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Chapter 6-7

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6.7 Salmon Habitat and Distribution

6.7.1 Salmonids in the Tillamook Bay Basin

▪ Objectives

The objective of this assessment was to develop an understanding of the life cycle characteristics of salmonid species native in the Tillamook Basin, their habitat requirements and population dynamics.

▪ Methods

Six different species or races of Pacific salmon are native to Tillamook Bay and its watershed (Kostow et al. 1995). These include chum salmon, coho, spring and fall chinook, winter steelhead, and cutthroat trout. Because the life histories and habitat preferences of these species differ, their temporal and spatial distributions within the basin also vary (Figures 6-7-1 and 6-7-2). Information on the history of these species within the basin, including catch statistics, spawner counts and hatchery programs, have been compiled by Moore et al. (1995), Coulton et al. (1996), and TBNEP (1998a).

Brief summaries of patterns of salmon use of the Tillamook Bay basin, particularly the lowlands and estuary, were developed, to identify the importance of these areas to each species inhabiting the basin. The information was synthesized from sources listed above and from additional literature on these fish. Relationships between spatial distributions the salmon species within the basin were assessed using GIS data available from the TBNEP. Pertinent GIS layers included CHUM, COHO, CHINFALL, CHINSPRG, STEELHEAD, and TILAHIST.

▪ Discussion

Chum Salmon. In north-coastal Oregon, chum salmon are rarely found very far inland (OSGC, 1961), preferring to spawn in the lower reaches of mainstem rivers or in small floodplain streams tributary to the lower rivers (TBNEP, 1998b). Chum are also known to spawn in the upper intertidal reaches of rivers, streams, and sloughs. They have the shortest period of freshwater residency of any salmon found in Oregon and move quickly to estuarine rearing areas after emergence. These areas include tidal creeks and sloughs that allow chum fry access to key feeding areas in estuarine marshes. Studies in other estuaries have shown that juvenile chum salmon spend up to about a month in estuarine environments before moving toward the open ocean (Simenstad and Salo, 1982). Of the salmon in Tillamook Bay, chum are those most closely associated with the lowlands, which account for about 65% of their current geographic distribution upstream of the estuary (Figure 6-7-3).

Coho Salmon. With their preference for slow-flowing habitats, off-channel areas, and the cover provided by woody debris, coho may be found in low to moderate gradient streams within all but the smallest Tillamook Bay watersheds (Figure 6-7-4). Juveniles of the species frequently spend at least a portion of their one-year stay in freshwater in side-channels, beaver ponds, lowland sloughs or varied floodplain habitats. Under natural conditions, coho use of aquatic habitats in the Tillamook Bay lowlands would have been both extensive and intensive. In fact, the productivity of sub-populations of coho that spawn in upper portions of the basin may have been substantially enhanced by their ability to overwinter as juveniles in off-channel habitats in the Tillamook Bay lowlands. At present, lowland channels are thought to account for about 25% of the geographic distribution of coho within the stream network draining into the bay.

