WILLAMETTE BASIN
Fish Management Plan

STATUS & PROGRESS 1979-85

Oregon Department of Fish & Wildlife

Willamette Basin Fish Management Plan: Status and Progress 1979-85

Philip J. Howell

Oregon Department of Fish and Wildlife

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FORWARD

The Willamette Basin Fish Management Plan was developed to direct the management of the fisheries resources of the Willamette Basin. It is a major element of the Department of Fish and Wildlife's (ODFW) statewide planning efforts. Species plans for coho and steelhead have been adopted, and management plans for chinook salmon, trout, and warmwater game fish are being prepared. These statewide plans will guide the development of more localized plans for individual river basins and subbasins. Likewise, the Willamette Plan provides general direction for subbasin plans within the Willamette Basin. Planning is underway for the McKenzie and Clackamas river subbasins.

These plans serve several needed functions. They present a logical, systematic approach to conserving our aquatic resources. They estabilsh management priorities and direct attention to the most critical problems affecting our fisheries so that the limited funds in the Department's budget can be used accordingly. They inform the public and other agencies about the Department's management programs and provide them with the opportunity to help formulate those programs.

The original Willamette Basin Plan directed management programs from July 1979 through July 1985. This report describes the current status of the fish populations, fisheries, and habitat in the Willamette Basin and highlights the progress made in achieving the objectives and solving the principal problems identified in the original plan. The objectives and management problems that will be the focus of ODFW's fisheries programs in the basin for the next 6 years are contained in a separate report, *Willamette Basin Fish Management Plan 1987-92*.

INTRODUCTION

The Willamette Basin is vital as a population center, resource base, and economic hub of the state. About two-thirds of the people in Oregon live in the Willamette Valley. Eight of the nine largest cities in the state are located there. The fisheries in the basin are equally significant. Willamette spring chinook accounted for almost 40% of the total spring chinook runs entering the Columbia River in 1980-85. In terms of sport fishing alone, more than 21% of the total angling statewide took place within the Willamette Basin.[1] Using that proportion, sport fishing in the basin generates about $63 million in personal income annually, based on statewide estimates for 1980.

In general, the run sizes of most stocks of salmon and steelhead are meeting the objectives of the plan or appear to be headed in that direction. The development of the introduced summer steelhead run into a major fishery in the basin is particularly noteworthy. Whether these stocks can be maintained at their present levels or continue to increase is uncertain.

Fish populations undergo natural fluctuations in abundance. This may be the result of fluctuations in habitat or other aspects of their environment, such as prey or predators, over which we have little or no control. El Nino emphatically demonstrated that the abundance of andromous species is highly dependent on ocean conditions as well as freshwater habitat. It is important that we view year-to-year variations in the context of long-term trends. For many other fishes, such as resident trout, warmwater game fish, and less used species, we have scant information on abundance and ecological characteristics, much less long-term data.

Although the runs of salmon and steelhead in the basin during the past 6 years have been encouraging, most of this production has been from hatchery stocks, except for the native Willamette winter steelhead. Hatchery production is heavily relied on to compensate for the loss of wild production caused by dams, to provide additional fish to the fisheries, and to sustain production of introduced species, such as coho salmon and summer steelhead.

The hatchery programs in the basin have been generally successful in helping maintain or increase production; however, they are costly and are not without inherent difficulties, such as diseases, maintenance of genetic diversity, and possible adverse effects on wild stocks. If our wild stocks are to be protected and enhanced for their values, their remaining habitat must be protected and enhanced and adequate spawning escapements insured.

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[1] *Lowry, H.M. 1978. Report of the 1977 Oregon Angler Survey. Oregon State University Survey Research Center, Corvallis.*

HABITAT

Background

Stream habitat throughout the Willamette Basin has been extensively altered by development. Dams, agricultural practices, channelization, gravel removal, logging, road construction, urbanization, industrial effluents, and other effects of an expanding human population have reduced the natural productive capacity of the Willamette system.

Some dams have completely blocked access of anadromous fish to prime spawning and rearing habitat in tributaries. Migrating juveniles and adults continue to have difficulties passing the dams that have fish passage facilities. Areas immediately above tributary dams have been converted from free-flowing streams to reservoirs, some with widely fluctuating water levels, which are now suited primarily for put-and-take hatchery trout fisheries and limited warmwater game fish production. Although water releases below dams have improved summer and early fall flows, benefiting fish production, discharges from dams have created additional problems with water temperature, sedimentation, and fishing conditions.

Water quality in the mainstem of the Willamette River was greatly improved through pollution control begun in the 1950s and 1960s. However, water withdrawals for irrigation, power generation, and municipal and industrial uses have decreased stream flows in tributaries and upper reaches of the river.

ODFW district biologists spend about 40% of their time working on habitat-related issues, such as reviewing timber sales and gravel removal permits and their habitat workload has been steadily increasing. However, their ability to prevent habitat loss is limited since ODFW does not have the authority to regulate land-use activities.

Progress

Objective 1. Attain guaranteed minimum flows in basin streams through instigating action by the Water Policy Review Board. Work with the Water Resources Department (WRD) to enforce existing minimum flows.

Two significant bills relating to water-use policy were passed by the Oregon Legislature in 1983. Senate Bill 225 (ORS 536.235 and 536.325) directed the Water Policy Review Board to consider 75 minimum streamflow recommendations made by ODFW and the Oregon Department of Environmental Quality (ODEQ). An additional 20 minimum streamflows were adopted for the Willamette Basin increasing the total number of minimum flow locations in the basin to 45 (Appendix A). Although this legislation does not guarantee that these flows will be available, it does give the minimum flows priority over water rights obtained after the recommended minimum flows were filed. Senate Bill 523 (Chapter 666, Oregon Laws 1985) began a coordinated effort among state resource agencies, including ODFW, for plannning and management of the state's water resources.

Objective 2. Improve fish passage for upstream and downstream migrants at Willamette Falls and at dams and other power projects on tributaries (McKenzie, North and South Santiam).

Passage Problems at Willamette Falls

Most of the anadromous fish produced in the Willamette Basin must pass Willamette Falls as juveniles and adults. The most serious problem identified in the original plan was the loss of salmon and steelhead smolts at the power generating facilities at Willamette Falls.

Crown-Zellerbach Corporation and Publishers Paper Company have agreed to shut down their generators during peak downstream migrations. However, the agreement with Portland General Electric Company (PGE) is limited to installation and testing of a system to bypass juveniles around the turbines at the Sullivan Plant. Testing of the bypass system has produced highly variable results. Bypass efficiencies have ranged from 60% to 95% depending on the species, timing, and flow.

PGE has shut down the Sullivan Plant at times but has continued to operate during some important smolt passage periods. ODFW does not believe the existing level of fish protection is adequate. However, criteria for protection have not been clearly defined.

Some spring chinook smolts have been released below the Falls to avoid mortalities from the Sullivan Plant. This strategy did increase survival, but returning adults from these release groups strayed to other areas in the basin.

Passage conditions at Willamette Falls also cause mortality and delay migration of adult salmon and steelhead. The problem is most acute during high flows in the spring when spring chinook are reluctant to use the fishway or have difficulty finding the entrance. As flow drops, some fish become stranded in pools, where they can be poached or die unless salvaged.

The fishway was modified to improve passage during high and moderate flows. However, it is still difficult and expensive to make necessary adjustments. Consequently, passage is less than optimum much of the time. Flashboards have been installed at the lip of the falls to divert spill so that fish are attracted to the fishway entrances, but these are sometimes washed away by high flows.

Passage Problems on Tributaries

Passage of anadromous fish has also been a major problem at Foster and Green Peter dams on the South Santiam River; Leaburg Dam and the Leaburg and Walterville diversions on the McKenzie River; and Fall Creek Dam on Fall Creek, a tributary of the Middle Fork Willamette River.

In cooperation with the U.S. Army Corps of Engineers (USACE), ODFW has been testing methods to solve passage problems for winter steelhead at Foster and Green Peter dams. Smolt passage at Foster was improved by lowering reservoir levels. At Green Peter adults have difficulty finding the entrance to the fish ladder, and downstream passage of smolts is inadequate.

Downstream migrants are delayed at Leaburg Lake, and some losses have occurred in the Leaburg and Walterville power diversion canals. Mortality of juvenile spring chinook passing through the Leaburg diversion and powerhouse was 28% prior to installation of a screen and bypass. Mortality of smolts caused by the Walterville diversion and power plant has not been determined. Adults are also delayed at Leaburg Dam and the Walterville powerplant.

The Eugene Water and Electric Board (EWEB) has agreed not to divert water through the canals during short periods when hatchery smolts are migrating. They are funding a study to determine if the screening system in the Leaburg canal is safely diverting downstream migrants away from the power plant. EWEB is also required to install a fish barrier below the outfall of the power plant at Walterville to prevent adults from entering the turbines. However, at times there is insufficient flow through the bypass channel to attract fish back into the river.

Fall Creek Reservoir is lowered in November to help evacuate smolts rearing in the reservoir. But water releases from the dam are often inadequate for upstream passage of returning adult spring chinook and winter steelhead.

Objective 3. Improve stream conditions for fish life below tributary dams by working with the U.S. Army Corps of Engineers to improve water temperature, reduce harmful fluctuations in flow, and enhance streamflow by changes in project operations and facilities.

USACE is conducting a study to determine the feasibility of installing multilevel intakes in dams in the North Santiam and McKenzie rivers so that water temperature below the projects can be regulated. Funding to implement recommendations of the study will require additional Congressional approval.

ODFW has also been negotiating with USACE and EWEB to adjust releases from Foster, Dexter, and Leaburg dams that impact fishing, adult salmonid migration, and fish production below these dams.

Objective 4. Minimize habitat loss by continuing to work with the Land Conservation and Development Commission (LCDC), counties, and cities to develop sound land-use plans.

Land-use plans for all counties and cities within the basin have been completed and approved by LCDC. All of the plans address fish and wildife concerns. ODFW staff provided input on portions of the plan relating to fish

habitat. ODFW will continue to review the plans as they are periodically ammended and revised.

Objective 5. Increase habitat by developing ponds for fisheries on trout and warmwater fish.

The St. Louis Pond complex north of Salem was developed for warmwater fishing and opened to the public in 1980.

SPRING CHINOOK

Background

Spring chinook is the only salmon native to the Willamette Basin above Willamette Falls. Major reductions in wild stocks followed construction of dams on the Willamette and its tributaries. Much of the prime adult holding and spawning habitat in the upper reaches was blocked by dams. Dams have also altered natural streamflow patterns and water temperature. These changes, coupled with other forms of habitat loss, increasing hatchery production, and possibly greater competition and predation from some introduced species have modified the genetic characterisitics of the native stocks and ultimately have reduced wild production to negligible or low levels. Adults no longer spawn during August in the Clackamas and McKenzie rivers. Many formerly productive streams do not support spring chinook.

