Volume II, Chapter 3
Columbia River Estuary Tributaries

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3.0 COLUMBIA RIVER ESTUARY TRIBUTARIES

3.1 Subbasin Description

3.1.1 Topography & Geology

The Columbia Estuary Tributaries Planning 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/Land 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. 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. 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.

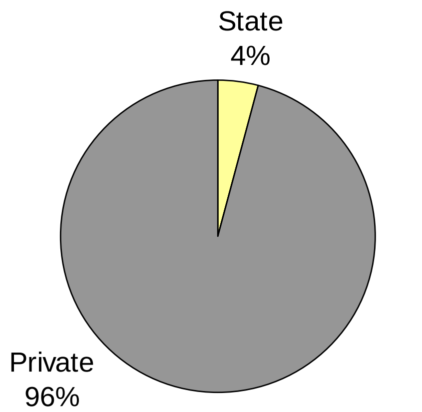


Figure 3-1.Estuary tributaries subbasin land ownership

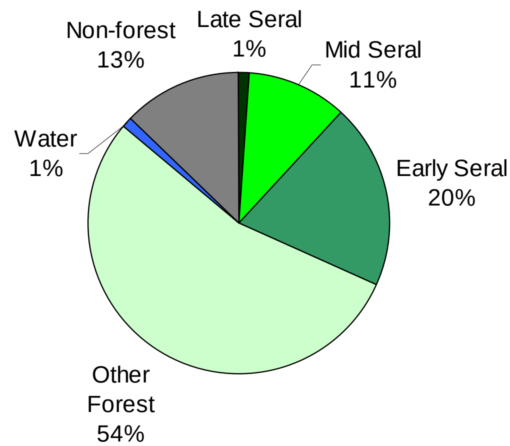


Figure 3-2. Estuary tributaries subbasin land cover

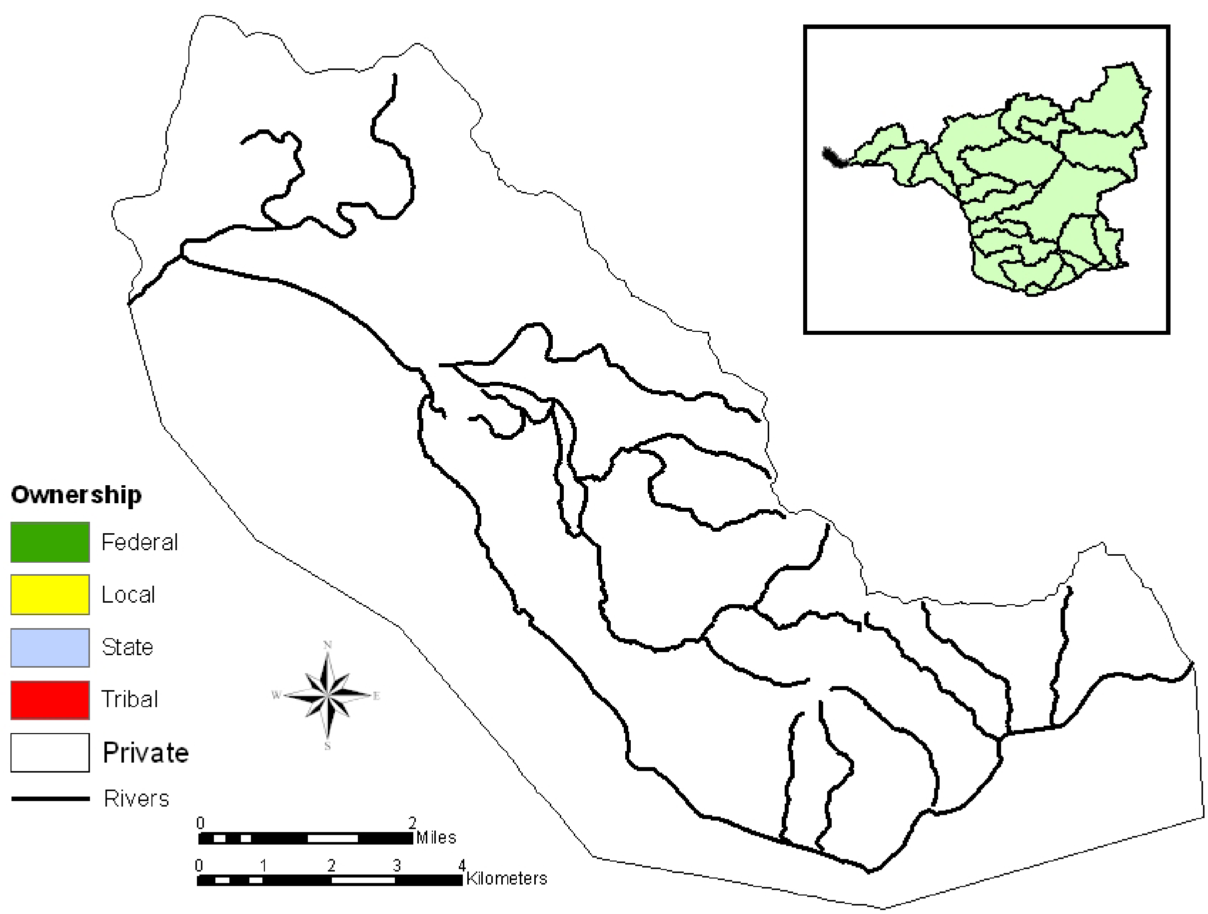


Figure 3-3. Landownership within the Columbia River Estuary tributaries subbasin. Data is WDNR data that was obtained from the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

