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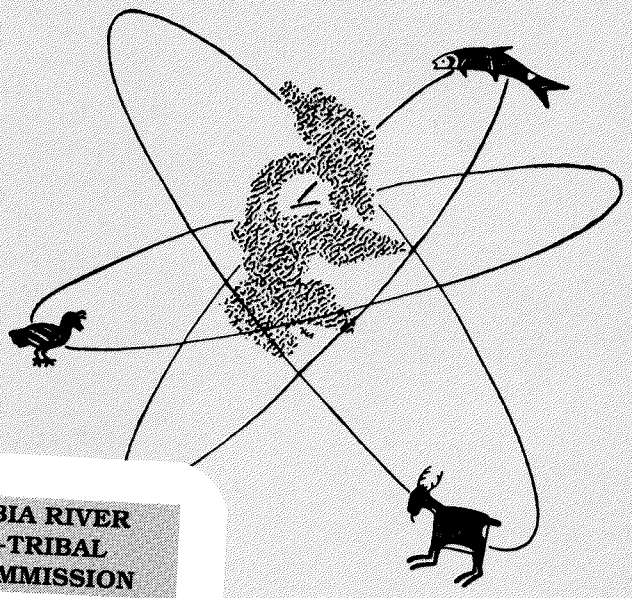

RESEARCH AND DEVELOPMENT SECTION

Oregon Department of Fish and Wildlife
Fish Division

Stock Assessment and Enhancement of Fall Salmon Species in the Willamette River System

ANNUAL PROGRESS REPORT

COLUMBIA RIVER FISHERY DEVELOPMENT PROGRAM

PROJECT TITLE: Stock Assessment and Enhancement of Fall Salmon Species in the Willamette River System

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ABSTRACT

The adult fall chinook runs over Willamette Falls have continued to decline over the past 4 years. In 1978, 17,902 fall chinook returned over the falls, 8,222 fewer than observed in 1977. A larger run was expected, but fall chinook returns declined throughout the region. Included in this adult run were wild[1] age 3 and 4 late spawning fall chinook returning to three tributaries. We found 56 redds of these fish although high muddy water prevented accurate counts.

A 4 year study was designed to determine the success and contribution of hatchery and wild adult early spawning fall chinook. Approximately 290,000 Ad/CWT juvenile fall chinook among the production release of 4.7 million hatchery fish comprised the initial release during May 1978.

Coho returns were again severely depressed with 1,711 adults counted at Willamette Falls. Initial returns of coho from a test comparing stocks were captured at Scoggins Creek in 1978. These returns revealed that the early spawning stock returned at a significantly higher rate than the late spawning stock. However, we believe late spawning stock were released too small and early to produce comparable survival.

MANAGEMENT IMPLICATIONS

1. The fall chinook run was less than expected. This is the fourth year of declining runs of fall chinook. Since pond releases have remained constant and spawning escapements in 1974 and 1975 were high, mortality has been high among those brood year groups. Further analysis is needed to determine the causes and if management options can be used to bring improvements.

2. Fall chinook redds were found in the following river systems, listed in descending order of redds counted: South Santiam, main-stem Willamette, Mill Creek (Salem), main-stem Santiam, Molalla, North Santiam, McKenzie. Protection of spawning areas and late season water quality in these rivers should be vigorously pursued in order to maintain wild production.

3. Introduction of late spawning fall chinook has successfully established some wild production in the Row River system. Mosby Creek seems to be the preferred spawning area. Therefore the Willamette System is amenable to developing production of late as well as early spawning stocks of fall chinook.

4. Releases of juvenile fall chinook from Stayton Pond need to remain consistent in numbers and release sites for the next three years in order to accurately assess the effects of those releases. The areas included in these releases are the lower Molalla River, North Santiam River from Stayton downstream, South Santiam below Lebanon, main-stem Santiam, main-stem Willamette from Eugene to Peoria.

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[1] *Fish spawned and reared under natural conditions in the stream. They may be offspring of other wild or hatchery fish.*

5. Coho returns remain low. Natural production contributed most of the returning adults. Smolt plants in Scoggins Creek returned at a rate of 0.05% and provided only 195 adults of the 1,711 returnees.

INTRODUCTION

A cooperative program to develop the natural potential of the Willamette River to produce salmon and steelhead was begun in 1971. However, an informal program to accomplish that end existed for several years prior to 1971. From 1971 to 1979, approximately one-third of the funding for the fall salmon program was contributed by the National Marine Fisheries Service (NMFS) and two-thirds by the Oregon Department of Fish and Wildlife (ODFW)[2]. This program concentrated on developing runs of fall chinook and coho salmon above Willamette Falls, historically a barrier to these fish but now passable due to construction of a new fishway. Effort has also been devoted to development of winter and summer steelhead in the system. Steelhead are considered a separate activity of the program and are reported on separately. The rationale behind the development program and methods were described in detail by Sams (1973).

Most of the fall salmon studies conducted prior to 1978 were developmental. In 1978 we began evaluating the results of the previous work. We will also describe the distribution and freshwater life history of these fish. If the proper fall salmon stocks or combination of stocks are introduced, the Willamette River system should produce large runs of fall chinook and coho salmon, which will contribute substantially to commercial and sport fisheries in the ocean and river.