Based on returns of marked hatchery fish and unmarked wild fish in the mid-1970s, it was estimated that only 25-30% of the runs were wild. Since then, the size of the runs appears to rely directly on the number of hatchery smolts released. Hatchery releases have doubled since 1963-73 to an average of about 4.5 million smolts per year (Table 1). In addition, some smolts are produced from releases of fingerlings that rear in four reservoirs and some streams in the basin. The number of smolts produced from fingerling releases in reservoirs has greatly declined in recent years.

Table 1. Spring chinook smolts[a] released into the Willamette Basin, 1963-83 broods.

Brood	Number released (millions)			Pounds released (thousands)	
	ODFW hatcheries[b]	ECNFH[c]	Total[d]	ODFW hatcheries	ECNFH[c]
1963-73[e]	2.258	0.545	2.803	233	35
1974	4.543	0.849	5.392	411	49
1975	3.443	0.252	3.695	318	18
1976	2.706	0.782	3.488	369	53
1977	3.570	0.421	3.991	397	28
1978	3.433	0.402	3.835	492	28
1979	4.653	0.941	5.594	600	62
1980	4.893	0.842	5.735	670	54
1981	3.719	0.540	4.259	496	50
1982	4.562	0.630	5.192	638	79
1983	4.502	0.619	5.121	577	58

[a] *Smolts are defined as juveniles larger than 16 fish/lb at time of release.*
[b] *Oakridge, McKenzie, South Santiam, Marion Forks, and Clackamas hatcheries.*
[c] *Eagle Creek National Fish Hatchery, Clackamas River subbasin.*
[d] *Does not include smolts produced from fingerlings released in reservoirs and streams.*
[e] *Average.*

Adult production is equally divided among ocean fisheries, freshwater fisheries, and returns to the hatcheries (Figure 1). Most of the ocean catch is taken by commercial trollers off British Columbia.

Most of the freshwater catch occurs in the lower Willamette River below Willamette Falls and in the Clackamas River. A winter gillnet fishery in the lower Columbia River also targets on Willamette spring chinook. Since 1981 the harvest in the lower Willamette and Columbia fisheries has been allocated on the basis of the average proportion of the commercial and recreational catches for 1975-79: 24% commercial and 76% recreational. From 1981 through 1985 the commercial catch averaged 6,400 fish (Table 2). During the same period lower Willamette and Clackamas river sport fishermen averaged almost 19,000 fish, compared with an average catch of about 13,000 fish for 1946-70. These sport fisheries are a major source of angling recreation in Oregon. Angling effort averaged 141,000 angler days per year from 1980 to 1984.

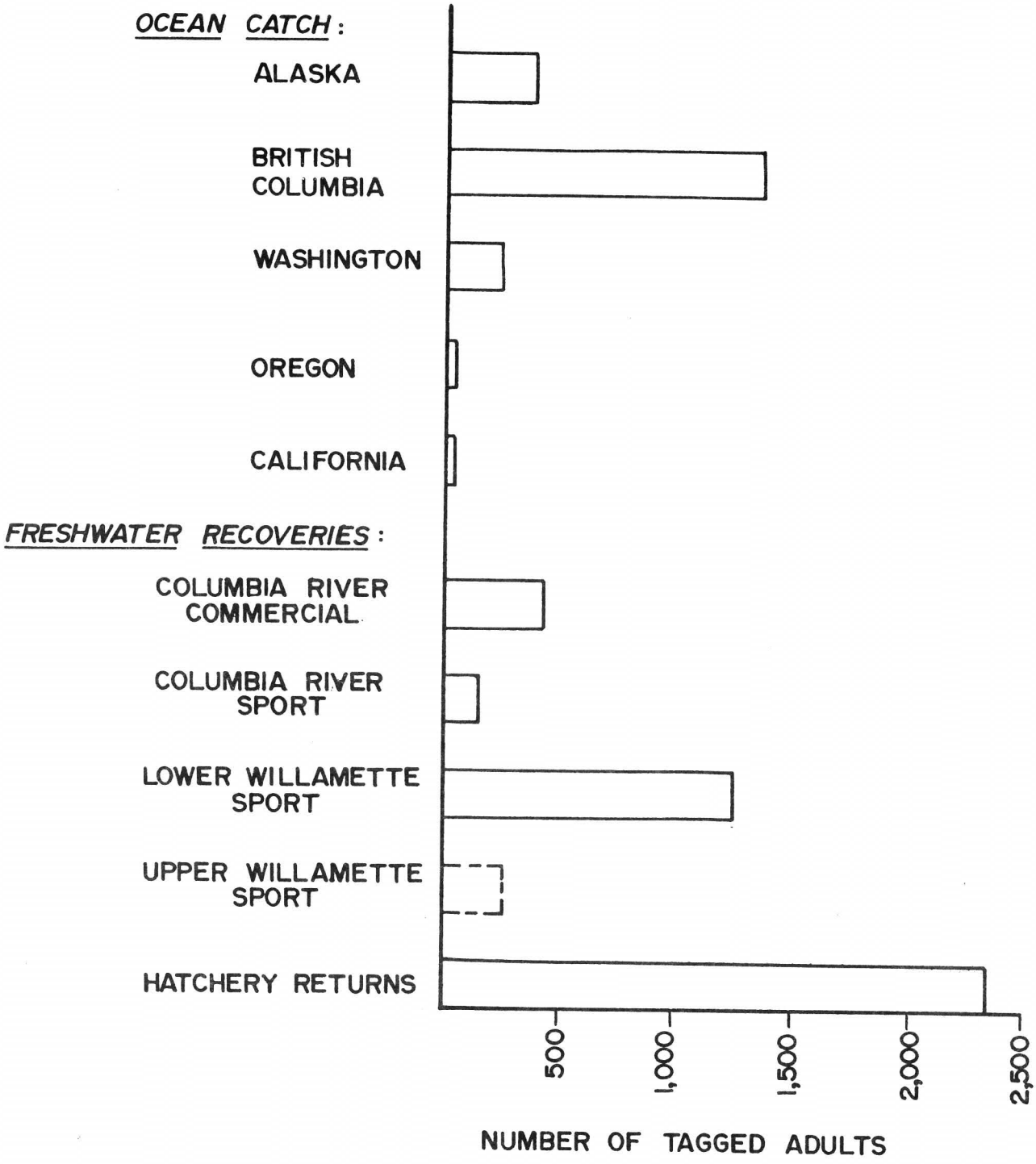

Figure 1. Recoveries of coded-wire tagged Willamette spring chinook released from Oakridge-Dexter and South Santiam hatcheries, 1974-1977.

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[1] *Upper Willamette sport fisheries are not intensively monitored. Estimated recoveries were based on mean annual percentage of reported above-falls catch estimated from salmon-steelhead tag returns in relation to below-falls harvest.*

Table 2. Estimated Willamette River spring chinook salmon runs (thousands of fish), 1971-85.

Year	Run entering Columbia River	Columbia R. Sport catch	Columbia R. Commercial catch	Lower Willamette River Sport catch	Lower Willamette River Willamette Falls count	Clackamas River Sport catch	Clackamas River Escapement	Run entering Willamette Numbers[a]	Run entering Willamette % caught
1946-70 average	--	--	--	12.6	36.0	0.1	2.5	51.2	25
1971	80.9	4.1	9.4	20.0	44.6	0.2	2.0	67.4	30
1972	58.4	0.2	11.1	18.5	26.2	0.2	2.0	47.1	40
1973	70.7	4.2	12.0	10.0	42.0	0.2	2.0	54.5	19
1974	82.4	1.3	9.3	25.0	44.5	0.2	2.0	71.8	35
1975	40.7	1.6	6.4	12.4	19.1	0.1	1.0	32.7	38
Average	66.6	2.3	9.6	17.2	35.3	0.2	1.8	54.7	32
1976	45.0	1.8	2.5	16.2	22.0	0.2	2.0	40.7	40
1977	64.4	1.5	4.8	14.0	40.0	1.0	3.0	58.1	26
1978	83.3	2.4	9.5	19.8	47.5	1.0	3.0	71.4	29
1979	49.2	0.7	3.9	12.9	26.6	1.2	3.8	44.6	32
1980	43.4	0.6	0.3	7.0	27.0	3.2	5.3	42.5	24
Average	57.1	1.4	4.2	14.0	32.7	1.3	3.4	51.5	30
1981	56.3	2.9	4.8	10.5	30.1	2.3	5.7	48.6	26
1982	78.0	1.9	3.6	18.9	46.2	2.5	4.8	72.5	30
1983	63.0	1.8	5.3	13.8	30.6	4.5[b]	6.9	56.1	33
1984	84.2	1.5	8.2	19.4	43.5	4.3	6.9	74.5	31
1985	68.1	1.0	10.0	15.5	34.5	2.5	4.1	57.1	32
Average	69.9	1.8	6.4	15.6	37.0	3.2	5.7	61.8	30

[a] *Includes annual estimated losses of 0 to 600 below Willamette Falls.*
[b] *Includes an estimate of 500 fish caught after the sampling program ended.*

Progress

Objective 1. Develop a minimum annual run of 100,000 Willamette spring chinook entering the Columbia River.

The average adult run since 1981 has been 69,900 fish (Table 2), a 22% increase in the average run for 1976-80. The annual run has not reached 100,000 since 1953, and the largest run since then was 84,000 fish returning in 1984.

Although this objective has not been met, considerable progress has been made in building the hatchery component of the run by improving the quality of hatchery smolts and increasing hatchery production. A major problem identified in the previous plan was high mortality (as much as 85%) of adult broodstock prior to spawning. This problem was largely eliminated through disease control, transfer of fish to holding facilities with better water quality, and reduction of fish density in the holding ponds.

Objective 2. Achieve an annual escapement of 45,000 spring chinook at Willamette Falls.

The average annual count of spring chinook passing Willamette Falls was 37,000 fish during 1981-85, up slightly from previous averages (Table 2). Counts exceeded the objective in 1982 and were only 1,500 fish short in 1984.

The chances of high escapements above Willamette Falls are increased by (1) restrictions on the gillnet season to protect upper Columbia River stocks that enter the Columbia River during the latter portion of the Willamette spring chinook run, and (2) high, turbid water conditions that frequently limit the catch in the lower Willamette sport fishery. As the total run builds, this objective should be met more frequently.

Objective 3. Develop a minimum run of 7,000 spring chinook salmon into the Clackamas River.