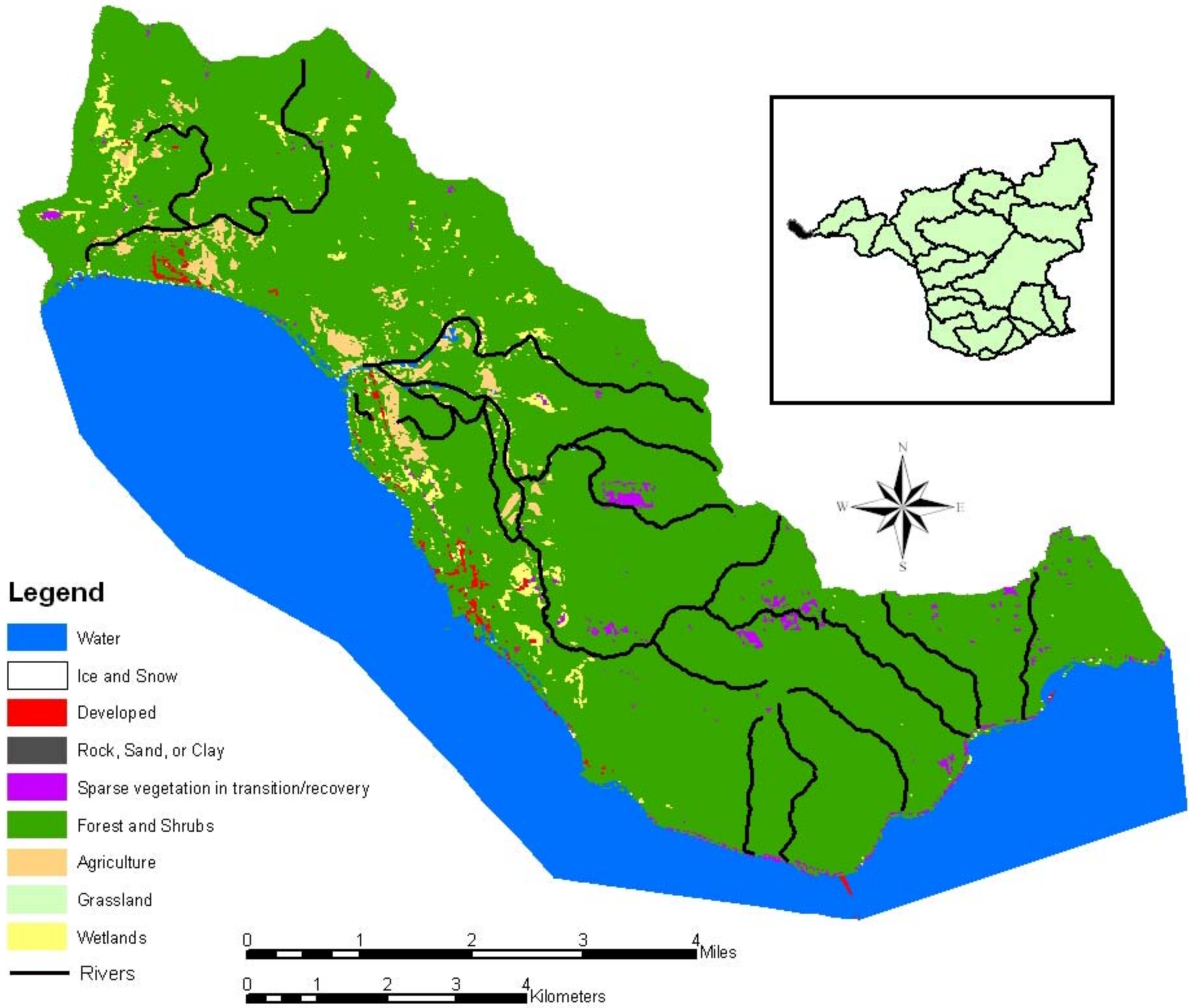
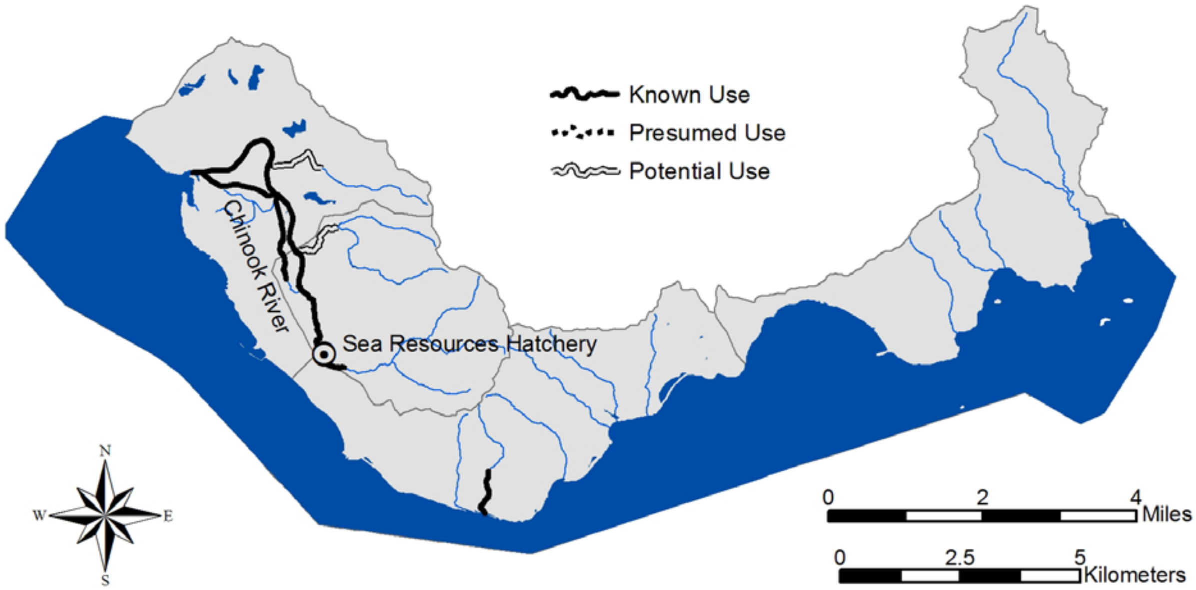


Figure 3-4. Land cover within the Columbia River Estuary tributaries subbasin. Data was obtained from the USGS National Land Cover Dataset (NLCD).