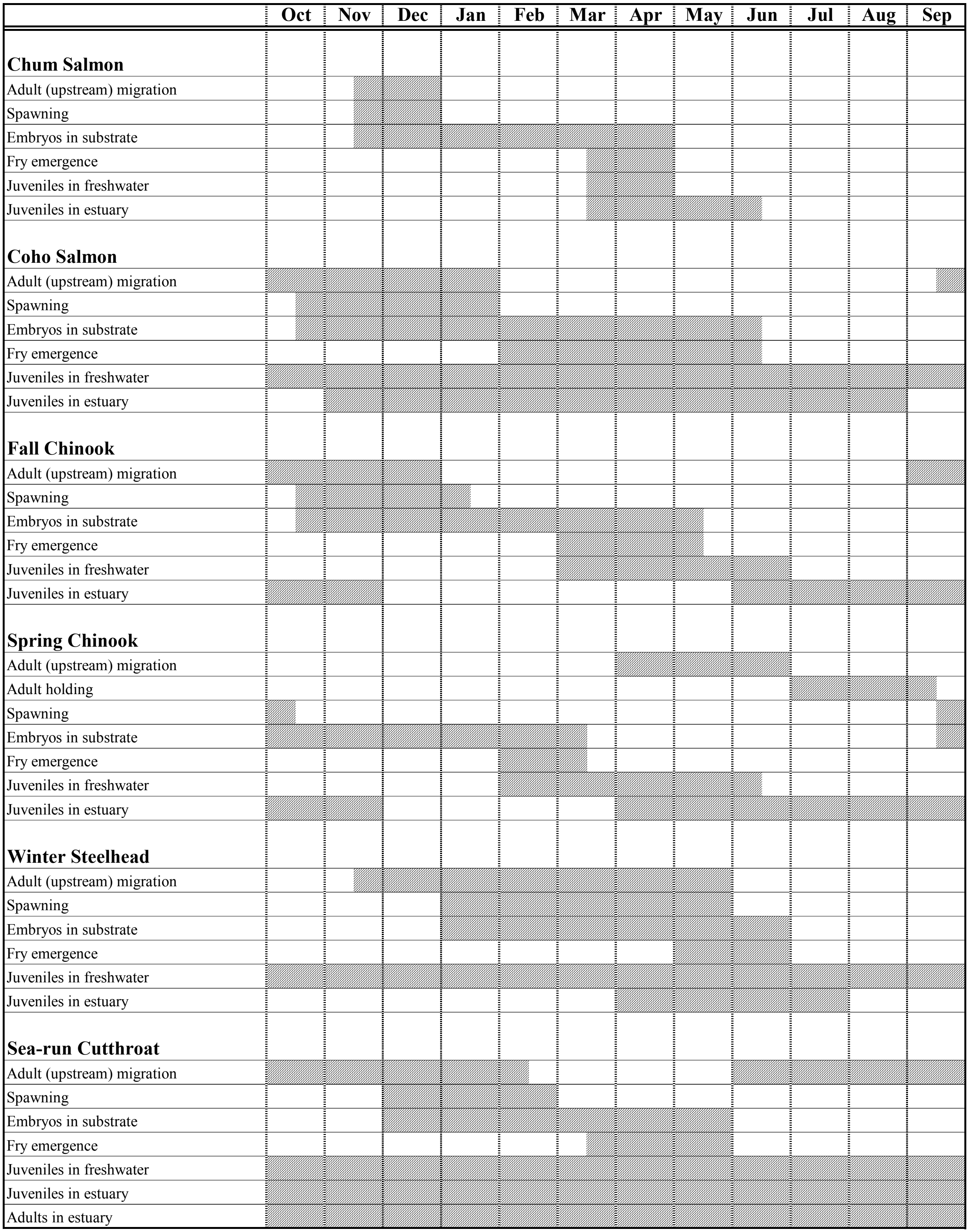

Figure 6-7-1. Seasonal Patterns in the Life Cycles of Tillamook Bay's Anadromous Salmonids

	Chum	Coho	Fall chinook	Spring chinook	Winter steelhead	Cutthroat trout
Uplands						
small streams:						
headwaters						Spawning and rearing
moderate-gradient tributaries					Spawning and rearing	
all low-gradient tributaries		Spawning and rearing			Rearing	Spawning and rearing
low-gradient tributaries to lower mainstems	Spawning	Spawning and rearing			Spawning and rearing	Spawning and rearing
small connected wetlands		Rearing				Rearing
larger tributary streams:						
main channels			Spawning and rearing		Spawning and rearing	
log jams and alcoves		Rearing	Rearing		Rearing	Rearing
protected sidechannels		Spawning and rearing	Rearing		Spawning and rearing	Spawning and rearing
small connected wetlands		Rearing				Rearing
upper mainstem rivers:						
main channels			Spawning and rearing	Spawning and rearing	Rearing	
log jams and alcoves		Rearing	Rearing	Rearing	Rearing	Rearing
protected sidechannels		Spawning and rearing			Spawning and rearing	Spawning and rearing
small connected wetlands		Rearing				Rearing
lower mainstem rivers:						
main channel	Spawning		Spawning and rearing	Rearing	Rearing	
log jams and alcoves		Rearing	Rearing	Rearing	Rearing	Rearing
protected sidechannels	Spawning	Spawning and rearing			Rearing	Spawning and rearing
small connected wetlands		Rearing				Rearing
Lowlands						
mainstem river channels	Spawning		Spawning and rearing	Rearing		
logjams and alcoves		Rearing	Rearing	Rearing	Rearing	Rearing
sidechannels	Spawning	Spawning and rearing			Rearing	Spawning and rearing
sloughs	Spawning	Rearing	Rearing	Rearing		Rearing
connected wetlands		Rearing				Rearing
larger tributaries	Spawning	Spawning and rearing	Spawning		Spawning and rearing	Rearing
small tributaries	Spawning	Spawning and rearing			Spawning and rearing	Spawning and rearing
Estuary						
tidal channels	Rearing	Rearing	Rearing	Rearing	Rearing	Rearing
salt marsh	Rearing		Rearing	Rearing		
mudflat		Rearing	Rearing	Rearing	Rearing	Rearing
eelgrass	Rearing		Rearing	Rearing		Rearing
open water		Rearing	Rearing	Rearing	Rearing	Rearing

Spawning areas

Rearing areas

Spawning and rearing areas

Figure 6-7-2. Historic Spawning and Rearing Areas for Salmon and Trout in Tillamook Bay's Uplands, Lowlands, and Estuary