This objective has been met every year since 1980 except in 1985, when the run was 6,600 fish. Hatchery releases in the Clackamas began in 1976 and culminated with returns of more than 10,000 adults in 1983 and 1984. In those two years anglers caught over 4,000 fish, more than 40 times the average catch for 1946-70.

Objective 4. Provide an annual harvest of 48,000 Willamette spring chinook from Astoria to Oregon City.

Average catch during the past 5 years has been about 24,000 fish. The highest catch in the previous 10 years was 35,600 fish. Given the normally high water during the sport season, this objective will probably not be reached until (1) the run size reaches 100,000 fish, (2) increases in upper

Columbia stocks warrant a more liberal commercial harvest during the gillnet season, and (3) the April sport fishery is restored in the lower Columbia River.

Objective 5. Provide anglers with the opportunity to harvest up to 10,000 spring chinook above Willamette Falls.

Based on salmon-steelhead tag returns, which are suspected of providing inflated estimates, the average catch of spring chinook by sport anglers above Willamette Falls averaged about 2,600 fish per year during 1980-84 (Table 3), close to the average catch from 1963 to 1980 (2,850 fish). No more than 4,400 chinook per year have been taken in upper river areas since 1963.

Spring chinook are available to anglers in the upper basin for only a short time from about June to mid-July. Passage over Willamette Falls does not peak until mid-May. Since the fish have already been in fresh water for a considerable time, they are less inclined to bite. However, anglers in upriver areas are developing improved techniques to catch them.

FALL CHINOOK

Background

Within the Willamette Basin, fall chinook are native only in the Clackamas River because historically Willamette Falls was impassable during the adult migration period. They were established above Willamette Falls in the late 1960s following improvements in water quality in the basin and passage facilities at the Falls.

The Willamette fall chinook run is largely the product of tule stock hatchery fish. Fry are obtained from Bonneville Hatchery and reared in gravel ponds at Aumsville and Stayton. Since tules spawn shortly after entering the Willamette, they are usually dark, have poor quality flesh, and do not bite well. To provide a "brighter" fish for a river sport fishery, later spawning Cowlitz stock from Washington were released from 1971 to 1977. Cowlitz releases were discontinued because the egg supply was not dependable. Tule releases have averaged 6 million smolts per year since 1980 (Table 4). Returning adults spawn in the mainstem of the Willamette River and the lower reaches of some tributaries.

Table 3. Sport catch[a] of spring chinook in the upper Willamette River and tributaries above Willamette Falls, 1975-84. "X" indicates that the stream was closed to angling.

Stream	1975	1976	1977[b]	1978	1979	1980	1981	1982	1983	1984
McKenzie River	461	139	1,071	924	312	384	493	627	221	618
Molalla River	12	0	6	22	0	X	X	X	X	X
Santiam River	287	53	785	103	81	194	98	235	114	66
North Fork	167	48	668	381	153	440	847	1,180	446	558
South Fork	44	80	267	393	153	219	145	105	164	409
Crabtree Creek	--	--	16	6	0	0	3	0	3	3
Willamette River,upper	c	c	d	671	237	484	428	508	370	532
Coast Fork	--	--	318	737	627	9	X	X	X	X
Middle Fork	--	--	44	929	219	209	209	983	531	940
Fall Creek	--	--	150	238	12	15	21	49	31	0
Total	971	320	3,325	4,404	1,794	1,954	2,244	3,687	1,880	3,126

[a] *Estimated from salmon-steelhead tag returns, adjusted for nonresponse bias.*
[b] *The first year to list catch in all open streams; in prior years catch in most tributaries was included in the mainstem catch.*
[c] *Combined with lower Willamette River catch.*
[d] *Incomplete.*

Table 4. Millions of fall chinook juveniles released into the Willamette Basin, 1967-77 broods.

Brood year	Tule stock	Cowlitz stock[a]
1967	1.741	
1968	1.341	
1969	10.710	
1970	10.566	
1971	11.037	2.315
1972	11.646	0.496
1973	11.896	2.497
1974	5.544	0
1975	6.007	2.303
1976	10.889	
1977	0.301	0.151
1978	4.692	
1979	6.349	
1980	5.903	
1981	6.751	
1982	6.911	
1983	5.171	
1984	4.534	

[a] *Released from 1971 through 1977.*

Progress

Objective 1. Determine the magnitude of the existing natural run of tule fall chinook in the Willamette River above the falls and evaluate the ability of these fish to sustain themselves.

About 37% of the runs above Willamette Falls the past 5 years have been naturally produced fish. These include the progeny of hatchery fish that returned and spawned in the wild. Since releases of hatchery fish have continued, it has not been possible to determine if the runs could become self-sustaining. It is apparent, however, that hatchery releases are necessary to maintain adult production at the present levels.

Objective 2. Determine the value to fisheries, especially Oregon's, of fall chinook produced naturally in the Willamette River.

Estimates of fishery contribution are only available for marked hatchery fish. It is assumed that naturally produced fish contribute similarly.

Willamette fall chinook are harvested primarily in ocean fisheries off British Columbia and Washington (Figure 2). Tag recoveries from juveniles released in 1979 indicate that combined British Columbia and Washington fisheries account for more than 85% of the catch. About 7% of the adults harvested were taken in the Columbia River, and 6.5% were caught in Oregon's offshore fisheries. Since 1980 about 600 fish have been taken annually by sport fishermen in the Willamette system, principally the Clackamas and Santiam rivers and their tributaries (Table 5).

Objective 3. Determine the need and value of supplementing naturally produced fall chinook in the Willamette with propagated fish.

The size of the Willamette fall chinook run is highly dependent on releases of hatchery fish. About two-thirds of the run is composed of hatchery-reared fish. A large proportion of the natural production in the Willamette system is the result of returning hatchery fish that spawn in the wild. Without the continued release of hatchery fingerlings, adult production would be drastically reduced.

The value of the hatchery program is reflected in the high survival rates of the juveniles released. The contribution to the fisheries of 1978 brood Willamette fall chinook was about 2 to 7 times the contribution from Oregon hatcheries on the lower Columbia River. And the returns to Willamette Falls from 1979 and 1980 releases were 2 to 125 times higher than returns to those same hatcheries.

Objective 4. Evaluate different stocks of fall chinook for their potential use by sport fisheries in the Willamette River.

Releases of Cowlitz stock did not produce self-perpetuating runs; however, the number of fish released may have been too small. A few naturally spawned juveniles were found in the Lukiamute and Row rivers. Additional work is needed to complete this objective.

Objective 5. Maintain an adult fall chinook run past Willamette Falls of at least 15,000 fish while the fall chinook program is being evaluated.

Since 1981, the fall chinook run above Willamette Falls has averaged more than 17,000 adults (Table 6). Returns in 1980 and 1983, which were below the

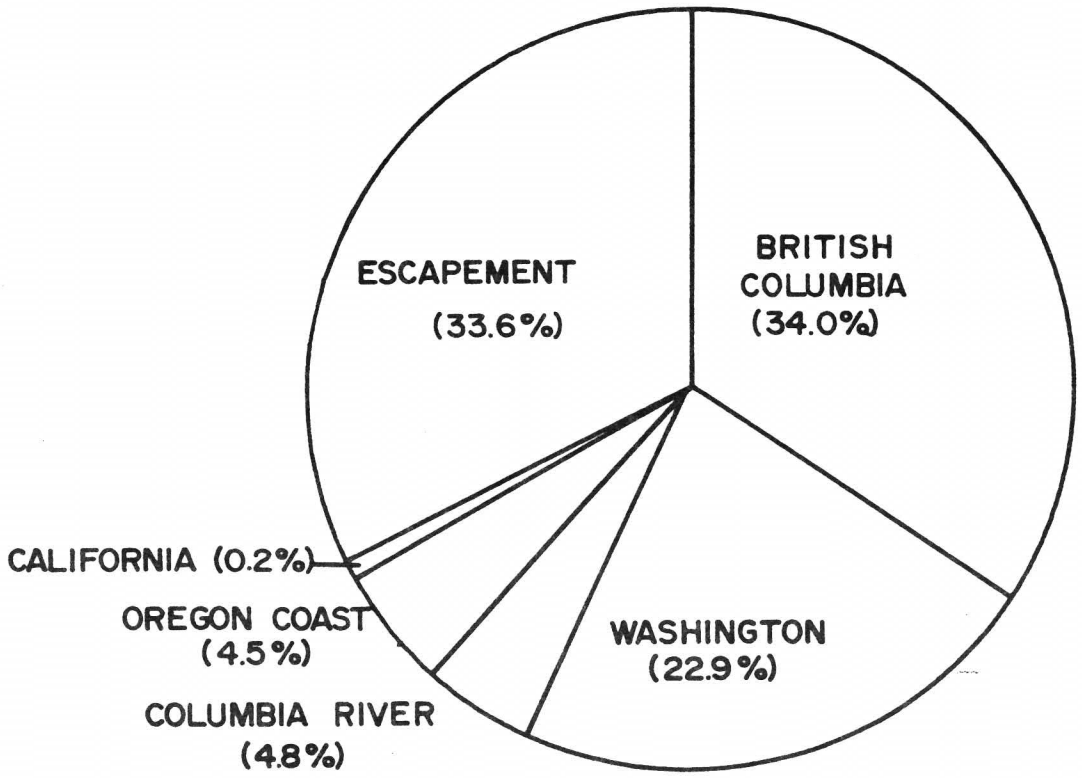

Figure 2. Catch distribution and escapement above Willamette Falls of Willamette fall chinook salmon as determined by recoveries of coded-wire tagged adults from 1978 brood releases.

Table 5. Sport catch[a] of fall chinook salmon in the Willamette River system, 1974-84. "X" indicates that the stream was closed to angling.

Stream	1974	1975	1976	1977[b]	1978	1979	1980	1981	1982	1983	1984
Clackamas River	200	54	153	8	57	114	194	135	188	126	22
Eagle Creek	149	0	0	0	53	171	114	114	172	3	83
Santiam River	30	363	320	440	88	111	89	154	293	47	89
North Fork	--	198	--	151	0	42	24	12	63	31	19
Little North Fork	--	--	--	--	--	--	6	6	0	0	0
South Fork	--	107	217	280	242	144	37	154	257	41	272
Tualatin River	--	--	--	0	0	3	0	6	3	0	3
Willamette River, lower	--	--	--	--	32	21	18	55	54	110	89
upper	--	--	--	0	0	24	3	9	20	0	32
Coast Fork	98	434	177	64	101	X	X	X	X	X	X
Total	477	1,156	867	943	573	630	485	645	1,050	358	609

[a] *Estimated from salmon-steelhead tag returns, adjusted for non-response bias.*
[b] *The first year to list catch in all open streams; in prior years in most tributary streams was included in the main stem catch.*

objective, may be the result of smaller releases of hatchery fish in 1978 and 1979 and suspected lower survival due to El Nino.