3.2 Focal Fish Species

3.2.1 Chum—Columbia River Estuary Tributaries Subbasin

ESA: Threatened 1999	SASSI: NA



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

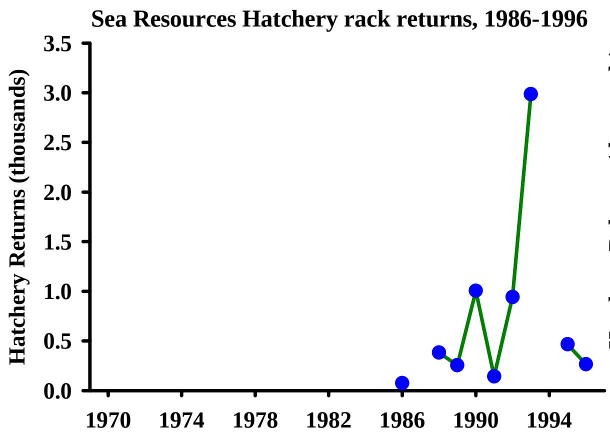
- Sea Resources Hatchery (on the Chinook River) brood stock has been taken from the Chinook, Nemah, Bear, and Naselle Rivers and other unknown stocks; current program produces only Grays River stock

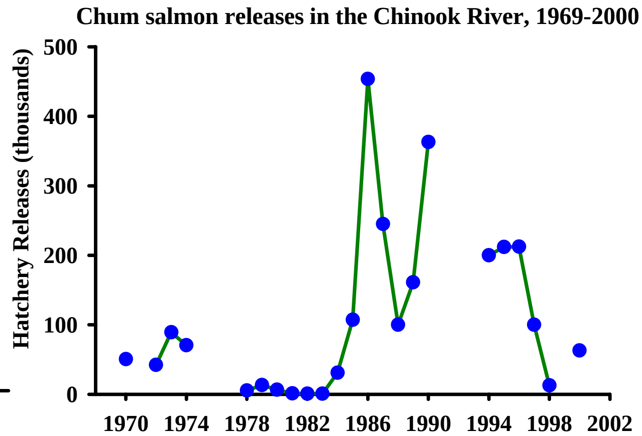
Abundance

- In 1951, estimated escapement to Crooked and Jim Crow Creeks was 1,200 chum

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

3.3 Potentially Manageable Impacts

The Potentially Manageable Impacts were not assessed for the Columbia Estuary Tributaries

3.4 Hatchery Programs

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.

- 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%.
- Coho salmon hatchery program release goal is 52,500 yearling coho smolts.
- 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. Hatchery rack returns have generally been under 1,000 adults; the current chum population is not self-sustaining.