The major emphasis during 1979-79 was to initiate a mark and recapture study to evaluate the abundance of hatchery and wild early spawning fall chinook. A proportion of four brood years ('78, '79, '80, and '81) of hatchery-reared fish will be tagged. The majority of the adult returns will be complete by 1985. During the spring 1979 approximately 6% of the 4.7 million juvenile fall chinook ('78 brood) released from Stayton Pond were Ad-CWT marked. Marked and unmarked juveniles were liberated into the Molalla, Santiam, North Santiam, South Santiam and Willamette rivers. Releases in following years will continue in the same areas.

FALL CHINOOK

Background

We have introduced early (September-October) and late (November-December) spawning races of fall chinook into the Willamette River. The first releases of the early spawning stock (1963 brood) were surplus fish reared at Columbia River hatcheries. Since 1970, most of these fish have been reared in Willamette Basin ponds. From 1970-77 we annually released into the Willamette River 5.5-12.5 million early spawning fall chinook, averaging 4.6-7.2 g/fish (99-63 fish/lb). All fish were released above Willamette Falls except for a release of 313,000 juveniles into the Clackamas River in 1971.

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[1] *Management and Research Division of the Fish Commission of Oregon prior to July 1, 1975.*

During 1977 and 1978 most hatchery fish were released below Willamette Falls or in the Columbia River. In 1977 critically low flows were forecast for the Willamette River during the downstream migration period. In order to reduce juvenile mortality due to turbine passage, 10.6 million of the 11.3 million hatchery fall chinook were released near Lake Oswego. Of this group, approximately 92,000 were Ad-CWT marked. Other releases that year included escapees from the rearing ponds and some 178,000 Ad-CWT-marked fish used to test turbine mortality.

In 1978, the Research and Development Section proposed to discontinue releases of hatchery fish into the Willamette system for 5 years to permit evaluation of the natural production. Consequently, most hatchery production (5.6 million) was released directly into the Columbia River at Bonneville. However, the turbine mortality study required that approximately 201,000 Ad-CWT-marked fall chinook juveniles be released near Willamette Falls, and 100,000 early spawning stock juveniles were released into Mill Creek (Salem) for a stock comparison study initiated during 1978.

We have since redesigned our evaluation project to determine the success of both the wild and hatchery portions of the fall chinook population in the Willamette system. Beginning in 1979 the release of hatchery-reared juveniles was resumed in the Willamette system above the falls. A proportion of these fish had been Ad-CWT marked for identification in the fisheries and at the Willamette Falls counting window upon return.

The late spawning stock has to date been introduced into three tributary systems in the basin. Large numbers of this stock from the Cowlitz Hatchery (Willamette) have been released in the Row River for three years and the Luckiamute River for two years (Table 1).

Table 1. Juvenile fall chinook of Cowlitz River stock released into the Willamette River system, 1972-78.

Brood year	Release date	Number released	Release site	Size (gm/fish)
1971	6/72	2,314,665	Row River	3.3
1972	5/73	495,675	Row River	4.0
1973	5/74	2,178,829	Row River	4.0
1973	5/74	131,250	L. Luckiamute R.	3.5
1973	5/74	78,000	Luckiamute R.	3.5
1973	5/74	109,153	Green Peter Res.	3.9
1974		(no fish available)		
1975	5/76	262,340	L. Luckiamute R.	3.5
1975	5/76	2,040,328	Luckiamute R.	3.7
1977	11/78	150,894 (CWT)	Mill Cr. (Salem)	19.7

Additionally, we released approximately 150,000 tagged, 1977 brood late-spawning stock into Mill Creek (Salem) in November 1978 to compare fishery contribution and return with a group of 100,000 tagged, early spawning stock released into Mill Creek in June 1978.

Developmental Activities 1978-79

Fall chinook passing Willamette Falls in 1978 included 17,437 adults and 465 jacks. This represents a continued decline in adult returns during the last three years (Table 2). Most of the fish passing the viewing window at the falls were judged to be early spawners.

Table 2. Escapement of fall chinook adults and jacks over Willamette Falls, 1965-78.

Year	Adults	Jacks	Total
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	378	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	365	17,902

Contributing to the 1978 run of early spawning fish were both hatchery and wild fish from the 1973-75 brood years. The run year composition was predominantly age 4 adults (75.7%), while age 3 adults accounted for 22% of the run (Table 3). A much larger run was expected because substantial numbers of hatchery juveniles of the '74 and '75 broods were released, and the spawning escapements were large during those years (Table 4).

In addition, the 1978 run included late spawning age 3 and 4 wild fish from the Row River and age 3 adults from releases of 2.3 million juveniles into the Luckiamute River.

Since 1969, we have annually surveyed the Willamette River system by aircraft to determine the distribution of early spawning fall chinook. Boats were used only in Mill Creek (Salem), which is a narrow, brush-covered stream. From these surveys, we planned to estimate spawning population trends to determine which parts of the Willamette system are most capable of sustaining natural production of early spawning fall chinook. From October 2-9, 1978, we counted 6,481 fall chinook redds during aircraft and boat surveys covering 581.7 km of stream above the falls (Table 5). Fall and spring chinook spawning may overlap in the following areas: McKenzie River above Inaterstate 5 bridge; upper areas surveyed in the Clackamas; North and South Santiam rivers; and below Dexter Dam on the Middle Fork of the Willamette.

Table 3. Age composition of fall chinook from the Willamette River and tributaries[a] determined from carcasses recovered September-October 1978.