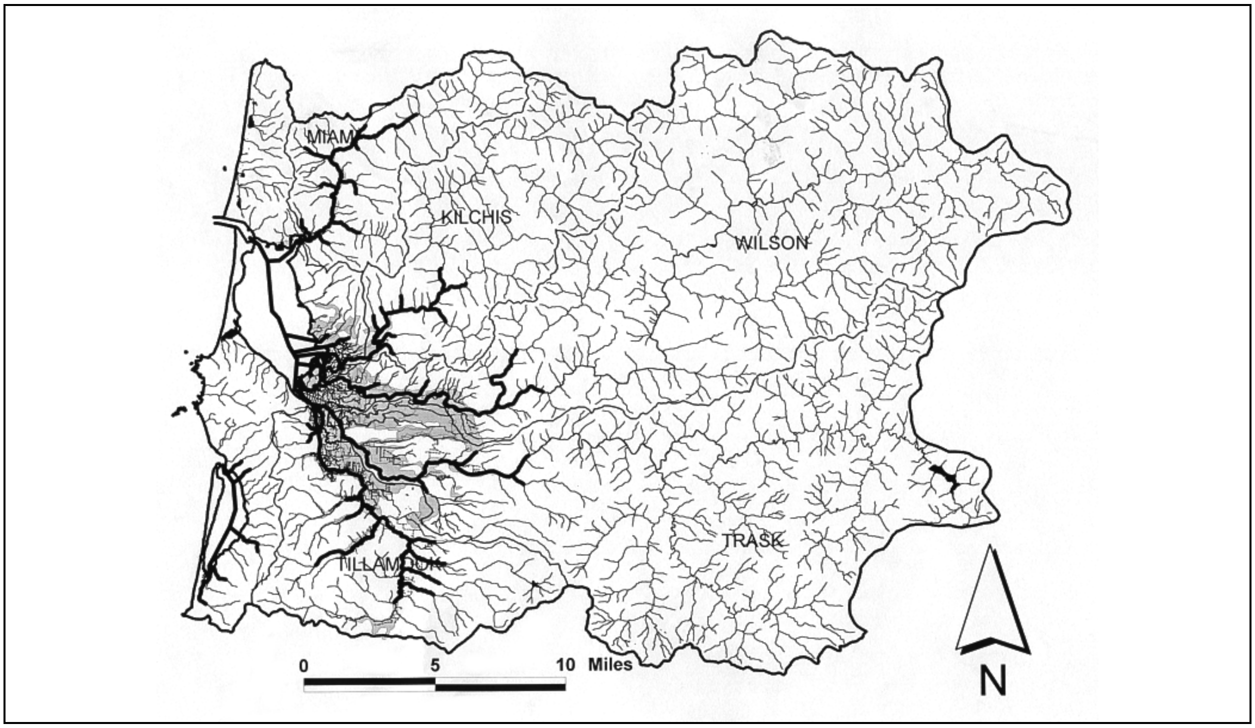

Figure 6-7-3. Chum Salmon

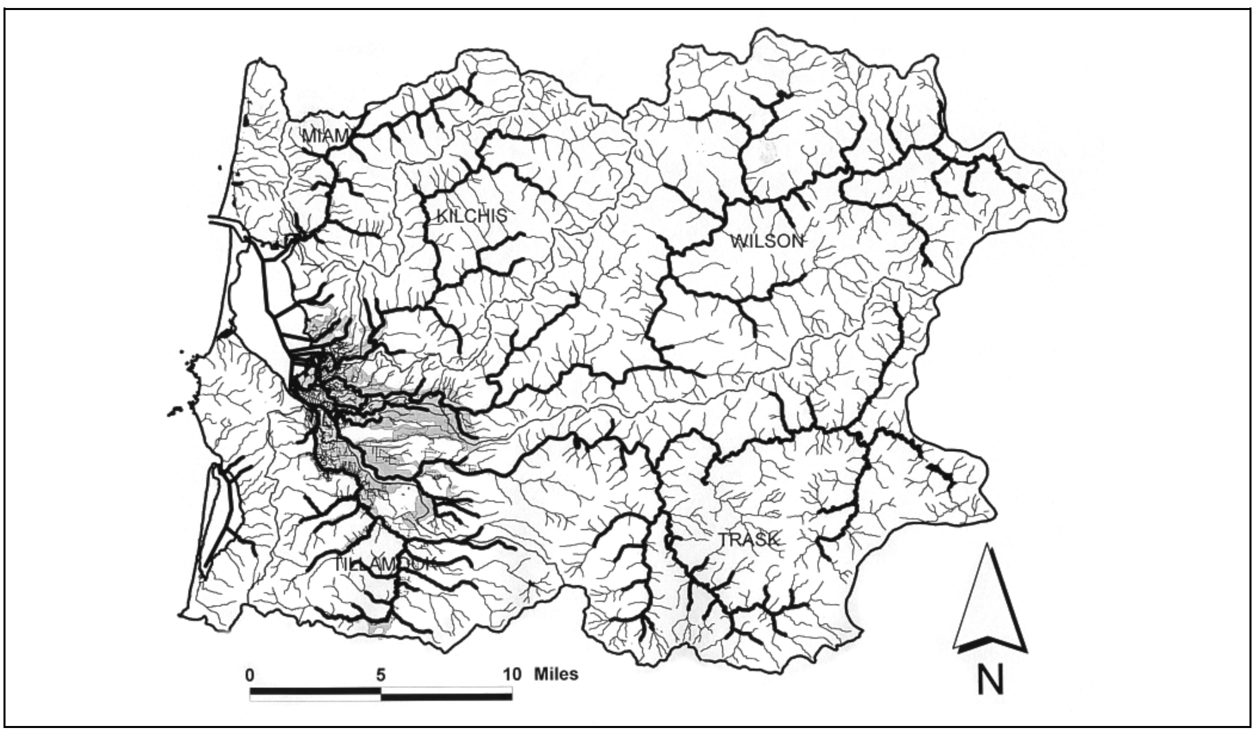

Figure 6-7-4. Coho Salmon

Spring Chinook. Spring chinook are native to the Trask, Wilson, and Kilchis river systems (Nicholas and Hankin 1988), but their distributions within these watersheds are generally restricted to mainstem channels and a couple of the largest tributaries (Figure 6-7-5). Lowland channels account for approximately 35% of the distribution of this species within the basin. Adult spring chinook migrate up the three rivers toward their upland spawning areas during the spring or early summer, hold during summer in pools that will be inaccessible to fall chinook until water levels rise after late fall rains, and spawn near their holding pools during the early fall. After emerging from the gravel during mid- to late winter, most juvenile spring chinook spend up to several months rearing in freshwater followed by up to six additional months in the estuary. Nicholas and Hankin (1988) note that all of the tidal reaches of Tillamook Bay have the potential to provide important estuarine rearing habitat for juvenile chinook.