Table 6. Estimated escapement of fall chinook above Willamette Falls, 1954-60 and 1965-85. No counts were made 1961-64.

Year	Adults	Jacks	Total
1954	225	145	370
1955	75	0	75
1956	6	15	21
1957	6	47	53
1958	96	29	125
1959	14	2	16
1960	5	4	9
1965	77	2	79
1966	771	255	1,026
1967	1,901	111	2,012
1968	4,043	203	4,246
1969	6,817	140	6,957
1970	7,457	101	7,558
1971	4,880	210	5,090
1972	11,614	212	11,826
1973	21,861	376	22,237
1974	33,924	265	34,189
1975	32,877	895	33,772
1976	29,269	931	30,200
1977	25,742	382	26,124
1978	17,437	465	17,902
1979	9,905	436	10,341
1980	7,760	625	8,385
1981	16,690	1,085	17,775
1982	25,760	1,123	26,883
1983	13,205	528	13,733
1984	20,060	1,084	21,144
1985	29,089	1,114	30,203

COHO

Background

Coho are native to the Clackamas River and smaller tributaries below Willamette Falls. They were first introduced above Willamette Falls in the 1920s. Runs over Willamette Falls peaked in the late 1960s and early 1970s following stocking of large numbers of smolts, fingerlings, and surplus hatchery adults. The adult runs in 1970 and 1971 reached almost 18,000 fish (Table 7).

Efforts to develop a self-sustaining run above Willamette Falls have been largely unsuccessful. Water quality is poor when adults of the early-run stock return to spawn, and low flows in the late spring and summer limit juvenile production. The coastal stocks introduced were susceptible to *Ceratomyxa shasta*, a naturally occurring disease organism in the Willamette and Columbia rivers. The harvest rate for coho in ocean and Columbia River fisheries was as high as 92%, which was much greater than naturally produced stocks could sustain. As hatchery releases declined, so did the Willamette coho runs.

Since 1980, the adult run above Willamette Falls has averaged about 1,900 fish (Table 7). During the same period, the only smolts released above Willamette Falls have been 50,000-60,000 fish/year to compensate for the Scoggins Creek Dam on a tributary of the Tualatin River. Up to 5.3 million presmolts and fry have also been released (Table 8).

The wild stock in the upper Clackamas River is the only remaining native wild coho stock of significant size in the Columbia Basin. The early-run hatchery stock is also regularly released in Eagle Creek and other tributaries of the lower Clackamas, but has not been stocked since 1972 in the upper Clackamas above North Fork Dam, where the native stock spawns. The native stock generally returns and spawns later than the early-run stock.

The early-run stock is harvested primarily in Oregon's off-shore troll and sport fisheries and in the lower Columbia gillnet fishery. Most of the fish taken by sport anglers in the basin are caught in the Clackamas River and Eagle Creek (Table 9).

Progress

Objective 1. Determine the value to Oregon of using late spawning Cowlitz stock coho in the Willamette River by comparing their contribution and survival to that of the Columbia River stock.

When the original Willamette plan was developed, it was felt that the time of return and spawning of the Cowlitz stock might be better suited than the early-run hatchery stock to the flows and water quality conditions in the basin. Results from releases of the two stocks in the Tualatin River indicated that survival rates were about the same; however, the contribution of the early-run stock to Oregon fisheries was almost 50% greater.

Table 7. Estimated escapement of coho salmon above Willamette Falls, 1954-60 and 1965-85. No counts were made 1961-64.

Year	Adults	Jacks	Total
1954	315	160	475
1955	340	1,810	2,150
1956	2,600	6,035	8,635
1957	2,950	1,200	4,150
1958	394	976	1,370
1959	2,065	840	2,905
1960	512	458	970
1965	7,080	2,184	9,264
1966	4,071	2,247	6,318
1967	7,084	1,614	8,698
1968	12,400	5,300	17,700
1969	3,260	14,032	17,292
1970	17,902	19,453	37,355
1971	17,410	6,670	24,080
1972	9,983	7,157	17,140
1973	5,174	1,583	6,757
1974	1,501	3,941	5,442
1975	5,922	6,927	12,849
1976	2,333	2,217	4,550
1977	1,007	2,120	3,127
1978	1,711	3,891	5,602
1979	1,788	1,691	3,479
1980	1,276	1,365	2,641
1981	1,032	2,417	3,449
1982	1,702	3,517	5,219
1983	1,586	2,103	3,689
1984	2,735	2,560	5,295
1985	2,788	2,278	5,066

Table 8. Number[a] of coho released into Willamette Basin, 1962-83 broods.

Brood year	Clackamas River[b]			Above Willamette Falls		
	Adults	Fingerlings	Smolts	Adults	Fingerlings	Smolts
1962	0	0	607	0	5,272	62
1963	0	0	787	0	0	179
1964	0	2,270	695	7,715	8,084	296
1965	0	461	1,047	1,846	9,568	0
1966	930	561	1,484	4,205	10,616	0
1967	1,349	1,541	781	9,208	7,895	0
1968	1,100	13	1,162	7,090	5,747	1,254
1969	702	420	1,142	5,216	5,565	1,346
1970	0	757	1,750	830	883	1,217
1971	2,385	799	1,119	1,450	1,364	1,253
1972	2,613	1,127	1,095	1,316	2,070	1,266
1973	0	0	1,320	1,139	631	190
1974	0	0	1,054	204	687	598[c]
1975	0	0	1,506	0	0	394[d]
1976	0	430	1,267	0	636	168[e]
1977	0	0	1,202	0	0	165
1978	311	0	2,313	0	0	60
1979	566	195	940	0	0	60
1980	266	992	929	0	543	55
1981	202	248	1,497	0	156	54
1982	201	893[f]	1,030	0	3,680[f]	60
1983	0	520[f]	1,023	0	1,026[f]	60
1984	900	810	782	0	5,297[f]	0

[a] *Actual number of adults, thousands of smolts and fingerlings.*
[b] *Includes releases made by ODFW and Eagle Creek National Fish Hatchery.*
[c] *Includes 498,000 Cowlitz stock released in several basin streams plus 40,000 Cowlitz stock released immediately below Scoggins Dam (Tualatin River).*
[d] *Includes 295,000 Cowlitz stock released immediately below Scoggins Dam.*
[e] *Includes 83,000 Cowlitz stock released immediately below Scoggins Dam.*
[f] *Includes fry released from STEP hatch boxes.*

Table 9. Sport catch[a] of coho salmon in the Willamette Basin, 1975-84. "X" indicates that the stream was closed to angling.

Stream	1975	1976	1977[b]	1978	1979	1980	1981	1982	1983	1984
Abernathy Creek	--	--	--	--	--	101	0	0	0	6
Clackamas River	402	788	485	425	522	1,059	741	943	857	856
Clear Creek	--	--	0	0	3	3	0	0	0	3
Eagle Creek	461	1,265	327	650	1,127	1,863	1,292	2,992	218	549
Luckiamute River	--	--	5	0	0	0	0	0	0	0
Molalla River	0	109	30	0	3	X	X	X	X	X
Pudding River	--	--	--	3	9	6	0	0	0	0
Santiam River	14	44	26	9	0	0	0	0	0	0
North Fork	0	0	2	0	3	9	0	0	0	0
South Fork	0	45	10	0	0	0	0	0	0	0
Scappoose Creek	0	0	8	3	0	0	3	3	0	6
Tualatin River	--	6	8	0	0	0	0	13	3	10
Willamette River, lower	237	166	22	0	21	22	21	46	48	58
Yamhill River, North Fk.	--	--	--	--	-	9	0	3	0	0
Total	1,114	2,423	923	1,090	1,688	3,069	2,057	4,000	1,126	1,494

[a] *Estimated from salmon-steelhead tag returns, adjusted for nonresponse bias.*

[b] *The first year to list catch in all open streams; in prior years catch in most tributaries was included in the mainstem catch.*

Objective 2. Maintain coho runs into the Willamette River tributaries below the falls at no fewer than 10,500 fish.

This objective was mainly directed at the Clackamas River. From the total run, it was assumed that sport fishermen would take 1,500 fish and the escapment would be 9,000 fish--2,000 to lower Clackamas tributaries and other lower Willamette tributaries, 4,000 to Eagle Creek National Fish Hatchery (ECNFH), and 3,000 above North Fork Dam.

The average annual catch in the Clackamas River and tributaries from 1980 through 1984 was about 2,300 fish. There are no estimates of total spawning escapement for the lower Clackamas and other lower Willamette tributaries. Returns to ECNFH have been sufficient for hatchery production needs. The major concern with respect to this objective is the escapement of the native wild stock above North Fork Dam. Total escapement above North Fork, which also includes some early-run stock, averaged 2,243 fish since 1981.

SOCKEYE AND KOKANEE

Sockeye were introduced into Green Peter Reservoir on the South Santiam River in the late 1960s. Since then a small, naturally reproducing run developed. Releases of kokanee (landlocked sockeye) in Green Peter in recent years (Table 10) may also have produced a few returning adults. Returns to the adult trap at Foster Dam downstream from Green Peter Dam have fluctuated from 2 fish in 1978 to 1,800 adults in 1980.

Table 10. Thousands of kokanee released in the Willamette Basin, 1978-85.

Year	Kokanee
1978	0
1979	50
1980	100
1981	200
1982	200
1983	100
1984	200
1985	200

Sockeye are frequently carriers of infectious hematopoietic necrosis (IHN), a contagious viral disease of fish for which there is no effective treatment. IHN was detected in adult spring chinook in the North Santiam River in 3 of the last 5 years. As a result, the entire egg takes from the infected stocks were destroyed in those years. Pathologists were concerned

that sockeye might spread the disease to the South Santiam River. Consequently, since 1983 all adult sockeye trapped at Foster Dam have been killed to terminate the run.

SUMMER STEELHEAD

Background

Like fall chinook, Skamania summer steelhead were successfully introduced into the Willamette Basin following passage improvements at Willamette Falls, the pollution abatement program in the 1950s and 1960s, and increases in summer flows from releases from dams on Willamette tributaries. Since its introduction, the runs have grown to a high of 36,000 fish in 1984 (Table 11).

Table 11. Counts of summer steelhead at Willamette Falls and North Fork Dam, Clackamas River, 1970-84.