Stream	Total scale samples	No. yearling downstream migrants	Age class (n)			
			2	3	4	5
Willamette River	11	2	0	2	7	0
Molalla River	50	0	0	13	35	0
Santiam River	62	0	1	14	43	2
South Santiam River	117	0	1	26	85	2
North Santiam River	64	1	0	6	55	0
McKenzie River	61	7	2	29	19	1
Mill Creek (Salem)	280	0	2	44	217	3
Total	645	10	6	134	461	8
Percentage			0.99	22.00	50.70	1.31

[a] *Clackamas River was not surveyed because of turbid water resulting from drawdown of North Fork Reservoir.*

Table 4. Numbers of hatchery-reared juvenile fish and naturally spawning adults contributing to the 1978 adult run of fall chinook.

Adult age in 1978 run	No. of hatchery juveniles (millions) released during brood year	No. of adults spawning in the wild during brood year
3	6.0	32,900
4	5.5	33,900
5	6.7	21,900

Table 5. Summary of early spawning fall chinook spawning ground surveys in the Willamette River system, 1978.

Stream	km surveyed	No. redds	redds/km
Willamette River	220.4	1,423	6.46
M. F. Willamette	27.0	13	0.68
C. F. Willamette	47.8	2	0.04
Row River	12.2	2	0.16
McKenzie River	33.8	230	6.80
Santiam River	18.8	644	34.26
North Santiam	43.0	264	6.14
South Santiam	60.7	2,102	34.63
Crabtree Creek	15.9	150	9.43
Thomas Creek	19.3	5	0.26
Molalla River	42.6	685	11.38
Mill Creek (Salem)	40.2	1,261[a]	31.37
Total above Willamette Falls	581.7	6,581	11.31
Clackamas	(not surveyed because of turbid water resulting from drawdown of North Fork Reservoir)		

[a] *Includes 230 redds in 4.8 km of Shelton Ditch.*

The redd count in the Willamette Basin was only 7% below that of 1977 (6,581 vs. 6,739), even though the 1978 run was down 31% from 1977 (17,902 fish vs. 26,125). An examination of the relationship between sex composition and redd count is helpful in explaining the relatively high redd count in 1978. About 53% (9,667) of the 17,902 returning adults were females (Table 6). Thus the 6,581 redds observed is 68% of the estimated potential. Redds surveyed in 1975, '76, and '77 accounted for only 50%, 60%, and 40% of the female escapement, respectively. We believe better visibility during surveys in 1978 resulted in higher and more accurate redd counts.

Table 6. Sex ratios of fall chinook from the Willamette River and tributaries as determined from carcasses recovered September-October 1978.

Stream[a]	Males		Females	
	No.	%	No.	%
Willamette River	5	45	6	55
Molalla River	18	36	32	64
Santiam River	30	48	32	52
South Santiam R.	83	71	34	29
North Santiam R.	26	41	38	59
McKenzie River	24	39	37	61
Mill Creek (Salem)	116	41	164	59
Total (above falls)	302		343	
Mean % (95% CI)		47 (±4%)		53% (±4%)

[a] *Clackamas River not surveyed because of turbid water resulting from drawdown of North Fork Reservoir.*

About 48% of the redds counted above Willamette Falls were in the Santiam System including the mainstem, North and South Santiam, and Crabtree and Thomas creeks; 22% in the main-stem Willamette; and 7% in the Molalla River. The highest redd count obtained in 1978 was in a 12.2 km section of the South Santiam River, where 69.9 redds/km were observed. In 1977 we observed 74.9 redds/km in this section. The most apparent changes of redd distribution from 1977 to 1978 were (1) more redds were observed in the main-stem Willamette (1,423 vs. 505) and Crabtree Creek (150 vs. 55); and (2) fewer redds were observed in the McKenzie River (230 vs. 304) and North Santiam River (264 vs. 451).

Numbers of fish returning to any tributary can be determined using a fish to redd factor. This factor is derived by dividing the total escapement above the falls (17,902) by the total redd count above Willamette Falls (6,581). Traditionally Mill Creek (Salem) has been used to monitor spawning. We counted 1,261 redds in Mill Creek and therefore estimate a spawning population of 3,430 during 1978.

Spawning ground surveys for the late spawning stocks were conducted on the Row and Luckiamute rivers. Adults returning to the Row River are wild, while those returning to the Luckiamute are from a hatchery release of 2.3 million juveniles in 1976. On November 28, 1978, we surveyed the upper 0.8 km of the Row River and 5.2 km of Mosby Creek and found a total 14 and 42 redds, respectively. No live fish were observed and only one carcass was found. Surveys on December 7 and 21, 1978, failed to find any redds or carcasses on the Luckiamute River.

Evaluation Program

Following guidelines set forth in the state management plan, current studies concerning fall chinook will evaluate the results of the past and

present development program. Specifically we will concentrate our efforts toward the following objectives:

Objective 1: Determine the magnitude of the wild and hatchery portions of the run of early spawning fall chinook above Willamette Falls, and evaluate the ability of the wild component of the run to maintain itself.

Beginning in 1979 with the 1978 brood, we will mark approximately 300,000 juveniles from Stayton Pond for 4 years. Marked fish will be remixed with other production fish in the pond each year prior to release. All hatchery fish will be released into the Willamette system above the falls. Releases of hatchery fish during each of the four years should remain consistent in their number, liberation sites and times to reduce variation in returns due to variation in releases.