Fall Chinook. Fall chinook are native to all five major rivers in the Tillamook Bay basin and differ from spring chinook in that they have a later upstream run (fall), a later spawning period, a wider selection of spawning sites due to differing streamflow conditions, and a later period of fry emergence (late winter or early spring). About 30% of the freshwater channels now used by these fish are found in the basin's lowlands (Figure 6-7-6). Historic dependence on these streams may have been greater if the geographic range of fall chinook has expanded in response to the simplification and widening of upland channels. Along with spring chinook, this race of salmon is thought to spend a period of time rearing in the estuary second only to sea-run cutthroat trout. Sub-yearling fish are found throughout the bay at certain times of the year.

Winter Steelhead. Winter steelhead are widely distributed throughout the Tillamook Bay basin and would have been similarly distributed prior to development (Figure 6-7-7). Lowland channels appear to account for about 20% of their freshwater distribution within the basin, a smaller percentage than for all of the other salmonids except cutthroat trout. Winter steelhead migrate upstream toward freshwater spawning areas from late fall through early spring, spawn in a diversity of stream channels during winter and spring, and emerge from spawning gravels as fry in late spring. Juveniles spend from one to three years rearing in freshwater, generally preferring tributary streams and areas with complex cover, before making a springtime migration to the estuary as smolts. These smolts move quickly through the estuary and out to sea.

Sea-Run Cutthroat Trout. Cutthroat trout are the most widely distributed salmonids in the Tillamook Bay basin. They exhibit both migratory and non-migratory life histories, and are typically the only salmonids found in the basin's steep headwater streams. Mature sea-run cutthroat trout migrate upstream toward freshwater spawning areas during summer and fall, then spawn in small first- and second-order streams in winter. Sea-run cutthroat fry emerge from spawning gravels in late winter or spring, then rear in small freshwater streams for two to four years before making a springtime migration toward the ocean as smolts. Under historical conditions, substantial numbers of these fish would have reared in small streams within the Tillamook Bay lowlands. Both juveniles and adults of the species commonly rear for extended periods in estuaries.