Year	Willamette Falls	North Fork Dam	Total
1970	146	0	146
1971	4,648	0	4,648
1972	1,526	202	1,728
1973	1,975	66	2,041
1974	6,796	849	7,645
1975	3,021	2,326	5,347
1976	6,001	1,515	7,516
1977	9,244	3,447	12,691
1978	15,162	4,087	19,249
1979	7,670	4,352	12,022
1980	11,200	5,803	17,003
1981	15,200	4,778	19,978
1982	12,567	4,140	16,707
1983	5,301	1,949	7,250
1984	25,002	11,062	36,064
1985	22,067	5,549	27,616

The increasing runs have resulted from improvements in hatchery release strategies rather than from increases in the number of fish released. From 500,000 to 750,000 smolts have been stocked annually since 1973 (Table 12). Research studies demonstrated that increasing the size of smolts released and releasing them later could boost survival rates to as high as 7%.

Table 12. Thousands of summer steelhead smolts released in to the Willamette Basin, 1966-84.

Year	Above Willamette Falls	Clackamas River	Total
1966	20	0	20
1967	0	0	0
1968	50	0	50
1969	148	0	148
1970	69	40	109
1971	87	0	87
1972	271	50	321
1973	416	106	522
1974	385	109	494
1975	473	154	627
1976	516	161	677
1977	452	189	641
1978	529	195	724
1979	391	182	573
1980	442	157	599
1981	401	154	555
1982	519	130	649
1983	441	153	594
1984	538	170	708
1985	581	165	746

Despite sustantial spawning escapements, summer steelhead have not reproduced naturally to any large degree. Thus, maintaining the runs in the basin will continue to rely on releases of hatchery smolts.

Progress

Objective 1. In the Clackamas River, provide the opportunity for at least 15,000 days of angling and maintain a minimum run of at least 5,000 adult summer steelhead annually.

Angler use of the Clackamas River has not been measured. However, the estimated average catch for 1980-84 was about 5,500 fish (Table 13), based on returns of salmon-steelhead tags. Although this may be an overestimate of actual catch, it does indicate that a major summer steelhead fishery has developed on the Clackamas. The average adult return to North Fork Dam increased from 2,763 fish in 1974-79 to 5,547 fish in 1980-85 (Table 11).

Table 13. Sport catch[a] of summer steelhead in the Willamette Basin, 1971-84.

Stream	1971	1972	1973	1974	1975	1976	1977[b]	1978	1979	1980	1981	1982	1983	1984
Abernathy Creek	--	--	--	--	--	--	--	4	0	--	--	--	--	--
Calapooya River	--	--	--	--	--	--	--	8	0	--	--	--	--	--
Clackamas River	0	582	359	576	1,095	1,495	2,117	5,092	3,382	5,001	3,986	4,300	2,011	9,585
Collowash River	--	--	--	--	--	37	201	487	266	466	561	417	45	456
Hot Springs Fork	--	--	--	--	--	--	--	9	26	69	47	112	17	116
Deep Creek	--	--	--	--	--	--	--	4	0	3	0	4	0	0
Eagle Creek	0	--	476	51	60	128	84	34	42	39	0	81	0	0
McKenzie River	--	23	24	366	610	473	732	2,958	1,406	813	2,145	985	263	2,212
Mill Creek (Marion Co.)	--	--	--	--	--	0	15	11	0	0	3	4	0	0
Molalla River	--	--	--	--	--	--	--	14	0	3	9	0	0	3
Santiam River[b]	452	283	204	1,745	129	496	1,552	1,024	751	836	582	632	201	461
North Fork	--	--	--	--	385	1,140	1,641	3,198	1,985	3,144	2,700	2,087	853	4,156
Little North Fork	--	--	--	--	--	0	36	140	115	138	92	131	30	211
South Fork	--	--	--	--	91	274	1,374	4,742	1,293	1,031	1,531	1,648	514	4,051
Crabtree Creek	--	--	--	--	--	0	12	8	22	0	0	0	3	0
Foster Reservoir	--	--	--	--	--	0	33	27	0	0	0	4	0	0
Tualatin River	--	--	--	--	--	--	--	8	0	--	--	--	--	--
Willamette River, lower	--	128	85	147	250	148	202	306	195	395	74	532	175	778
upper	--	--	--	--	--	0	4	38	71	72	121	47	17	216
Middle Fork	--	--	--	--	--	--	--	0	12	0	15	0	13	196
Fall Creek	--	--	--	--	--	--	--	4	0	6	0	0	0	3
Willamina Creek	--	--	--	--	--	--	--	4	0	--	--	--	--	--
Yamhill River	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	452	1,016	1,148	2,885	2,620	4,191	8,003	18,120	9,366	12,016	11,866	10,984	4,142	21,444

[a] *Estimated from salmon-steelhead tag returns, adjusted for non-response bias.*
[b] *Prior to 1977, the catch in most tribtuaries was included in the mainstem catch.*

When combined with the catch below the dam, the average run the past 6 years has exceeded the objective.

Objective 2. Provide an opportunity for at least 32,000 days of angling and maintain a minimum run of at least 10,000 fish annually above Willamette Falls.

Most of the catch above Willamette Falls is taken in the Santiam River system (Table 13). The McKenzie River produced good catches in 1978 and 1981. Recent introductions of summer steelhead in the Middle Fork Willamette and Molalla rivers should also increase angling opportunities.

Salmon-steelhead tags indicate that the summer steelhead catch averaged 6,200 fish/year during 1980-84. However, a comparison of 1978 creel surveys and punchcard estimates for the Santiam River showed that punchcard estimates were twice that of creel estimates.

Average adult returns above Willamette Falls were more than 15,000 fish in 1980-85, almost double the average for 1974-79 (Table 11). The runs exceeded the objective in 5 of the past 6 years.

Objective 3. Maintain a minimum return of 2,000 adults to basin hatcheries each year as broodstock.

Returns to adult collection facilities have provided an adequate number of eggs throughout the 6-year period. Broodstock have been collected from the South Santiam and McKenzie rivers to develop locally adapted broodstocks and to prevent the loss of an entire year of production in case of disease outbreaks at one of the hatcheries.

WINTER STEELHEAD

Background

Winter steelhead are native to eastside tributaries of the Willamette River below the McKenzie River and to the Yamhill and Tualatin rivers on the west side of the basin. Small wild runs have also developed in the Luckiamute and Marys rivers and in the Middle Fork Willamette River and Fall Creek following introduction of native Willamette stock in the 1950s.

The native Willamette stock is a late run, passing Willamette Falls from February through May. To expand angling opportunities, Big Creek hatchery stock, which return primarily in December and January, were introduced in the Clackamas, Tualatin, Molalla, and Yamhill rivers in the 1960s. Releases in the Yamhill River were discontinued when a fishery failed to develop.

The late Willamette winter steelhead is the only anadromous salmonid run above Willamette Falls that consists primarily of wild fish. Major losses of

wild production have been caused by dams on the North and South Santiam. Hatchery production of winter steelhead at Marion Forks Hatchery on the North Santiam partially compensates for those losses.

Progress

Objective 1. Enhance the winter steelhead runs in tributaries below Willamette Falls (primarily Clackamas River) and provide increased angling opportunity from December through March.

Estimates of the total size of the runs in the Clackamas are not available. Counts at North Fork Dam, which are primarily wild fish, have averaged 1,500 fish/run-year since 1980, a slight decrease from the average for the previous 5 years (1,700 fish) (Table 14). To enhance runs for the early season fishery in the lower Clackamas, about 200,000 smolts of Big Creek stock and early Eagle Creek stock that was developed from Big Creek stock have been released annually. ECNFH has also released 60,000 smolts per year developed from late-run native stock (Table 15).

Winter steelhead catch in tributaries below Willamette Falls averaged about 6,500 fish/year during 1980-84 (Table 16). Catch for the preceding 5 years averaged about 5,200 fish.

Changes in angling regulations in the lower Clackamas have reduced the harvest of steelhead smolts by trout anglers. Improvements at the Carver and Feldheimer ramps have increased angling opportunity.

Objective 2. Develop and mantain an annual minimum run of at least 5,000 early-run (November through January) winter steelhead above Willamette Falls and provide up to 15,000 angler days of recreation.

The run size objective has been achieved in 4 of the last 6 years, while the run has averaged almost 6,000 fish/year (Table 14). Substantial natural reproduction of Big Creek stock is occurring. Approximately 20-26% of the early run passing Willamette Falls in 1981-83 were naturallyproduced, and 43% of the January and February catch sampled from the Molalla in 1979-84 were naturally produced.

An early winter steelhead fishery has developed on the Molalla and Tualatin rivers; however, there are no estimates of the angling effort. Estimates of catch in the upper Willamette system include both early-run Big Creek stock and late-run native stock.

Objective 3. Reestablish and maintain an average run of 14,000 native (late-run) winter steelhead above Willamette Falls.

The average run of native steelhead above Willamette Falls increased substantially from 6,500 fish in 1974-79 to 10,600 fish in 1980-85. Scale

Table 14. Counts of winter steelhead at Willamette Falls and North Fork Dam, 1970-71 through 1984-85 run years.

Run year	Willamette Falls fishway			North Fork Dam
	Early stock[a]	Late stock[b]	Total	
70-71	8,016	18,314	26,330	4,352
71-72	6,572	16,588	23,160	2,634
72-73	6,239	11,511	17,750	1,899
73-74	6,292	8,528	14,820	680
74-75	3,096	3,034	6,130	1,509
75-76	4,204	5,196	9,400	1,488
76-77	5,323	8,277	13,600	1,525
77-78	8,600	8,270	16,870	2,019
78-79	2,855	5,865	8,720	1,517
79-80	6,258	16,142	22,400	2,065
80-81	7,662	9,038	16,700	2,700
81-82	6,106	6,894	13,000	1,446
82-83	4,598	4,702	9,300	1,099
83-84	6,680	10,720	17,400	1,238
84-85	4,549	16,051	20,600	1,225

a *15 October through 14 February. These are mainly introduced Big Creek stock.*
b *15 February through 15 May. These are mainly indigenous Willamette stock.*

Table 15. Thousands of winter steelhead smolts released into the Willamette Basin, 1965-85.

Year	Stock released					
	Below Willamette Falls			Above Willamette Falls		
	Alsea	Big Creek	Eagle Creek[a]	Alsea	Big Creek	N. Santiam
1965	0	0	55	0	0	151
1966	50	0	213	35	0	--
1967	20	5	228	0	0	176
1968	10	30	--	35	0	114
1969	20	22	96	25	0	82
1970	31	51	28	30	10	19
1971	30	5	21	31	0	100
1972	93	28	184	52	0	83
1973	0	87	205	9	54	84
1974	122	5	77	114	0	10
1975	37	91	97	70	51	61
1976	(b)	110	155	(b)	148	73
1977		123	96		128	79
1978		137	112		173	69
1979		116	166		165	78
1980		97	86		161	118
1981		112	149		157	126
1982		66	101		85	91
1983		165	113		131	102
1984		148	100		134	93
1985		144	154		126	89

a *Reared and relesaed at Eagle Creek National Fish Hatchery includes both an early Big Creek stock and a late Clackamas stock.*
b *Releases of Alsea stock were discontinued after 1975 because of susceptibility to Ceratomyxa shasta, a naturally occurring disease organism in the Columbia Basin to which Willamette and Big Creek stocks are resistant.*

Table 16. Sport catch[a] of winter steelhead in the Willamette Basin, 1971-83. "X" indicates that the stream was closed to angling.