We will estimate the spawning escapement of hatchery and wild adults by the following method. A population estimate of hatchery fish will be based on counts of marked adults at the Willamette Falls fishway viewing window and the proportion of marked to unmarked juveniles released into the Willamette system. The difference between the total count at the falls and the estimated number of hatchery adults will be an estimate of wild fish passing Willamette Falls.

Analysis of the yearly variations in the hatchery and wild components of the run will enable us to determine (1) if the two components vary independently or similarly and (2) the effects of annual releases of approximately 6 million hatchery juveniles on total production. Trends will be used to determine the ability of the two run components to maintain acceptable levels of returns.

Downstream fisheries will be sampled to determine the catch of tagged hatchery fish. The catch of unmarked hatchery fish will be estimated by multiplying the tagged catch by the proportion of untagged:tagged fish released. To estimate the catch of wild fish, we will assume that the catch:escapement ratios for hatchery and wild fall chinook are identical. Scale samples will be taken from spawners throughout the system to distinguish brood years.

The first adults will return in the fall of 1981 and continue through the fall of 1985. A very few age 5 adults will return in 1986. In 1981 we may have difficulty accurately estimating the population because Ad+CWT-marked, age 4, adults from the stock comparison test will be returning to the Willamette. It may be possible to separate these fish at the Willamette Falls counting window by color. Tagged fish caught in the fisheries and carcasses collected on the spawning grounds may also help to estimate the relative proportion of each returning group.

We marked (Ad+CWT) 312,000 juveniles from Stayton Pond between April 18 and May 1, 1979 and remixed these with the production fish in the pond (Table 7). At liberation we examined 31,565 fish and determined 6.04% were marked.

Table 7. Marked and unmarked 1978 brood early spawning fall chinook released into the Willamette River system from Stayton Pond, May 7-21, 1979.

River	Size (g/fish)	No. of unmarked fish in release	No. of fish in release with Ad+CWT mark
Willamette	6.90	1,005,815	65,493
Santiam	6.86	664,023	43,269
S. Santiam	6.78	1,393,129	40,122
N. Santiam	6.50	394,693	27,648
Molalla	7.00	946,921	60,265
Total	5.80 (67 fish/lb)	4,404,588	287,097

Objective 2: Determine the need for and value of supplimenting wild fall chinook in the Willamette with hatchery fish.

Data collected under objective 1 will be analyzed to provide information regarding the value of the hatchery supplementation program. This information will include determination of: (1) ocean distribution; (2) catch distribution among political units and user groups; (3) cost/benefit evaluation to provide administrators with monetary values associated with this program.

In order to determine the need of releasing hatchery fish into the Willamette system, we will compare contribution and escapement with other fall chinook hatchery programs in the Columbia River. By releasing hatchery fish in a system where large areas exist for natural production adult hatchery fish continually enter into the naturally spawning population. If the hatchery releases result in a favorable combination of hatchery and natural production, this program will benefit the overall Columbia River enhancement efforts. Furthermore if the Willamette program is able to increase overall Columbia system production at a favorable benefit/cost ratio, managers will be able to justify continuation of the program.

Objective 3: Evaluate different stocks of fall chinook for their potential use by sport fisheries in the Willamette, as well as their contribution to downstream fisheries.

The stock comparative study is being limited to a single year release of two stocks of fall chinook. The release phase of the study was completed with the liberation of 150,000 Ad+CWT-marked late spawning juveniles into Mill Creek (Salem) in November 1978. Information on fishery contribution and returning adults will be collected primarily during 1980 and 1981 run years. A few age 5 adults may return in 1982.

Objective 4: Determine the freshwater life history types of juvenile chinook (including spring chinook) utilizing the Willamette River and tributaries.

During the report period no significant activities were undertaken addressing this objective. Future seining efforts will concentrate on defining life history types of the late spawning fall chinook in the Row and Luckiamute rivers. Periodic seining will aid the spring chinook studies. Analysis of the numerous chinook scales collected in past years will also assist in defining the life histories.

Natural production of Cowlitz stock

One 3-year cycle of Cowlitz River fall chinook, beginning with the 1971 brood, was stocked in the Row River. The first adults produced by natural spawning alone were expected to return as age 3 in 1977, and any adults returning in 1978 would be from natural production. Natural production was to be estimated by counts of bright fish at Willamette Falls and by spawning ground surveys. However, we were unable to monitor the Willamette Falls counting window to determine the number of bright fish because of a shortage of manpower. Spawning ground surveys were conducted to collect scales for age composition and to estimate the number of redds for comparison with the spawning potential of the parent run. We were able to find five carcasses of age 4 fish in 1977 and only 1 carcass in 1978, which had no readable scales. High muddy water in Row River in both years precluded estimating the total return of late spawning adults.

We have evidence from our seining in the Row River during 1977 that wild, late spawning, fall chinook juveniles emigrate in the fall. This should be considered when planting streams with other rearing salmonids present. No further releases of this stock are planned until the results of the stock comparative and production evaluation studies are completed.