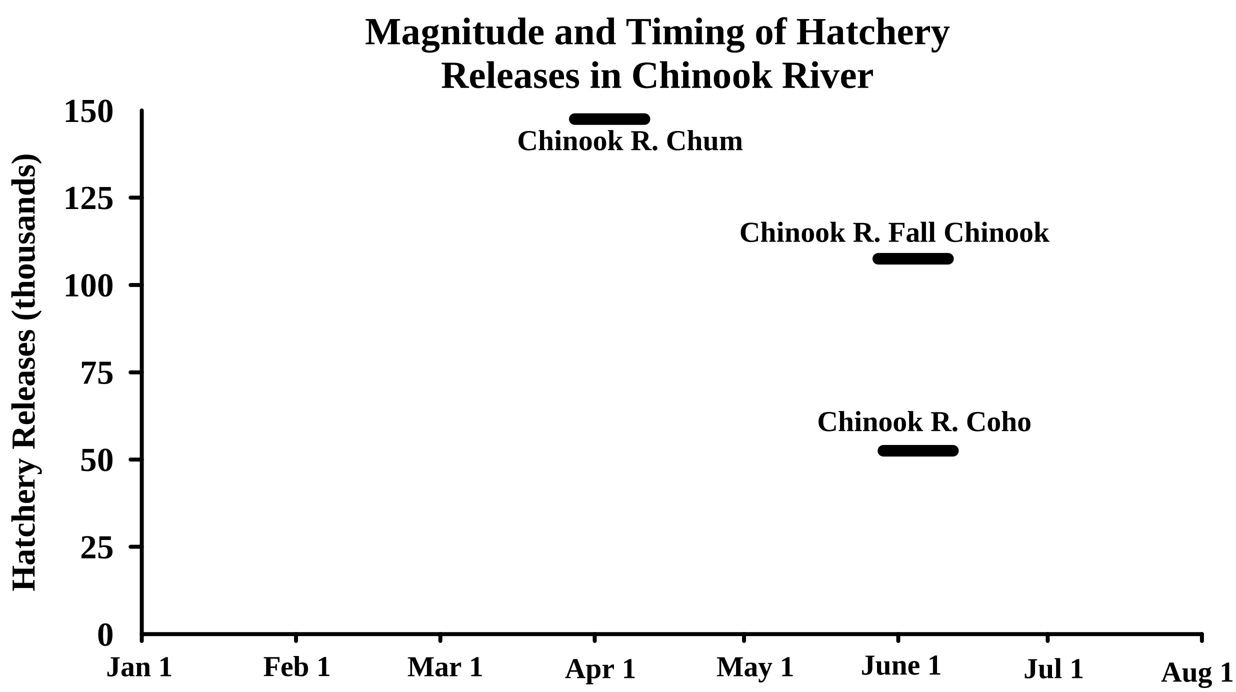


Figure 3-5. Magnitude and timing of hatchery releases in the Chinook River basin by species, based on 2003 brood production goals.

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.

There is some uncertainty about the origin of broodstock for the coho salmon hatchery program at the Sea Resources Hatchery; current broodstock collection likely comes from adults returning to the hatchery.

Chum salmon broodstock for the Sea Resources Hatchery had 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, despite large releases of hatchery smolts. 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.

3.4.1.1 Deep River

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 3-6). 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 3-6).

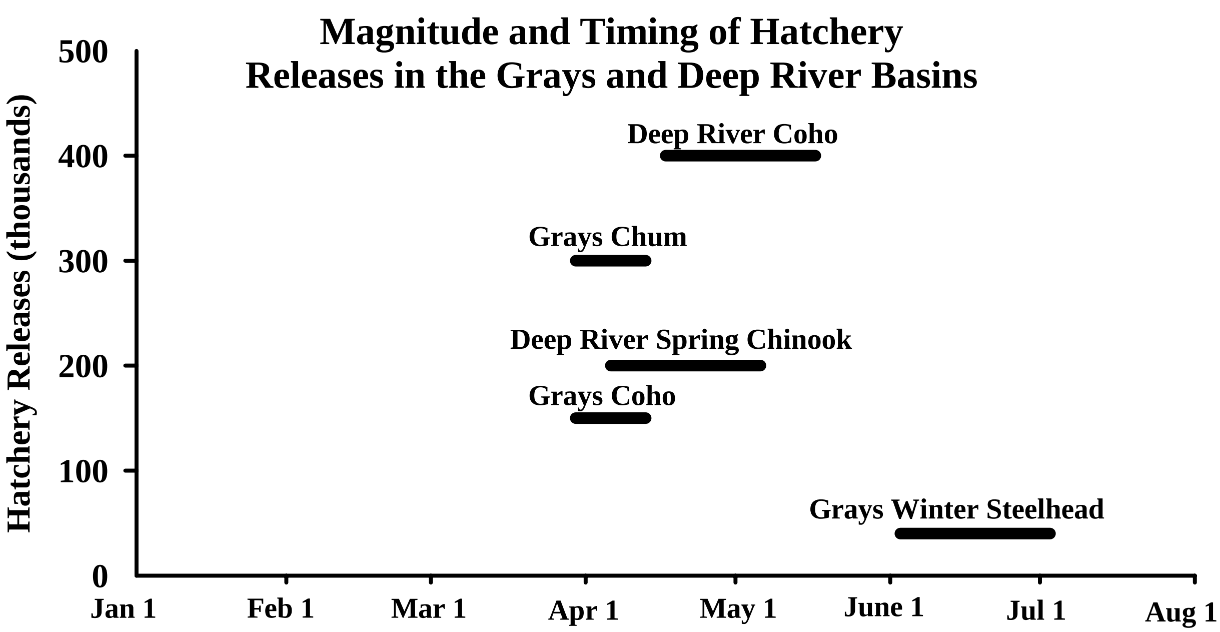


Figure 3-6. Magnitude and timing of hatchery releases in the Deep River and Grays River basins by species, based on 2003 brood production goals.

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 3-7). 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.