Stream	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77[b]	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84
Abernathy Creek	--	--	--	--	--	3	7	7	6	6	4	7	6
Calapooia River	169	182	51	33	177	80	0	96	122	48	32	7	20
Clackamas River	8,856	2,612	1,628	4,753	2,335	2,083	4,863	3,252	6,467	5,489	4,724	3,328	4,869
Clear Creek	--	--	--	--	--	6	75	23	73	70	109	99	95
Collowash River	--	--	--	--	--	18	23	21	30	9	0	68	3
Hot Springs Fork	--	--	--	--	--	--	--	113	7	0	0	7	3
Deep Creek	--	--	--	--	--	0	24	7	42	0	37	17	57
Eagle Creek	--	1,697	1,095	2,418	1,449	425	1,923	514	1,549	399	1,502	1,301	2,077
Johnson Creek	19	12	10	32	4	0	21	14	9	0	21	11	26
Kellogg Lake	--	--	--	--	--	--	4	0	3	0	9	0	0
Luckiamute River	--	--	--	--	--	0	6	4	0	0	0	0	0
Marys River	--	--	--	--	--	3	10	3	16	13	9	0	3
McKenzie River	34	0	0	0	0	0	0	0	0	0			
Mill Creek (Marion Co.)	--	---	--	--	--	9	4	0	9	0	9	5	0
Mill Creek (Yamhill Co.)	--	--	--	--	--	3	10	13	26	59	13	13	7
Milton Creek	--	--	--	--	--	0	20	13	29	16	28	3	20
Molalla River	323	570	419	589	573	882	1,294	498	2,062	1,443	830	531	1,123
Pudding River	--	--	--	--	--	--	4	15	9	0	0	10	3
Abiqua Creek	--	--	--	--	--	207	111	35	253	10	136	41	71
Butte Creek	--	--	--	--	--	21	32	16	36	59	13	11	6
Santiam River	1,224	1,528	698	679	636	966	965	395	818	434	340	90	254
North Fork	--	--	--	321	277	791	1,391	437	1,129	918	757	281	681
Little North Fork	--	--	--	--	--	15	139	92	118	93	89	48	35
South Fork	--	--	--	64	127	207	748	57	74	25	30	42	288
Crabtree Creek	--	--	--	--	--	28	4	6	51	72	33	45	29
Foster Reservoir	--	--	--	--	--	--	5	0	0	6			
Thomas Creek	--	--	--	--	--	125	145	23	102	45	81	24	51
Scappoose Creek	56	22	59	101	26	3	42	7	23	46	31	28	3
North Fork	--	--	--	--	--	0	21	6	171	119	67	104	57
South Fork	--	--	--	--	--	0	10	0	40	31	8	28	7
Silver Creek	--	--	--	--	--	--	--	--	20	18	7	30	13
Sucker Creek	35	6	21	5	0	3	17	6	33	3	22	11	90
Tualatin River	--	--	--	--	--	62	87	26	55	3	99	31	44
Gales Creek	--	--	--	--	--	145	209	11	324	315	193	221	289
Willamette River, lower	2,256	1,415	823	986	1,380	690	755	465	1,121	1,102	1,081	783	1,087
Upper	--	--	--	--	--	10	111	125	299	264	110	119	165
Coast Fork	--	--	--	--	--	--	12	20	3	0	X	X	X
Middle Fork	--	--	--	--	--	28	60	0	32	36	28	4	7
Fall Creek	--	--	--	--	--	53	26	3	6	24	7	14	0
Willamina Creek	--	--	--	--	--	9	135	29	69	97	54	27	57
Yamhill River	--	--	--	--	--	--	8	0	3	22	4	10	0
North Fork	--	--	--	--	--	9	18	0	7	58	4	8	7
South Fork	--	--	--	--	--	--	15	0	0	13	20	14	3
Total	12,972	8,044	4,804	9,981	6,984	6,884	13,354	6,352	15,246	11,365	10,541	7,411	11,556

[a] *Estimated from salmon-steelhead tag returns, adjusted for nonresponse bias.*
[b] *Prior to 1977 the catch in most tributaries was included in the mainstem catch.*

analysis indicated that 85% of the run sampled in 1982 was wild. About 100,000 smolts of native Willamette stock have been released each year in the North and South Santiam rivers (Table 15). Experimental releases of presmolts have also been made in the upper South Santiam. Since 1979, ODFW has been conducting a study to restore the native winter steelhead run in the South Santiam above Foster and Green Peter dams.

SHAD

Background

Shad were introduced into the Willamette and Columbia rivers in the late 1800s. An anadromous species like salmon and steelhead, shad enter the Willamette in mid-May and concentrate below Willamette Falls in June. They are unable to pass upstream through the fishway because of its design, but some fish migrate through the navigation locks to spawning areas above the falls.

Shad were commercially harvested in Willamette Slough until 1967, when the fishery ended because of a depressed market. An active sport fishery still continues between the mouth of the Clackamas River and Willamette Falls.

Progress

Objective 1. Stimulate greater sport harvest of shad by informing anglers of local angling opportunities and techniques and by educating the angling public to the fine sporting and excellent eating qualities of shad.

Angling effort and catch have leveled off the past 2 years after substantially increasing from 1978 through 1983 (Table 17). A concerted effort was made to stimulate sport angling by informing fishermen of local angling opportunities and success through the fishing reports distributed by ODFW. Publications and news releases have also promoted the sporting and eating qualities of shad.

Table 17. Estimated angler trips and catch of shad on the lower Willamette River, 1978-85.

Year	Angler trips	Catch
1978	4,000	5,800
1979	7,200	15,100
1980	11,400	15,500
1981	9,500	20,400
1982	13,400	21,700
1983	13,400	36,800
1984	10,100	19,800
1985	10,500	16,200

Objective 2. Monitor growth of the recreational fishery by maintaining accurate estimates of anger catch and effort.

Sport catch and effort have been estimated every year since 1978 (Table 17).

Objective 3. Support development of selective commercial fishing gear that will enable fishermen to harvest shad with minimal impact on salmonids.

Since the commercial fishery in the Columbia River can more than supply the limited market for shad, there has been no need to pursue this objective in the Willamette Basin.

STURGEON

Background

White sturgeon are mainly found below Willamette Falls. Some fish do migrate into the Willamette River from the Columbia and may move through the navigation locks into reaches of the mainstem above the falls.

There appears to be adequate natural reproduction to maintain the population below the falls. It may be feasible to stock areas above the falls.

Progress

Objective 1. Maintain assessment of sport catch and distribution.

Anglers fish for sturgeon year-round. However, the fishery takes place primarily in the spring and summer in the lower Willamette River between Milwaukie and the falls and near the mouth. A few sturgeon are caught above the falls, particularly near Wilsonville and at the mouth of the Long Tom River.

Since 1978 angler trips and catch on the lower Willamette have been estimated from mid-March to early July (Table 18). During the remaining months, periodic surveys are made by boat and aircraft. Angler trips have generally increased, while catch has been quite variable. Thousands of small, sublegal-sized sturgeon are caught and released each year.

Table 18. Estimated angler trips and catch of white sturgeon from mid-March to early July in the lower Willamette River, 1978-85.

Year	Angler trips	Catch
1978	2,200	300
1979	3,600	550
1980	5,900	310
1981	5,600	380
1982	5,900	360
1983	6,000	270
1984	5,900	190
1985	6,400	310

RESIDENT TROUT

Background

Native rainbow and cutthroat are the principal trout species in the Willamette Basin. Brook trout have been introduced into some high lakes in the Cascades. A few bull trout also occur.

Most of the trout in streams are wild. Population data are lacking for most streams; however, by a conservative estimate there are a minimum of 1 million wild trout 6 inches and larger in the basin. Hatchery production compensates for some losses in wild production due to dams and provides additional fish for harvest where angling demand is heavy (Table 19).

Table 19. Thousands of trout released in the Willamette Basin[a], 1978-85.

Year	Trout	
	Fingerling	Yearling
1978	1,608	1,130
1979	985	1,103
1980	885	1,098
1981	1,066	1,091
1982	989	1,111
1983	913	1,111
1984	1,018	1,102
1985	844	1,105

[a] *Does not include high lakes in the Cascades.*

Progress

Objective 1. Manage wild populations to maintain production potential, genetic integrity, and genetic and size diversity.

In 1982 the daily trout bag limit for streams was reduced from 10 fish to 5 fish, which may have reduced the harvest of wild fish somewhat. Stocking of hatchery trout is restricted to 457 miles of the 6,279 miles of trout streams in the basin. The number of legal-sized trout stocked in streams was reduced from 527,000 in 1980 to 499,000 in 1985. District biologists spend a large portion of their time on habitat issues, which include protection of trout habitat.

Objective 2. Provide the opportunity for at least 1,280,000 angler days of recreation.

This objective was a projection based on increasing license sales in the 1970s, which did not continue into the 1980s. A general survey of trout angling effort throughout the basin has not been conducted since 1977.

The number of legal-sized trout stocked in reservoirs has increased slightly from 486,000 in 1980 to 520,000 in 1985. Fingerlings are released in the high lakes but no longer in reservoirs in the basin. The survival of fingerlings in most reservoirs is poor because water levels fluctuate as much as 177 feet, fish are flushed from shallow reservoirs in winter, and many reservoirs have large populations of rough fish. Most lakes and reservoirs were opened to year-round angling to increase angling opportunity.

Objective 3. Initiate a public education program relative to the value of wild trout, angling potentials within the state, and angler involvement.

A variety of information for the public has been produced regarding angling opportunities on the McKenzie River and Gold Lake. The public has also been introduced to wild trout issues and has become involved in habitat improvement projects through the Salmon and Trout Enhancement Program (STEP).

Objective 4. Encourage land management agencies to coordinate future road and trail systems to provide optimum access to meet management objectives.

This objective was largely directed at controlling access to some high lakes in the Cascades to prevent overfishing. A special high lakes management option was developed for inclusion in the management plan for the Willamette National Forest.

Objective 5. Explore ways of using hatchery trout to manipulate angler pressure and provide more angling opportunities.