COHO

Background

The present development program in the upper Willamette River began in 1964 with releases of large numbers of unfed fry, fingerlings and adults. These fish were an early spawning coho (Columbia River stock), surplus to our hatchery needs. While initial results appeared promising, recent returns have been disappointing (Table 8). In 1970 a record of 17,092 adults passed above Willamette Falls as a result of these plants. In 1971 we expected even greater returns as 1.25 million smolts were released the previous year. In addition, the progeny of 12,400 adults in 1968 and large fry releases (1968 brood) should have also contributed to the 1971 adult run. The return of 17,410 adults in 1971, although high, was considerably less than expected. Since 1971, the escapements over Willamette Falls have steadily decreased to 1,501 in 1974 and 5,922 in 1975, despite continued releases of approximately 1.25 million smolts for four additional years (1969-72 broods). Beginning with the 1973 brood, we substantially reduced releaes of the Columbia River stock. The 1978 return continued at a low level with only 1,711 adults passing the falls.

Table 8. Calculated escapement of coho adults and jacks over Willamette Falls, 1954-60 and 1965-78.

Year	Adults	Jacks	Total[a]
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	9,483	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	1,867	2,874
1978	1,711	3,891	5,602

[a] *Totals expanded through 1960 are corrected for 8-hour daytime passage, they are expanded to include 24-hour passage since 1965.*

A number of factors are believed to affect the production and success of this stock. Heavy offshore fishing, coupled with variable oceanic productivity, can drastically reduce the number of these fish returning to the river. Additionally, this particular stock may not be suited to late season, low water conditions in the Willamette system.

We began looking for a later spawning stock of coho which would enter tributaries of the Willamette when flows were elevated and temperatures lower. The Alsea River (coastal) and Sandy Hatchery (November egg take) stocks were tried with little success. In 1976 we began experimenting with Cowlitz River (Washington) late spawning coho. This stock primarily returns from November to early December and spawns in December and January. In 1976 we released 40,479 Ad+CWT-marked, 1974 brood, juvenile coho of the late spawning stock below Scoggins Dam in the Tualatin River. Additionally, we released approximately 0.5 million unmarked, late spawning coho into 10 other Willamette River tributaries above the falls. No marked jacks were observed returning to Scoggins Dam in fall 1976, and only six adults were counted in 1977. However, we calculated 74 additional untagged adults returned to other Willamette subsystems. Low survival of tagged adults to Scoggins Creek in 1977 may have been due to (1) the small size of the juveniles (18.2 g/fish) at release, (2) unseasonally

low stream flow at release and (3) an improperly designed weir in the ladder at Scoggins Dam, the site of adult return.

Beginning with the 1975 brood, a 3-year stock comparative study was initiated. Both early spawning (Columbia R.) and late spawning (Cowlitz Hatchery) stocks were chosen as test stocks. Smolts were released into Scoggins Creek where an adult trapping facility could assure consistent return information. Marked (Ad+CWT) juveniles of the two stocks were released to determine comparative fishery contribution and survival. A cumulative total of 240,000 marked fish of each stock was released from 1977 through 1979 (Table 9). Adult returns to the facility are complete for only the 1975 brood year. The percentage of return for the Columbia River stock was 0.17%, compared to 0.013% for the Cowlitz stock (jacks excluded). The relatively small size at release may have adversely affected the Cowlitz stock.

Table 9. Releases and partial returns of coho liberated into Scoggins Creek, 1977-79.

Brood year	Stock	Release			Return		
		No.	Date	Size/fish (gm)	Adults No.	% of release	Jacks No.
1975	Cowlitz R.	92,523	Apr. 77	16	12	0.013	1
1975	Col. R.	90,766	"	22	154	0.17	2
1976	Cowlitz R.	71,743	May 78	30			37
1976	Col. R.	68,801	"	28			15
1977	Cowlitz R.	74,577	May 79	23			
1977	Col. R.	81,189	"	24			

Both marked groups released in 1977 were reared at Cascade Salmon Hatchery, where cold water makes it difficult to get late spawning coho to smolt size by May 1. We believe these fish should be reared at a warmer water station to a minimum size of 30 g/fish and released after May 1.

On May 8 and 9, 1978, we released 68,801 early and 71,743 late spawning coho of the 1976 brood, both coded-wire tagged, into Scoggins Creek below the dam. The fish were reared at Big Creek Salmon Hatchery, a relatively warm water station. At release, the early and late spawning coho were 28 and 30 g/fish, respectively. In fall 1978, 15 early spawning and 37 late spawning jacks returned. We expect the survival of these fish to be better than those of the 1977 release.

The third and last release for this test was made in spring 1979. Although these fish were reared at Big Creek Hatchery, an extremely cold winter resulted in smaller than desirable juveniles at release.

This study will not be complete until the final adult returns of 1980 are calculated and information on fishery contribution is received from the mark processing center. Conclusions from this study will provide

management biologists with information needed to formulate stocking policies of coho in the system.

Developmental Activities 1978-79

The adult return of 1,711 coho over Willamette Falls in 1978 consisted of three categories of juveniles of the 1975 brood. Listed in Table 10 are the types and numbers of these juveniles. Using the percentage of return of the marked fish, it was possible to calculate the number of fish returning from each category. Thus, 1,504 adults were of wild origin, while 207 originated from the hatchery plants at Scoggins Creek.

Table 10. Coho salmon of 1975 brood which contributed to the 1978 adult run over Willamette Falls.