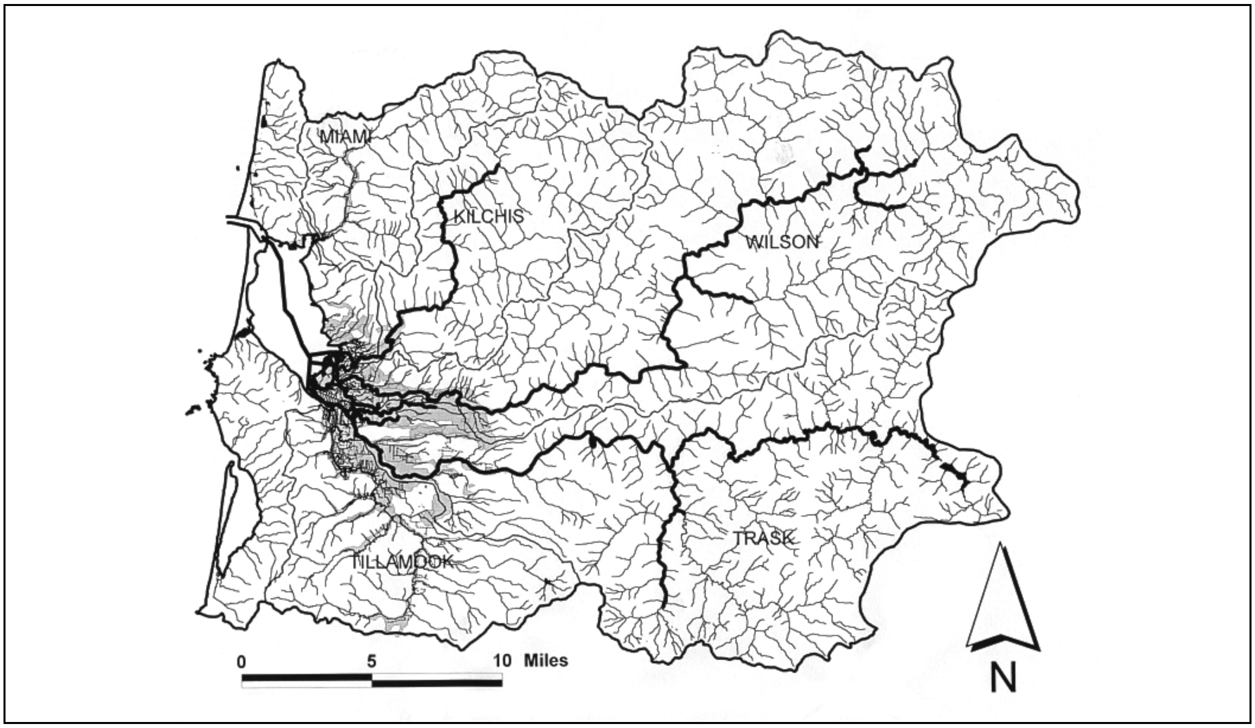

Figure 6-7-5. Spring Chinook

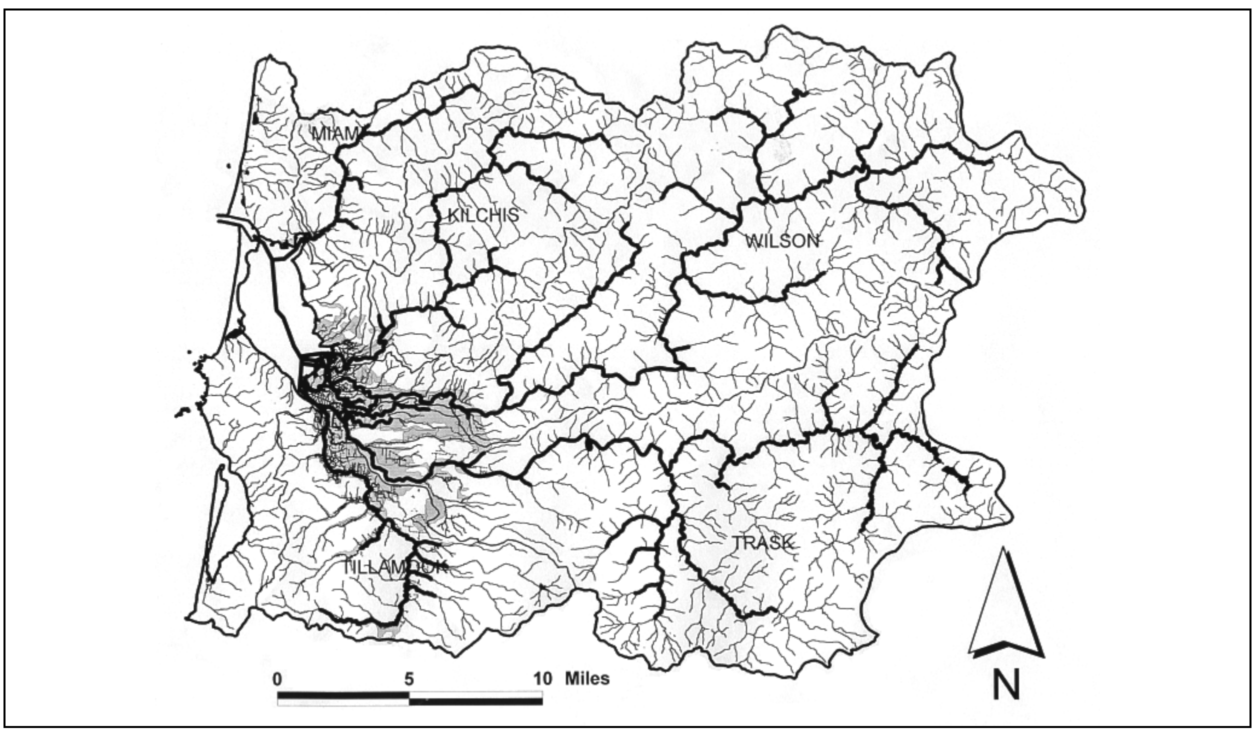

Figure 6-7-6. Fall Chinook

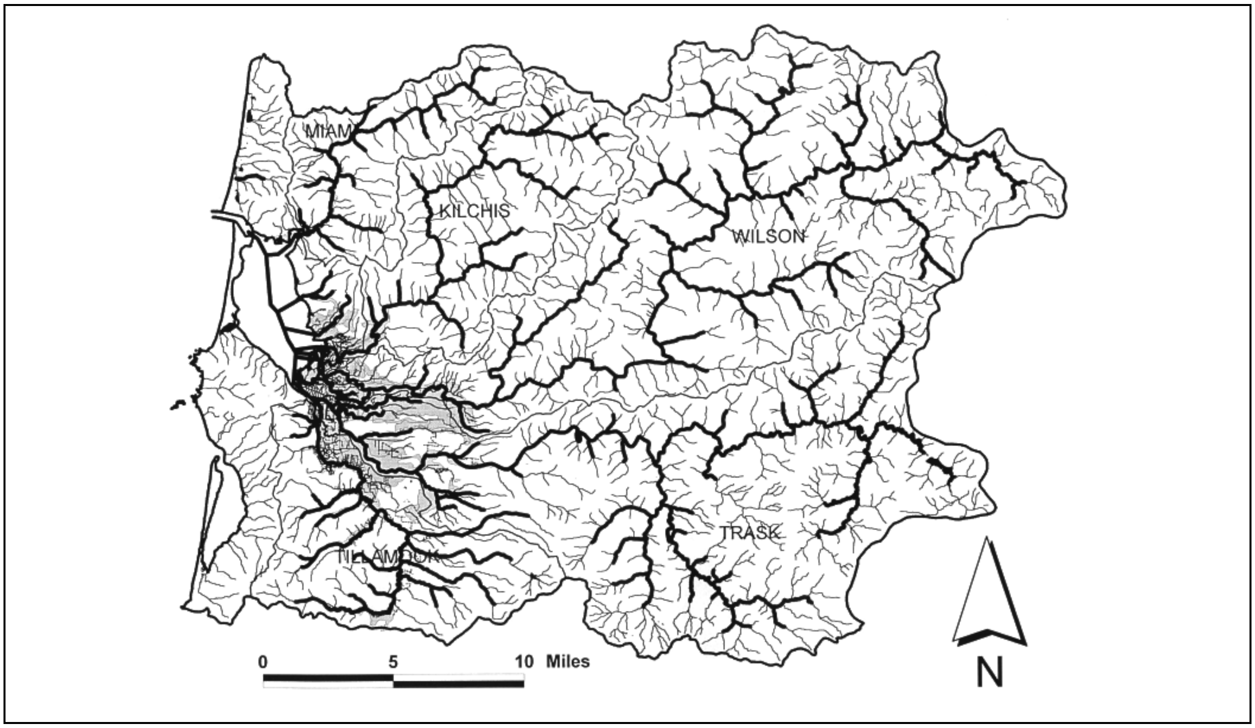

Figure 6-7-7. Winter Steelhead

6.7.2 Historic Salmon Abundance

■ Objectives

The objective of this assessment was to develop an understanding of the historic salmon production on the Oregon Coast and how production in the Tillamook Bay Basin compared to other coastal basins.

■ Methods

We examined data that Cobb (1930) summarized on the annual pack of salmon at canneries that operated at the turn of the century on Tillamook Bay and within other coastal Oregon basins, then supplemented these data with information on historic gill net catches reported by Cleaver (1951) and Smith (1956). We then examined recent assessments of these data by Lichatowich and Nicholas (1991) and Huntington and Frissell (1997), and drew general conclusions about turn of the century salmon production in Tillamook Bay and how it compared to other coastal basins. Data on the historic abundance of salmon were scaled to drainage basin area, to provide a common basis upon which to compare historic salmon productivity among basins.

■ Discussion