To increase the catch of hatchery fish and minimize competition between hatchery and wild fish, the Cape Cod strain of rainbow trout is used exclusively for stocking. Previous studies indicated that this strain migrates from the stocking area less than other strains. Current experiments are attempting to develop methods to reduce the migrational tendency further.

Statistical creel surveys were conducted on the McKenzie and Molalla rivers and Foster Reservoir to evaluate catch rates of hatchery fish. The daily bag limit for Hagg Reservoir was reduced from 10 to 5 fish to spread the catch of stocked trout over a longer period of time.

WHITEFISH

Background

Whitefish are found throughout the basin. Although they are members of the same family of fishes as trout and salmon, they are sometimes confused with suckers because of their mouth and large scales.

Whitefish are most frequently caught incidentally by trout anglers. There are no harvest or inventory data; however, they are considered to be relatively abundant and underutilized.

Progress

Objective 1. Educate the angling public to the excellent sporting and eating qualities of whitefish.

Objective 2. Make anglers aware of specific whitefish populations by improving ODFW's knowledge of the resource through research and management activities and disseminating the information.

Oregon Wildlife magazine ran a feature article on whitefish, which pinpointed several locations for fishing. The lower section of the McKenzie River was opened to year-round angling for whitefish.

WARMWATER GAME FISH

Background

Introduced warmwater species in the basin include largemouth and smallmouth bass, white and black crappie, and five other species of sunfishes; yellow perch; walleye; and three species of catfish. Bullfrogs are also included in this group by state statute. Bass, crappie, bluegill, and bullheads dominate the catch.

Warmwater game fish are found primarily in low elevation reservoirs, backwater areas along the Willamette River and its major tributaries, and in man-made ponds. For the most part they occupy habitats previously used by native nongame fishes, except in some reservoirs, where trout and juvenile salmon and steelhead also occur.

Their high reproductive capability combined with less than optimum habitat and growing conditions often results in small fish. Management to increase size or abundance is very complex; except for channel catfish, supplemental release of hatchery fish is not a feasible technique.

Progress

Objective 1. Achieve a harvest of at least 1,180,000 warmwater game fish in 240,000 angler days.

The projections in the original plan that this objective was based on did not fully materialize. As the economy declined, sales of angling licenses leveled off rather than increased. The St. Louis Ponds have provided several thousand angler days annually, though not the 20,000 forecasted in the plan. Access has been gained to Santosh Slough, a popular bank fishing area near Scappoose. ODFW also published a warmwater angling guide for the Portland area.

We have no current measure of catch or effort. However, interest and participation in warmwater fishing appears to be growing. Only bass and channel catfish are apt to be adversely affected by increased harvest. With most other species, removal of more fish would increase the growth rate of the remaining fish.

The warmwater fish program of ODFW has been expanded. A statewide warmwater fish mangement plan and a new management strategy for Cottage Grove Reservoir are being developed. Additional inventories of warmwater species in Dorena, Fern Ridge, Foster, Green Peter, Lookout Point, and Hagg reservoirs are being conducted. These will provide needed information on species abundance for management of those waters.

Objective 2. Improve channel catfish and largemouth and smallmouth bass populations to provide or improve fishable populations in suitable areas.

Channel catfish seldom reproduce in western Oregon. Consequently, only remnant populations can be maintained without continual stocking. Attempts to rear fry obtained from California to stocking size have not been successful because of high mortalities during shipment and temperature shock from cold water in the rearing ponds. Funding has not been available to buy from a local private hatchery fingerlings that may potentially be more successfully reared to size for stocking.

Smallmouth bass were introduced into the Coast Fork of the Willamette, but there is no evidence that they have become established. However, a few smallmouth have been reported in the mainstem of the Willamette downstream from Corvallis.

The habitat in existing reservoirs is generally more suited to smallmouth than largemouth bass. Largemouth bass populations in several of those impoundments vary from fair to marginal. The introduction of smallmouth bass into Lookout Point Reservoir is under consideration. Potential conflicts with salmonid production in reservoirs will have to be resolved prior to increasing efforts to enhance warmwater game fish production in those waters. Through the expansion of the warmwater game fish program, we are beginning to collect the data necessary to evaluate bass populations.

MISCELLANEOUS SPECIES

Background

This group includes suckers, squawfish, chubs, sculpins, dace, carp, lamprey and other nongame species. Except for carp, they are native to the basin. Populations of the Oregon chub *Hybopsis crameri*, which is primarily found in the Middle Fork Willamette drainage, appear to be below former levels. It is currently on the state list of protected species and is a candidate for the federal list of endangered species. The sand roller *Percopsis transmontana*, which is more widely distributed, is also suspected of being at low levels, but its exact status is unknown.

Habitat changes, which have contributed to the decline of salmonids, have favored some of these species. Large populations, especially of carp, suckers, and squawfish, occur in some waters managed for game fish. Some of these species may compete with and consume game fish, although the interrelationships of these fish communities is largely unknown.

There are no estimates of harvest of these species. Most are probably caught incidentally by anglers fishing for game fish. Some carp are taken with hook-and-line, bow-and-arrow, and seines.

Progress

Objective 1. Increase harvest of carp, squawfish, lamprey, and other nongame species which are currently underutilized.

There is no information to measure changes in harvest levels, and there is little indication that harvest has increased. A private company is planning to commericallly harvest carp in the lower Willamette. Commercial harvest offers the greatest potential for increased use of these fishes, but markets must first be established.

Objective 2. Control undesirable species where they impact the growth or abundance of more desirable species.

Toxicants have previously been commonly used to eradicate nongame fish in waters managed for game fish production. This technique has not been used often in the Willamette Basin because of high costs and concern over the effects on other species. Future reservoirs will be designed so they can be completely drained to control undesirable species.

FRESHWATER INVERTEBRATES

Background

Crayfish are the invertebrate species of greatest direct interest and provide the only harvest of any consequence. Other invertebrates, particularly aquatic insects, are important as food organisms for fish and contribute to the overall productivity of aquatic communities.

Progress

Objective 1. Determine the size and importance of the recreational crayfish harvest.

Recreational harvest is widespread and appears to be increasing; however, there are no estimates of harvest or effort. Carrying out this objective would have been costly and was not given a high priority.

Objective 2. Assess crayfish populations and commercial harvest potentials in major water bodies.

Commercial catch is reported by county, not by water body. Counties within the Willamette Basin accounted for about 18% of the statewide harvest in 1984 and 26% in 1985. Most of the 1985 harvest occurred in Multnomah, Clackamas, and Yamhill counties. Data on catch, effort, and size composition of the catch were collected for Timothy Lake in 1983.

MAJOR PROBLEMS

The Willamette Plan identified 29 problems that needed to be solved to meet the objectives of the plan. Some of these have been solved to varying degrees, and some continue to impact the fisheries in the basin. The following section reviews the major problems identified in the plan that were not discussed in other sections of this report.

Habitat Loss

Stream alterations resulting from land-use practices degrade habitat and reduce fish production.

ODFW staff continue to review state and federal permits for logging, road construction, fill and removal, and other land use activities to prevent damage to aquatic habitats. The number of permits has been increasing each year.

The filling and removal of gravel and other material in streams is regulated by the Division of State Lands. Compliance with the fill-removal law has been improving based on the number of *reported* violations. However, not all violations may be formally reported, and most projects are not inspected to monitor compliance with permit conditions.

The Forest Practices Act, which regulates timber management on private commercial timber lands, contains provisions for protection of aquatic habitat. ODFW reviewed the existing regulations and recommended to the State Board of Forestry changes that would provide greater habitat protection. Recommendations for aquatic habitat protection relating to national forest management plans and comprehensive land-use plans were also provided to the U.S. Forest Service, cities, and counties.

ODFW completed a study funded by the ODEQ to assess the causes and impacts of nonpoint pollution on salmon and trout. The Willamette River Sediment Transport Investigation provided information on the supply, movement, and replenishment of gravel in the Willamette River and its major tributaries.

Educating the public about habitat issues and encouraging public participation in habitat improvement projects is a major thrust of the Salmon and Trout Enhancement Program (STEP). The Riparian Tax Incentive Program passed by the legislature in 1981 offers tax exemptions and credits to owners of agricultural and private forest lands who agree to protect streamside vegetation or improve instream habitat.

Wild Fish

The Willamette Plan identified three problems relating to the production and harvest of wild fish.

1. Populations of wild salmon, steelhead, and resident trout are insufficient to meet present-day user demands.

The current production of spring chinook, fall chinook, coho, summer steelhead, and early winter steelhead largely depend on releases of hatchery fish. Access to major spawning and rearing areas of spring chinook and to a lesser degree native late winter steelhead has been completely blocked or at least complicated by dams. There is some natural production of introduced runs of coho, fall chinook, and early winter steelhead. There is essentially no natural production of summer steelhead.

Hatchery programs have been generally successful in boosting the population levels of these species to keep pace with the demand of commercial and recreational fisheries. However, awareness of the need to improve the management of wild salmonid stocks has also been growing.

Several steps have been taken to protect and enhance production of wild fish. In 1984, the Fish and Wildlife Commission adopted a revised Wild Fish Management Policy, which was designed to increase recognition and improve

management of wild stocks. The trout season opening was pushed back to late May on the Santiam, Molalla, and lower Clackamas rivers to reduce the catch of salmon and steelhead smolts. Some releases of catchable trout were transferred to reservoirs and lakes to also reduce the incidental catch of wild salmonids in streams by fishermen targeting on hatchery trout. Department biologists and STEP volunteers have devoted considerable effort to habitat protection and improvement necessary for wild fish.

2. When large numbers of hatchery fish are mixed with fewer wild fish, wild fish may be overharvested.

To reduce the overharvest of wild trout, the number of hatchery trout planted and the stream areas stocked have been reduced. All releases of hatchery summer steelhead have been marked so they can be identified and selectively harvested in the lower Columbia and Willamette Basin fisheries. Later-returning summer steelhead have also been selected to minimize the overlap with wild late-run winter steelhead.

3. High ocean harvest rates for fall chinook and coho prevent development of natural runs above Willamette Falls and are excessive for established wild populations.

The ocean harvest of coho has been reduced to levels that provide adequate overall escapement of wild stocks in coastal basins. However, additional harvest in the Columbia River, which is managed for production and harvest of hatchery fish, further reduces the spawning escapement of fish to the Willamette Basin. In 1985, the Fish and Wildlife Commission reaffirmed its intent to manage the Columbia River and its tributaries for the production and harvest of hatchery coho. A self-sustaining population is no longer the objective of coho managment above Willamette Falls.