Stock	Origin	No. released with CWT	No. w/o CWT	Release site
Early	Bonneville Hat.	90,766	8,540	Scoggins Creek
Late	Cowlitz Hat.	92,522	202,134	"
Early	Wild spawning in Willamette system		Progeny of 5,922 adults	Selected tributaries in the basin

REFERENCES

Sams, R. E. 1973. Willamette River Development Program, Annual Report, Fish Comm. Oreg. 42 p.

APPENDIX

The text does not refer to the tables and figures included in this appendix. Data in the appendix will provide some background relating to fall salmon runs in the Willamette River.

Appendix Table 1. Releases of 1967-78 broods of pond reared early spawning juvenile fall chinook (Columbia River stock) into the Willamette River system.

Brood	Molalla River	Mill Creek	North Santiam R.	South Santiam R.	Main-stem Santiam R.	Willamette River[d]	Total
1967[a]	---	1,741,317	---	---	---	---	1,741,317
1968[a]	---	1,248,796	---	---	---	---	1,248,796
1969[b]	646,803	400,135	4,120,074	4,880,000	---	662,615	10,709,717
1970[b]	478,743	474,773	3,423,923	5,301,202	---	551,101	10,229,742[e]
1971[b]	513,583	974,086	3,831,618	3,758,318	---	1,959,288	11,036,893
1972[b]	1,383,990	2,867,125	3,954,693	3,391,307	---	1,050,682	12,647,797[f]
1973[c]	1,109,676	180,880	980,985	2,989,542	---	1,390,762	6,651,845[g]
1974[c]	1,077,025	---	---	2,032,832	---	2,434,147	5,544,104[h]
1975[c]	471,924	216,202	117,507	2,153,301	---	3,047,839	6,006,773
1976[c]	---	259,075	186,000	---	---	10,788,305	11,233,380
1977	---	100,239[i]	---	---	---	201,004[j]	301,243[k]
1978	1,006,486	--	422,189	1,482,919	761,239	1,018,768	4,691,601[l]

[a] *Salem Pond.*
[b] *Aumsville, Salem and Stayton Ponds.*
[c] *Aumsville and Stayton Ponds.*
[d] *Main Willamette releases at Eugene and Harrisburg except 1976-brood release which was below Willamette Falls.*
[e] *Total does not include 313,373 fish released into the Clackamas River.*
[f] *Total is subjective because estimated fish released by Fish Culture personnel after trucking terminated was high.*
[g] *Additional releases of 2,205,955 into Mill Creek and 4,019,625 into the North Santiam River were estimated to have been made from Aumsville and Stayton Ponds, respectively, by Fish Culture personnel after trucking terminated. We believe most of the fish were pond mortalities.*
[h] *Fish culture personnel subjectively estimated 6,330,000 additional fish migrated from the ponds after trucking terminated. We believe most of the fish were pond mortalities.*
[i] *Ad+CWT marked and released into Mill Creek to determine fishery contribution.*
[j] *Ad+CWT marked and released into Willamette Falls forebay and tailrace to determine turbine mortality.*
[k] *An additional 5,858,856 unmarked juveniles were released into the Columbia River at Bonneville Hatchery.*
[l] *6.04% Ad+CWT marked.*

Appendix Table 2. Releases of fry, fingerlings, and pond-reared fall chinook contributing to return Willamette River system, 1965-78.

Year	Adult returns			Releases (millions) contributing to age 3 returns			Releases (millions) contributing to age 4 returns		
	Total[a]	Age 3	Age 4	Fry	Fing.	Pond	Fry	Fing.	Pond
1965	79	---	---	0	0	0	0	0	0
1966	1,026	---	---	4.8	7.2	0	0	0	0
1967	2,012	---	---	0	2.9	0	4.8	7.2	0
1968	4,246	---	---	10.8	3.2	0	0	2.9	0
1969	6,957	---	---	9.7	7.9	0	10.8	3.2	0
1970	7,558	4,989	2,320	0	4.0	1.7	9.7	7.9	0
1971	5,090	1,675	3,272	0	3.5	1.3	0	4.0	1.7
1972	11,826	10,289	1,242	0	10.5	10.7	0	3.5	1.3
1973	22,237	13,609	8,317	0	0	10.6	0	10.5	10.7
1974	34,189	16,684	16,855	0	0	11.0	0	0	10.6
1975	33,772	5,302	27,696	0	0	12.6[b]	0	0	11.0
1976	30,200	23,888	4,409	0	0	6.7	0	0	12.6[b]
1977	26,124	12,631	13,062	0	0	5.5	0	0	6.7
1978	17,902	3,836	13,200	0	0	6.0	0	0	5.5

[a] *Jacks included in total.*

[b] *Total is subjective because Fish Culture personnel report of estimated fish released after trucking terminated is believed to be too high.*

Appendix Table 3. Age composition of early spawning fall chinook, Willamette River system, 1970-78.[a]

Year		Age class 2	3	4	5	Total
1970	No.	2	60	28	0	90
	%	2.2	66.7	31.1	0	100
1971	No.	4	47	92	0	143
	%	2.8	32.9	64.3	0	100
1972	No.	13	504	61	2	580
	%	2.2	86.9	10.5	0.4	100
1973	No.	15	713	385	8	1,121
	%	1.3	63.7	34.3	0.7	100
1974	No.	11	757	811	21	1,600
	%	0.7	47.3	50.7	1.3	100
1975	No.	24	255	1,294	18	1,591
	%	1.5	16.0	81.4	1.1	100
1976	No.	29	1,038	192	54	1,313
	%	2.2	79.1	14.6	4.1	100
1977	No.	2	485	505	8	1,000
	%	0.2	48.5	50.5	0.8	100
1978	No.	6	134	461	8	609
	%	1.0	22.0	75.7	1.3	100

[a] *Includes Clackamas River, except in 1978 when turbid water resulting from drawdown of North Fork Reservoir precluded surveying.*

Appendix Table 4. Number of redds observed by location of early spawning fall chinook, Willamette River System, 1969-78[a].