Historic peaks in annual cannery packs of salmon suggest that at the turn of the century the Tillamook Bay basin was the most productive salmon producer in the Oregon Coast Range (Figure 6-7-8). Not only was the area highly productive for salmon, but it differed from other coastal river basins within the Coast Range in that the most abundant species was chum and not coho salmon. This historical dominance of chum salmon has been overlooked in most retrospective assessments of the Tillamook Bay ecosystem. Lichatowich and Nicholas (1991) suggest that at the turn of the century the Tillamook Bay basin produced coho salmon at a rate (about 310 adults/mi^2/yr) equal to or higher than most other basins in the Oregon Coast Range. Huntington and Frissell (1997) estimated that the basin's capacity to produce chum salmon (apparently more than 610 adults/mi^2/yr, double the number of coho) was far greater than that of other river basins in coastal Oregon. Aquatic habitats within the basin have also been quite productive for other anadromous salmonids. Available data suggest that the basin was at or near the upper end of the range of Oregon's coastal basins in productivity for chinook salmon and for winter steelhead, although both of these species were less abundant than chum and coho.

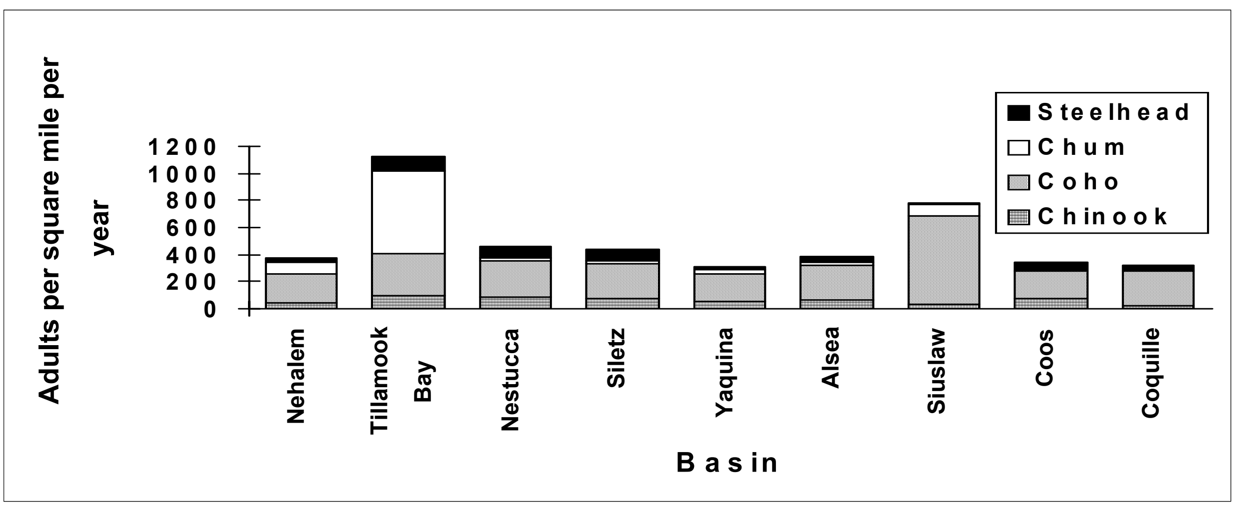

Figure 6-7-8. Catch-Based Estimates of Historic (c. 1900) Pacific Salmon Production in Nine Coastal Oregon River Basins. Adapted from Huntington and Frissell 1997.

