlitz spring chinook rearing density study. Washington Department of Fisheries (WDF), Salmon Culture Division.

Hymer, J. 1993. Estimating the natural spawning chum population in the Grays River Basin, 1944-1991. Washington Department of Fisheries (WDF), Columbia River Laboratory Progress Report 93-17, Battle Ground, WA.

Hymer, J., R. Pettit, M. Wastel, P. Hahn, K. Hatch. 1992. Stock summary reports for Columbia River anadromous salmonids, Volume III: Washington subbasins below McNary Dam. Bonneville Power Administration (BPA), Portland, OR.

Keller, K. 1999. 1998 Columbia River chum return. Washington Department of Fish and Wildlife (WDFW), Columbia River Progress Report 99-8, Vancouver, WA.

Lawson, P.W. 1993. Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. Fisheries 18(8):6-10.

LeFleur, C. 1987. Columbia River and tributary stream sruvey sampling results, 1986. Washington Department of Fisheries (WDF), Progress Report 87-8, Battle Ground, WA.

LeFleur, C. 1988. Columbia River and tributary stream survey sampling results, 1987. Washington Department of Fisheries (WDF), Progress Report, 88-17, Battle Ground, WA.

Leider, S. 1997. Status of sea-run cutthroat trout in Washington. Oregon Chapter, American Fisheries Society. In: J.D. Hall, P.A. Bisson, and R.E. Gresswell (eds) Sea-run cutthroat trout: biology, management, and future conservation. pp. 68-76. Corvallis, OR.

Lisle, T., A. Lehre, H. Martinson, D. Meyer, K. Nolan, R. Smith. 1982. Stream channel adjustments after the 1980 Mount St. Helens eruptions Proceedings of a symposium on erosion control in volcanic areas. Proceedings of a symposium on erosion control in volcanic areas. Seattle, WA.

Lower Columbia Fish Recovery Board (LCFRB) 2001. Level 1 Watershed Technical Assessment for WRIAs 25 and 26. Prepared by Economic and Engineering Services for the LCFRB. Longview, Washington.

Lower Columbia Fish Recovery Board (LCFRB). 2004. Grays-Elochoman and Cowlitz Rivers Watershed Planning - WRIAs 25 and 26. Watershed Management Plan. September 2004 DRAFT.

Marcot, B.G., W.E. McConnaha, P.H. Whitney, T.A. O'Neil, P.J. Paquet, L. Mobrand, G.R. Blair, L.C. Lestelle, K.M. Malone and K.E. Jenkins. 2002. A multi-species framework approach for the Columbia River Basin

Marriott, D. et. al. . 2002. Lower Columbia River and Columbia River Estuary Subbasin Summary. Northwest Power Planning Council.

McKinnell, S.M., C.C. Wood, D.T. Rutherford, K.D. Hyatt and D.W. Welch. 2001. The demise of Owikeno Lake sockeye salmon. North American Journal of Fisheries Management 21:774-791.

Mikkelsen, N. 1991. Escapement reports for Columbia Rive hatcheries, all species, from 1960-1990. Washington Department of Fisheries (WDF).

National Research Council (NRC). 1992. Restoration of aquatic systems. National Academy Press, Washington, D.C., USA.

National Research Council (NRC). 1996. Upstream: Salmon and society in the Pacific Northwest. National Academy Press, Washington, D.C.

Pyper, B.J., F.J. Mueter, R.M. Peterman, D.J. Blackbourn and C.C. Wood. 2001. Spatial convariation in survival rates of Northeast Pacific pink salmon (Oncorhynchus gorbuscha). Canadian Journal of Fisheries and Aquatic Sciences 58:1501-1515.

Roni, P., T.J. Beechie, R.E. Bilby, F.E. Leonetti, M.M. Pollock and G.R. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest Watersheds. North American Journal of Fisheries Management 22:1-20. American Fisheries Society.

Rothfus, L.O., W.D. Ward, E. Jewell. 1957. Grays River steelhead trout population study, December 1955 through April 1956. Washington Department of Fisheries (WDF).

Tracy, H.B., C.E. Stockley. 1967. 1966 Report of Lower Columbia River tributary fall chinook salmon stream population study. Washington Department of Fisheries (WDF).

Wade, G. 2001. Salmon and Steelhead habitat Limiting Factors, Water Resource Inventory Area 25. Washington State Conservation Commission. Water Resource Inventory Area 25.

Wade, G. 2002. Salmon and steelhead habitat limiting factors, WRIA 25 (Grays-Elochoman). Washington Department of Ecology.

Wahle, R.J., A.H. Arp, A.H., S.K. Olhausen. 1972. Contribution of Columbia River hatcheries to harvest of 1964 brood fall chinook salmon (Oncorhynchus tshawytscha). National Marine Fisheries Service (NMFS), Economic Feasibility Report Vol:2, Portland, OR.

Wahle, R.J., R.R. Vreeland. 1978. Bioeconomic contribution of Columbia River hatchery fall chinook salmon, 1961 through 1964. National Marine Fisheries Service (NMFS). Fishery Bulletin 1978(1).

Wahle, R.J., R.R. Vreeland, R.H. Lander. 1973. Bioeconomic contribution of Columbia River hatchery coho salmon, 1965 and 1966 broods, to the Pacific salmon fisheries. National Marine Fisheries Service (NMFS), Portland, OR.

Wahle, R.J., R.R. Vreeland, R.H. Lander. 1974. Bioeconomic contribution of Columbia River hatchery coho salmon, 1965 and 1966 broods, to the Pacific Salmon Fisheries. Fishery Bulletin 72(1).

Washington Department of Ecology (WDOE). 1998. 303(d) List of Threatened and Impaired Water Bodies. WDOE Water Quality Program. Olympia, WA.

Washington Department of Ecology (WDOE) 2004. 2002/2004. Draft 303(d) List of threatened and impaired water bodies .

Washington Department of Fish and Wildlife (WDFW). 1996. Lower Columbia River WDFW hatchery records. Washington Department of Fish and Wildlife (WDFW).

Washington Department of Fish and Wildlife (WDFW). 1997. Preliminary stock status update for steelhead in the Lower Columbia River. Washington Department of Fish and Wildlife (WDFW), Vancouver, WA.

Wendler, H.O., E.H. LeMier, L.O. Rothfus, E.L. Preston, W.D. Ward, R.E. Birtchet. 1956. Columbia River Progress Report, January through April, 1956. Washington Department of Fisheries (WDF).

Western Regional Climate Center (WRCC). 2003. National Oceanic and Atmospheric Organization - National Climatic Data Center. URL: http://www.wrcc.dri.edu/index.html.

Woodard, B. 1997. Columbia River Tributary sport Harvest for 1994 and 1995. Washington Department of Fish and Wildlife (WDFW), Battle Ground, WA.

Worlund, D.D., R.J. Wahle, P.D. Zimmer. 1969. Contribution of Columbia River hatcheries to harvest of fall chinook salmon (Oncorhynchus tshawytscha). Fishery Bulletin 67(2).