Stream	Km[b] surveyed	1969	1970	1971	1972	1973	1974	1975	1976	1977[e]	1978
Willamette River	220.4	26	101	27	391	1,326	1.041	1,134	475	505	1,423
M.F. Willamette	27.0	7	30	27	24	74	82	80	21	39	13
C.F. Willamette	47.8	8	92	8	30	17	11	10	1	1	2
Row River	12.2	1	0	3	0	20	5	3	2	3	2
McKenzie River	33.8	5	64	71	138	361	216	200	182	304	230
Calapooia River	13.2	1	5	1	0	22	1	0	0	-	-
Santiam River	18.8	225	229	224	293	781	2,175	1,393	1,260	847	644
North Santiam	43.0	165	100	36	110	685	720	1,491	510	451	264
South Santiam	60.7	382	559	348	269	780	2,578	1,054	1,881	2,310	2,102
Molalla River	42.6	162	207	37	614	1,171	778	340	655	767	485
Mill Creek (Salem)	35.4	-[c]	961	600	1,354	1,992	1,990	2,819	1,656	1,410[d]	1,261[g]
Total above Willamette Falls	554.9	982	2,348	1,382	3,223	7,282	9,597	8,524	6,642	6,439[f]	6,581[h]
Clackamas River	36.7	89	59	89	110	426	554	436	274	180	-[i]

[a] *All surveys were conducted by aircraft except Mill Creek survey, which was made from boats. Surveys were made from September 23-October 10.*

[b] *Km shown extend from the mouth upstream the specified distance, except for the main-stem Willamette River which is from Newberg upstream to the junction of the Coast and Middle forks of the Willamette.*

[c] *Survey not made; no fish were due to return until 1970.*

[d] *Includes 265 redds in 4.8 km of Shelton Ditch.*

[e] *Includes counts from 28 km not surveyed in 1969-76.*

[f] *Includes 47 redds in Thomas Creek and 55 redds in Crabtree Creek.*

[g] *Includes 230 redds in 4.8 km of Shelton Ditch.*

[h] *Includes 5 redds in Thomas Creek and 150 redds in Crabtree Creek.*

[i] *Not surveyed because of turbid water resulting from drawdown of North Fork reservoir.*

Appendix Table 5. Spawning surveys of fall chinook salmon in the Willamette River system, October 2-4, 1978.

River	River section: Reference points	River km	Redds	Km surveyed	Redds/km
Willamette R.	Newberg to Wheatland Ferry	80.5-115.7	14	35.2	0.40
	Wheatland Ferry to Salem	115.7-135.2	136	19.5	6.97
	Salem to Independence	135.2-154.6	24	19.4	1.24
	Independence to Albany	154.6-192.0	99	37.4	2.65
	Albany to Marys R.	192.0-212.6	14	20.6	0.68
	Marys R. to American Can Co. (Concrete water intake structure)	212.6-237.2	273	24.6	11.10
	American Can Co. water intake to Harrisburg	237.2-259.4	468	22.2	21.08
	Harrisburg to McKenzie R.	259.4-281.3	381	21.9	17.40
	McKenzie R. to Jct. Coast & Middle Forks	281.3-300.9	14	19.6	0.71
	Total		1,423	220.4	1.92
Middle Fork Willamette R.	Mouth to Fall Cr.	8.0- 18.2	1	18.2	0.05
	Fall Cr. to Dexter Dam	18.2- 27.0	12	8.8	1.35
	Total		13	27.0	0.48
Coast Fork Willamette R.	Mouth to Row R.	0.0- 33.3	0	33.3	0.00
	Row R. to Cottage Grove Res.	33.3- 47.8	2	14.5	0.14
	Total		2	47.8	0.04
Row R.	Mouth to Dorena Dam	0.0- 12.2	2	12.2	0.16
	Total		2	12.2	0.16
Mill Cr.[a]	Mouth to Jct. of Stayton Ditch	0.0- 35.4	1,261	40.2	31.37
	Total		1,261	35.4	35.62

[a] *Includes 230 Redds in 4.8 km of Shelton Ditch.*

Appendix Table 5 (continued)