6.7.3 Changes in Salmon Abundance

■ Objectives

The objective of this assessment was to document what is known about the recent and historic changes in salmon abundance.

The status of wild salmon populations within a basin is often considered an indicator of environmental health. Salmon declines in coastal Oregon and elsewhere in the Pacific Northwest have had many causes, including degradation and loss of freshwater and estuarine habitats, over-harvesting, and losses of genetic integrity due to the effects of hatchery practices and introductions of non-local stocks (Nehlsen et al., 1991; Kostow et al., 1995; OCSRI, 1997). These factors have often acted in concert, but the loss, degradation, and fragmentation of habitat have been those most frequently recognized as responsible for the declines (Nehlsen et al., 1991). Natural cycles in oceanic productivity also affect the abundance of Oregon's salmon (Bottom et al., 1986; Nickelson, 1986; Pearcy, 1992). These cycles complicate salmon management (Lichatowich, 1996), and make declining productivity of freshwater and estuarine habitats particularly troublesome for salmon during periods of low oceanic productivity (Lawson, 1995).

■ Methods

Recent status reviews of Tillamook Bay's multiple species of salmon were referenced. Then, available catch, escapement, harvest rate, and other records were used to reconstruct historic trends in abundance of the basin's wild chum and coho salmon. The reconstruction of abundance trends for these two species extended from 1923, the year the State of Oregon began keeping consistent records of the numbers of salmon caught by commercial fisheries, to the present. The focus is on chum and coho because of the quantitative dominance of these salmon in the historic ecosystem.

■ Discussion

The Current Status of Tillamook Bay Salmon. The status of various species of Tillamook Bay salmon has been reviewed by Nehlsen *et al.* (1991), Nickelson *et al.* (1992), ODFW (1995), Huntington *et al.* (1996), Huntington and Frissell (1997), multiple investigators from the National Marine Fisheries Service, and Ellis (1998). A general synthesis of these reviews, based largely on the assessment of Ellis (1998), is given in Table 6-7-1. Natural production of all species of salmon in the Tillamook Bay basin except fall chinook has declined during this century, with chum and coho salmon exhibiting the greatest reductions in numbers.

A full explanation of why Tillamook Bay's fall chinook are doing well is unavailable, but historic catch statistics suggest they became consistently more abundant than the basin's spring chinook after the mid-1930s. Gharrett and Hodges (1950) reported that they were doing better than most other fall chinook stocks on the Oregon Coast as far back as the late 1940s. Huntington and Frissell (1997) suggested that factors contributing to the currently robust status of the basin's fall chinook may include: colonization of tributaries inaccessible to them before stream channels became simplified; use of habitats least vulnerable to land use impacts or left vacant by declining salmon species; factors of ocean feeding locations, harvest patterns, and partial recovery of the Tillamook Burn.

TABLE 6-7-1. Current Status of Wild Anadromous Salmonids in the Tillamook Bay Basin, Oregon

Species/race	Status	Recent population trends[1]
Chum salmon	**severely depressed (two or more orders of magnitude less than historic abundance)**	**declining**
Coho salmon	**severely depressed (two or more orders of magnitude less than historic abundance)**	**declining**
Fall chinook	**healthy (recent abundance has been similar to historic levels, suggesting robust populations)**	**stable or increasing**
Spring chinook	**depressed from historic levels, heavily influenced by hatcherty fish**	**possibly declining**
Winter steelhead	**depressed (perhaps one order of magnitude less than historic abundance), heavily influenced by hatchery fish**	**declining**
Sea-run chutthroat trout	**depressed**	**possibly declining**

Patterns of Decline for Tillamook Bay Chum and Coho Salmon. The reconstruction of post-1923 declines in the abundance of Tillamook Bay chum and coho salmon are given in Figure 6-7-8, with changes in stock sizes and spawning escapements shown separately. Abundance of chum salmon appears to have been erratic but relatively high from the mid-1920s until the mid-1940s, when it began experiencing a steep decline from which it has not recovered. Oakley (1966) noted that similar, perhaps less precipitous declines were observed across large areas of the Pacific Northwest at about this same time, and suggested that a climate shift or oceanic factor was largely responsible. Deleterious lowland and watershed conditions that were widespread in the region but particularly severe in the Tillamook Bay basin have also played a role, affecting important spawning and early rearing areas. Chum abundance in the basin rose slightly after all commercial salmon fishing within Tillamook Bay ended in 1961, but began a second period of decline in the late 1970s that continues today. Despite their low abundance by historical standards, chum salmon are more abundant in the Tillamook Bay basin than elsewhere in Oregon. The basin represents the best opportunity for assuring the species' continued presence in the state.