Like coho, fall chinook are harvested in both ocean and Columbia River commercial and sport fisheries. The U.S.-Canada Salmon Interception Treaty, agreed to in 1985, sets a ceiling on fall chinook catch off the west coast of British Columbia, which accounts for a large percentage of the harvest of the tule stock. This should eventually increase the tule runs in the Columbia and Willamette rivers. Fall chinook are also managed for the production and harvest of hatchery fishery in the Willamette Basin. Consequently, maintaining spawning escapement is not a primary objective of the management program.

Information Needs

Both Our Information Base and Information Systems Are Inadequate to Meet Goals and Objectives in the Most Efficient Manner.

Adequate information is essential to good management. There is a continuing need for information on life histories, habitat requirements,

harvest, angler activity, and hatchery production, particularly for resident and warmwater species, and improved methods for handling that information.

Fish passage is monitored daily at Willamette Falls, North Fork Dam on the Clackamas River, Foster Dam on the South Santiam River, and Leaburg Dam on the McKenzie River. These counts provide an important measure of adult runs of anadromous salmonids and smolt production. Other population inventories are conducted by biologists and STEP volunteers. A computer system is now used to track hatchery production.

Returns of salmon and steelhead tags provide a gross estimate and relative index of sport catch in individual streams. Tag returns have now been analyzed through 1984. The spring chinook fishery below Willamette Falls is intensively sampled. Angler surveys are also conducted on the lower Willamette and Clackamas rivers for steelhead and on the Willamette River for sturgeon and shad. Statistical creel surveys were completed on the Molalla River in 1982 and on the McKenzie River in 1983.

Most of the physical and biological surveys of streams in the basin were made in the 1950s and 1960s. Thus, much of the data is outdated and of limited use in evaluating the current condition and capacity of streams. Some surveys are being updated, and additional streams surveyed by ODFW, and the U.S. Forest Service, and the Bureau of Land Management.

Disease

Problems With General Fish Health and Disease Continue to Reduce Survival and Returns of Salmonids.

Improved hatchery practices and a routine disease monitoring program have decreased losses and improved survival. Injecting spring chinook broodstock with antibiotics has reduced prespawning mortality in the hatcheries. Injections and feedings of antibiotics have also helped to control bacterial kidney disease (BKD). The disease monitoring program has aided in the detection of infectious hematopoietic necrosis (IHN). Treatment of eggs with iodophor has reduced egg losses.

Counts at Willamette Falls

A High Percentage of Adult Spring Chinook Passing Willamette Falls Are Unaccounted for at Upstream Locations.

At the time the original Willamette Plan was prepared, it was estimated that approximately 25% of the spring chinook run passing Willamette Falls could not be accounted for when returns to hatcheries and estimates of catch and spawning escapement were combined. A more recent detailed analysis of counts for 1970-80 indicates the average discrepancy is considerably higher--42%. "Losses" of summer steelhead are also suspected. There are similar problems at other counting sites, such as North Fork Dam on the Clackamas River and Sherars Falls on the Deschutes River.

Several explanations may be possible. Some fish may drop back over the falls and be recounted when they pass through the counting facility again. This has been frequently observed at other counting sites and appears likely at Willamette Falls, given the location of the fishway exit above the falls. Fish ultimately destined for the Clackamas River may also momentarily pass above the falls. From 12% to 25% of the adults tagged and released in the fishway were subsequently recaptured below the falls and in the Clackamas River. However, this may have been a response to tagging rather than normal behavior. Other explanations for the problem include illegal harvest, undetected natural mortality, and underestimates of fish spawning in the streams.

Hatchery Release Criteria

Fish Are Not Always Stocked at the Size, Time, Location Or Under Conditions Required to Provide Optimum Survival to Adults Or Maximum Return to Target Fisheries.

The success of early hatchery programs was often measured in the number or pounds of fish released. Considerable progress has been made in aiming hatchery efforts at increasing survival and benefits to specific fisheries. Tagging studies conducted by research and technical services personnel have been used to determine the effects of varying the size of smolts released and the time of release. These studies have resulted in recommendations for program improvements that are being implemented.

Studies of spring chinook have evaluated the effects of smolt size on adult returns. Tagged smolts are now being released to find out the best month for release. We now know that hauling smolts from upriver hatcheries for release below Willamette Falls will increase the number of adults available to lower river fisheries. The survival rates of tagged fish have also indicated which hatcheries should be rearing larger proportions of the annual production and where rearing programs need improvement. For example, the stocking density in the ponds at South Santiam Hatchery was reduced after the survival of fish from heavily loaded ponds was found to be lower.

Size and time of release studies with steelhead consistently revealed that larger steelhead smolts survive better. Conversely, tagging studies of tule fall chinook suggest that the time the smolts enter the ocean affects survival more than smolt size. As a result of these studies, hatchery programs have been modified to produce large steelhead smolts and to release fall chinook earlier.

Management biologists continue work to define the effects of release time and location of hatchery trout on harvest, to assess harvest rates, and to identify changes in angling regulations that will protect anadromous fish smolts. However, in some cases smolt harvest has continued in spring trout fisheries because of public demand.

Angler Access

The Public is Denied the Use of Many Desirable Fishing Waters Where Access Is Controlled by Private Owners.

Rivers and streams are accessible by boat where ramps are available; however, bank angling opportunities are scarce in many areas. ODFW obtained public fishing access to Santosh Slough, a popular fishing area near Scappoose. Ponds in Lane and Polk counties, which may provide some additional fishing, have been inventoried. Additional access sites have been developed on the Molalla and North Santiam rivers, and several ramps on the mainstem Willamette have been improved.

Appendix A. Locations of adopted minimum perennial streamflows in the Willamette Basin.

SUBBASIN Stream	LOCATION
WILLAMETTE RIVER	
Mainstem	above Falls at Oregon City
Mainstem	at Wilsonville
Mainstem	at Salem
Mainstem	at Albany
Mainstem	from Coast Fork to McKenzie River
LOWER WILLAMETTE SUBBASIN	
Milton Cr.	above confluence of Salmon Cr.
Cox Cr.	above mouth
Salmon Cr.	above mouth
North Scappoose Cr.	above mouth
Alder Cr.	above mouth
Cedar Cr.	above mouth
Chapman Cr.	above mouth
North Fork Scappoose Cr.	above mouth
Sierkes Cr.	above mouth
South Fork of North Scappoose Cr.	above mouth
South Scappoose Cr.	above confluence with Raymond Cr.
Gourlay Cr.	above mouth
Raymond Cr.	above mouth
CLACKAMAS SUBBASIN	
Mainstem	Big Bottom
Mainstem	above Three Lynx to mouth
Lowe Cr.	above mouth
Pinhead Cr.	above mouth
Collawash R.	above mouth
East Fork Collawash R.	above mouth
Elk Lake Cr.	above mouth
Eagle Cr.	above mouth
North Fork Eagle Cr.	above mouth
Deep Cr.	above mouth
North Fork Deep Cr.	above mouth
Tickle Cr.	above mouth
Clear Cr.	above mouth
Clear Cr.	above Viola
Hot Springs Fork Collawash R.	above mouth
Oak Grove Fork Clackamas R.	above mouth
Roaring R.	above mouth
Fish Cr.	above mouth
Fish Cr.	above confluence of Wash Cr.
Wash Cr.	above mouth

Appendix A. (continued)

SUBBASIN Stream	LOCATION
TUALATIN SUBBASIN	
Mainstem	RM 70
Mainstem	at West Linn
Seine Cr.	above mouth
Tanner Cr.	above mouth
Gales Cr.	above mouth
Gales Cr.	above RM 12
Beaver Cr.	above mouth
Little Beaver Cr.	above mouth
North Fork Gales Cr.	above mouth
South Fork Gales Cr.	above mouth
West Fork Dairy Cr.	at Banks to mouth
East Fork Dairy Cr.	above RM 13
Denny Cr.	above mouth
Plentywater Cr.	above mouth
McKay Cr.	above RM 15.5
East Fork McKay Cr.	above mouth
McFee Cr.	above confluence of Gulf Canyon Cr.
MOLALLA SUBBASIN	
Mainstem	near Wilhart
Mainstem	near Canby
Milk Cr.	at mouth
Pudding R.	near Mt. Angel
Pudding R.	at Aurora
Silver Cr.	Silverton to mouth
Abiqua Cr.	at mouth
YAMHILL SUBBASIN	
Mainstem	at Lafayette
South Yamhill R.	near Willamina
South Yamhill R.	near Whiteson
South Yamhill R.	near Whiteson to mouth
Agency Cr.	at mouth
Willamina Cr.	near Willamina
Willamina Cr.	from Willamina to mouth
Mill Cr.	at mouth
Deer Cr.	at mouth
North Yamhill R.	at Pike
RICKREALL SUBBASIN	
Rickreall Cr.	near Dallas

Appendix A. (continued)

SUBBASIN Stream	LOCATION
LUCKIAMUTE SUBBASIN	
Mainstem	near Hoskins
Mainstem	at Pedee
Mainstem	at Suver
Mainstem	at mouth to RM 1
Pedee Cr.	at mouth
Little Luckiamute R.	at Falls City to Highway 223 crossing
SANTIAM SUBBASIN	
Mainstem	near Jefferson
Mainstem	between mouth and RM 1
South Santiam R.	at Cascadia
South Santiam R.	at Waterloo
Middle Santiam R.	near Foster
Wiley Cr.	above mouth
McDowell Cr.	at mouth
Hamilton Cr.	at mouth
Crabtree Cr.	at mouth
Thomas Cr.	at mouth
North Santiam R.	near Detroit
North Santiam R.	at Niagra
North Santiam R.	at Mehama
North Santiam R.	near Jefferson
Little North Santiam R.	near Mehama
CALAPOOIA SUBBASIN	
Mainstem	at Holley
Mainstem	at Albany
MARY'S SUBBASIN	
Mainstem	near Philomath
Mainstem	at mouth
Greasy Cr.	at mouth
LONG TOM SUBBASIN	
Long Tom R.	at Gage 14170000

Appendix A. (continued)

SUBBASIN Stream	LOCATION
MCKENZIE SUBBASIN	
Mainstem	at gauge 14162500
Mainstem	at Highway 5 bridge
South Fork	at mouth
Blue R.	at mouth
Gate Cr.	at mouth
Mohawk R.	at mouth
MIDDLE FORK SUBBASIN	
Mainstem	above confluence with North Fork
Mainstem	at mouth
North Fork of Middle Fork	at mouth
Lost Cr.	at mouth
Fall Cr.	at mouth
Little Fall Cr.	at mouth
Hills Cr.	at mouth near Jasper
COAST FORK SUBBASIN	
Coast Fork Willamette R.	above confluence with Row River
Coast Fork Willamette R.	at mouth
Row R.	at mouth

[a] *RM = River Mile.*