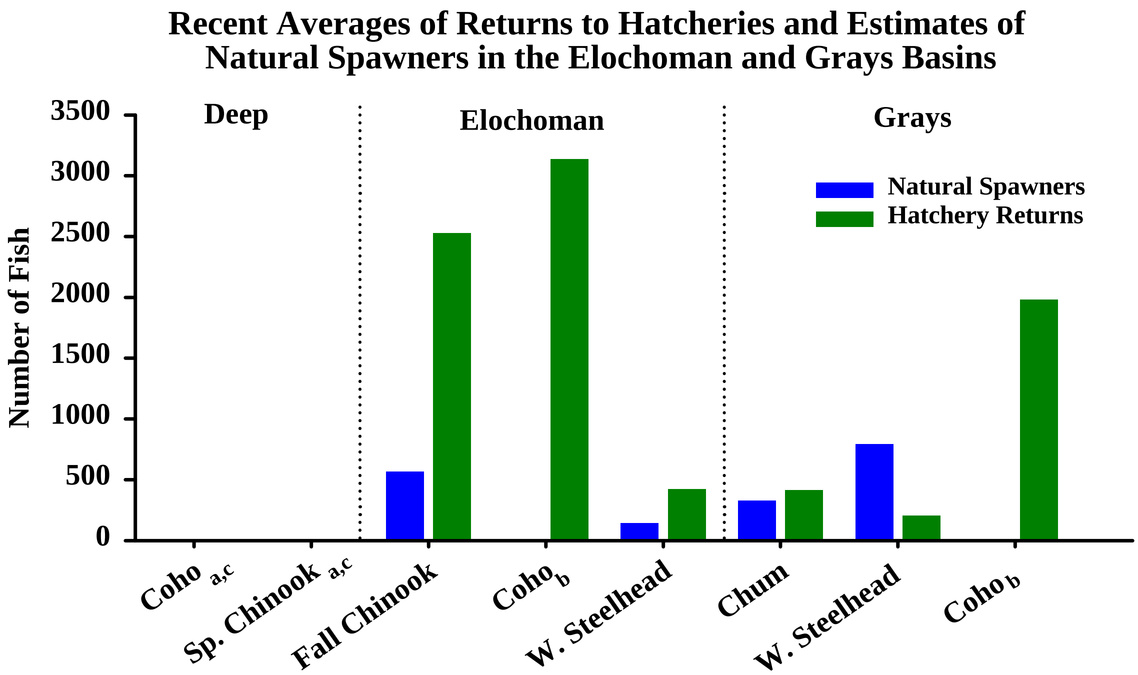


Figure 3-7. Recent average hatchery returns and estimates of natural spawning escapement in the Deep, Grays, and Elochoman River basins by species. The years used to calculate averages varied by species, based on available data. The data used to calculate average hatchery returns and natural escapement 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).

[a] There is no hatchery facility in the basin to enumerate and collect returning adult hatchery fish. All hatchery fish released in the basin are intended to provide harvest opportunity.

[b] A natural stock for this species and basin has not been identified based on populations in WDFW’s 2002 SASSI report; to date, escapement data are not available.

[c] Although a natural population of this species in the identified basin exists based on populations identified in WDFW’s 2002 SASSI report, escapement surveys have not been conducted and the stock status is unknown.

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.

3.5 Fish Habitat Conditions

3.5.1 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 3-8). 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 3-8. Tide gate at the mouth of the Chinook River.

3.5.2 Stream Flow

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).

3.5.3 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).

3.5.4 Key Habitat

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.

3.5.5 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.

3.5.6 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).

3.5.7 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).

3.5.8 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.

3.5.9 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).

3.6 Fish/Habitat Assessments

No Fish/Habitat Assessments have been completed for the Columbia River Estuary Tributaries.

3.7 Integrated Watershed Assessment

The Columbia Estuary Tributaries Subbasin 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.

3.7.1 Results and Discussion

IWA results for each subwatershed are presented in Table 3-1.As indicated, IWA results are calculated for each subwatershed at the local level (i.e., within a subwatershed, not considering upstream effects) and the watershed level (i.e., integrating the effects of the entire upstream drainage area as well as local effects). A reference map showing the location of each subwatershed in the basin is presented in Figure 3-9. Maps of the distribution of local and watershed level IWA results are displayed in Figure 3-10.