Wild Tillamook Bay coho appear to have declined more slowly than the basin's chum salmon, although by the early 1940s their total numbers (i.e., stock size) had already fallen to less than half those estimated for the turn of the century (<130 adults/mi^2/yr versus about 310 adults/mi2/yr). The basin's production of wild coho declined in an erratic fashion between the late 1930s and late 1950s, then increased during the 1960s and early 1970s in response to highly favorable ocean conditions. Our estimates of this increased wild production (as seen in Figure 6-7-8) are inflated to an unknown degree by increases in natural spawning by stray hatchery fish. Much like the chum, coho have declined since the mid-1970s and are now no more than about 1% as abundant as they are estimated to have been at the turn of the century. ODFW (1995) and Nickelson and Lawson (1997) identified Tillamook Bay's coho populations as being among the most severely 'at-risk' of the many ESA-listed populations on the Oregon Coast. Declining habitat quality, periodic downturns in oceanic productivity, and harvest rates that have at times been extraordinarily high for coho salmon, have combined to severely depress the numbers of adult chum and coho salmon reaching spawning grounds within the Tillamook Bay basin since the late 1950s. Research by Cederholm *et al.* (1999) on the role of salmon in cycling marine nutrients back to watersheds suggests that low spawning escapements such as these may themselves have had deleterious effects on the basin's aquatic ecosystems.

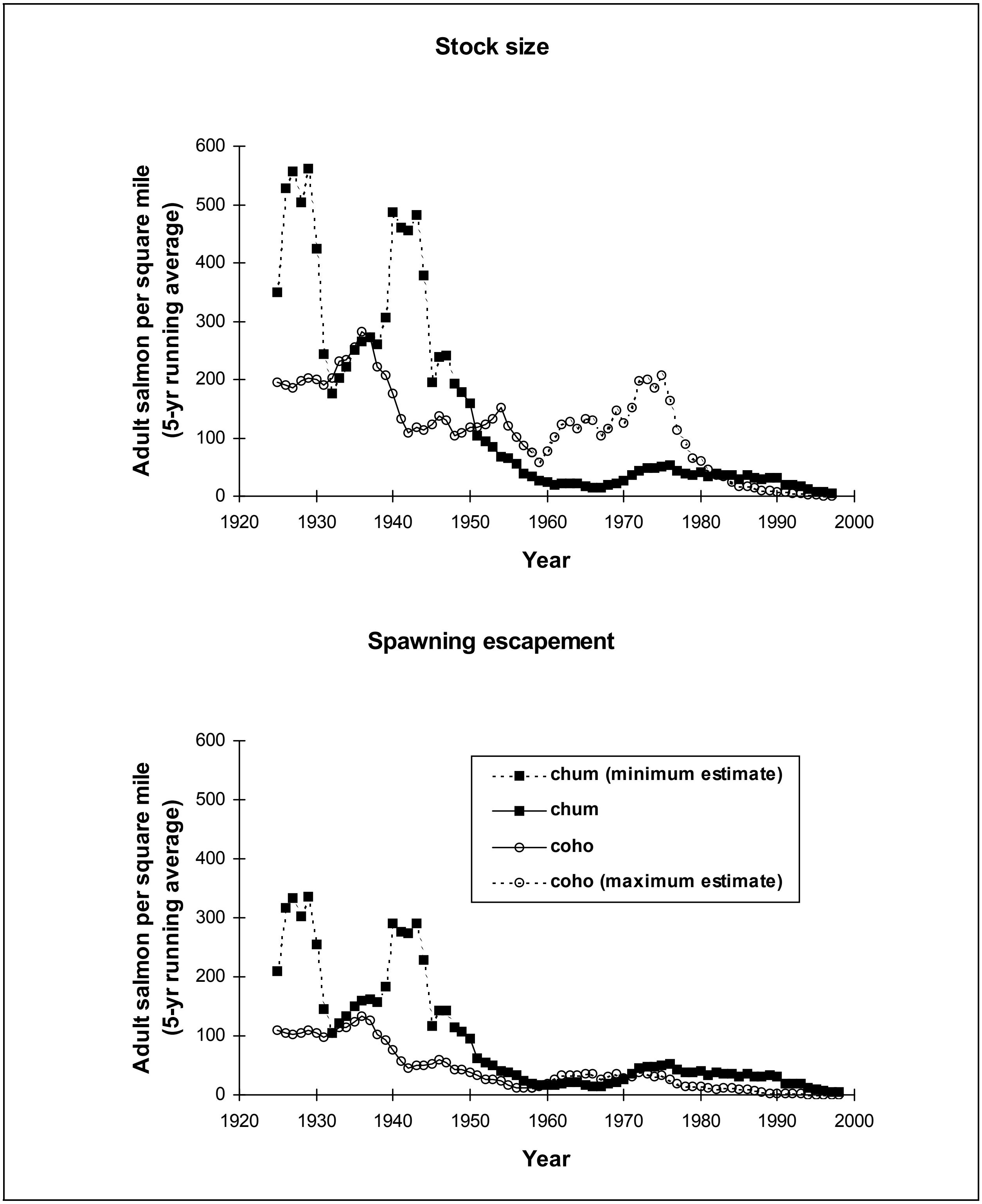

Figure 6-7-9. Estimated Declines in Stock Sizes (top) and Spawning Escapements (bottom) for Wild Tillamook Bay Chum and Coho Salmon, 1923-1999. (See Appendix 1 on the following page for more information.)