Table 3-1. WA 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 3-9. Map of the Columbia Estuary tributaries watershed showing the location of the IWA subwatersheds

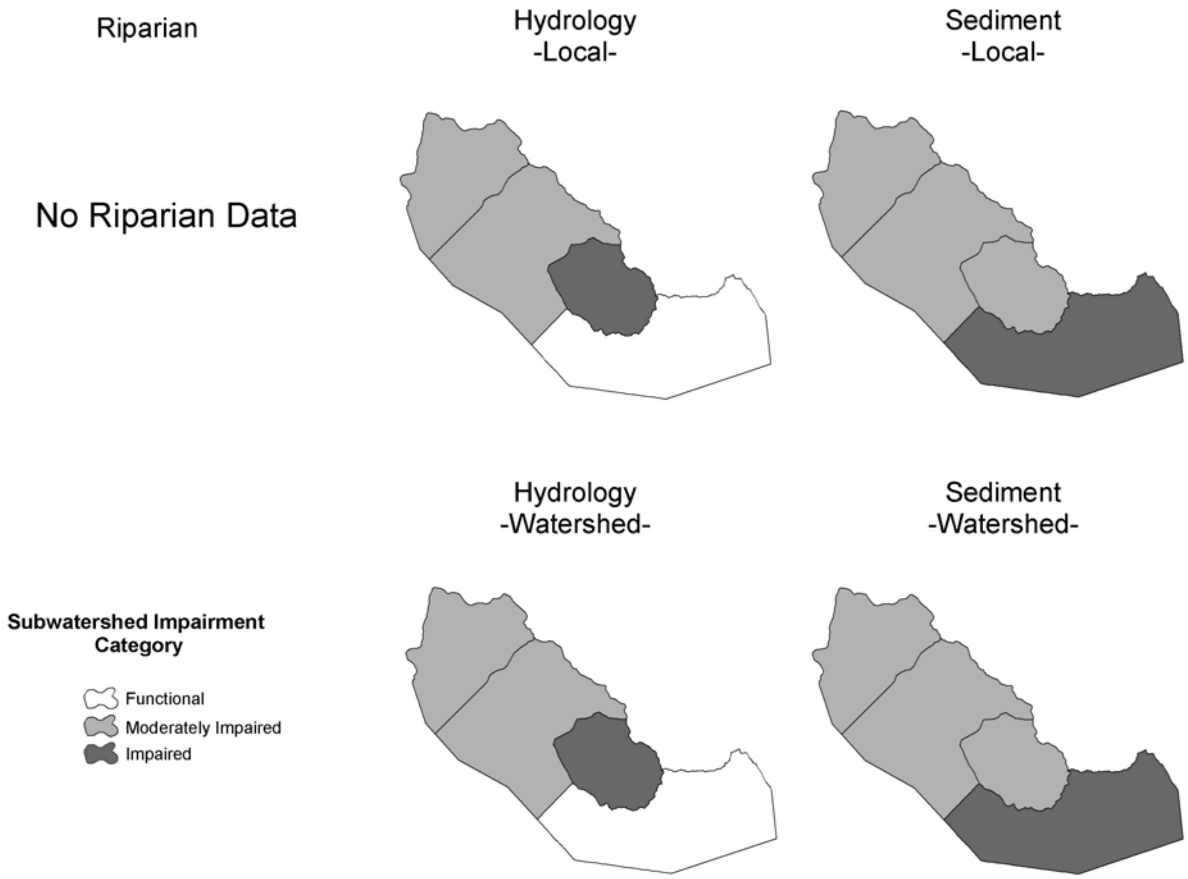


Figure 3-10. IWA subwatershed impairment ratings by category for the Columbia Estuary tributaries watershed.

3.7.1.1 Hydrology

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.

3.7.1.2 Sediment Supply

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 subbasin (30503). As with hydrologic conditions, the IWA watershed level sediment conditions are the same as the local level ratings.

3.7.1.3 Riparian Condition

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

3.7.2 Predicted Future Trends

3.7.2.1 Hydrology

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.

3.7.2.2 Sediment Supply

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.

3.7.2.3 Riparian Condition

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.

3.8 References

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