River	River section: Reference points	River km	Redds	Km surveyed	Redds/km
McKenzie R.	Mouth to Interstate 5 Br.	0.0- 7.1	47	7.1	6.62
	Interstate Br. to Mohawk R.	7.1- 17.2	75	10.1	7.43
	Mohawk R. to Hendricks Br.	17.2- 33.8	108	16.6	6.51
	Total		230	33.8	6.80
Calapooia R.	Mouth to Corvallis Hwy. Br.	0.0- 13.2	-	-	-
	Corvallis Hwy. Br. to SPRR Br.	13.2- 27.5	-	-	-
	SPRR Br. to Brownsville	27.5- 52.0	-	-	-
	Total		-	-	-
Santiam R.	Mouth to OERR Br.	0.0- 5.1	129	5.1	25.29
	OERR Br. to Interstate 5 Br.	5.1- 10.3	232	5.2	44.62
	Interstate 5 Br. to Jefferson Br.	10.3- 15.4	171	5.1	33.53
	Jefferson Br. to Jct. of N. & S. Santiam R.	15.4- 18.8	112	3.4	32.94
	Total		644	18.8	34.26
North Santiam R.	Mouth to First Hwy. Br.	0.0- 4.7	38	4.7	8.09
	Hwy. Br. to SPRR Br.	4.7- 17.9	205	13.2	15.53
	SPRR Br. to Stayton Br.	17.9- 26.9	15	9.0	1.67
	Stayton Br. to L. N. Fork	26.9- 43.0	6	17.0	0.35
	Total		264	43.0	6.14
South Santiam R.	Mouth to Crabtree Hwy. Br.	0.0- 12.2	853	12.2	69.9;
	Crabtree Hwy. Br. to Lebanon Br.	12.2- 29.4	1,129	17.2	65.64
	Lebanon Br. to Leban Dam	29.4- 33.5	95	4.1	23.17
	Lebanon Dam to Foster Dam	33.5- 60.7	25	27.2	0.92
	Total		2,102	60.7	34.63
Thomas Cr.	Mouth to County Road Br.	0.0- 3.5	2	3.5	0.57
	County Rd. Br. to Covered Br. above Scio	3.5- 19.3	3	15.8	0.19
	Total		5	19.3	0.26

Appendix Table 5 (continued)

River	River section: Reference points	River km	Redds	Km surveyed	Redds/km
Crabtree Cr.	Mouth to SPRR Br.	0.0- 6.0	47	6.0	7.83
	SPRR Br. to Transmission Lines	6.0- 15.9	103	9.9	10.40
	Total		150	15.9	9.43
Molalla R.	Mouth to Hwy. 99E Br.	0.0- 5.8	46	5.8	7.93
	Hwy. 99E Br. to Goods Br.	5.8- 9.7	57	3.9	14.62
	Goods Br. to SPRR Br.	9.7- 16.3	152	6.6	23.03
	SPRR Br. to Hwy. 213 Br.	16.3- 23.2	115	6.9	16.67
	Hwy. 213 Br. to Feyer Pk.	23.2- 29.9	97	6.7	14.48
	Feyer Pk. to Robbins Rd.	29.9- 33.3	5	3.4	1.47
	Robbins Rd. to N. F. Molalla	33.3- 42.6	13	9.3	1.40
	Total		485	42.6	10.75
	Total Above Willamette Falls		6,581	581.7	11.31

Appendix Table 6. Sex ratios of early spawning fall chinook, Willamette River System, 1970-78.

Year	Males		Females		Total
	No.	%	No.	%	
1970	300	46.3	348	53.7	648
1971	164	43.2	216	56.8	380
1972	481	58.4	342	41.6	823
1973[a]	1,930	61.0	1,234	39.0	3,164
1974	760	47.4	842	52.6	1,602
1975	825	50.1	821	49.9	1,646
1976	867	63.9	489	36.1	1,356
1977	364	36.0	648	64.0	1,012
1978[b]	302	47.0	343	53.0	645

[a] *Sex ratios taken on Mill Creek tag and recovery carcass survey.*
[b] *Clackamas River excluded; turbid water resulting from drawdown of North Fork Reservoir precluded surveying.*

Appendix Table 7. Releases of early spawning stock adults, fry-fingerlings, and smolts contributing to returning coho adults, Willamette River system, 1965-78.

Year	Willamette Falls counts		Releases contributing to adult run		
	Adults	Jacks	Adults	Fry-Fingerlings	Smolts
1954	315	160			
1955	340	1,810			
1956	2,600	6,035			
1957	2,950	1,200			
1958	394	976			
1959	2,065	840			
1960	512	458			
1961-64	(fall counts discontinued)				
1965	7,080	2,184	--	5,272,700	61,800
1966	4,071	2,247	--	--	178,600
1967	7,084	1,614	7,715	8,084,300	296,300
1968	12,400	5,300	1,846	9,465,400	--
1969	3,260	14,032	4,205	10,615,700	--
1970	17,902	19,453	9,208	7,894,500	--
1971	17,410	6,670	7,090	5,747,100	1,253,800
1972	9,903	7,157	5,216	5,565,100	1,345,400
1973	5,174	1,583	830	883,200	1,217,000
1974	1,501	3,941	1,450	1,364,100	1,253,000
1975	5,922	6,927	1,316	2,060,300	1,266,200
1976	2,333	2,217	1,139	631,400	189,800
1977	1,007[a]	1,867	204	687,000	59,900
1978	1,711[b]	3,891	0	0	90,766

[a] *We calculated 927 of these fish were early spawning adults and 80 late spawning adults. Five-hundred and thirty-eight thousand 1974-brood juveniles contributed to the return of late spawning adults. The first year that late spawning adults were expected to return to the Willamette was 1977.*

[b] *We calculated 1,666 of these fish were early spawning adults and 45 late spawning adults. Late spawning smolt plants are not included in table. However, 92,522 Ad+CWT marked and 193,811 unmarked of the 1975 brood were released into Scoggins Creek below the dam on April 1, 1977.*

Appendix Table 8. Releases of coho adults, fry, and smolts into the Willamette River system above Willamette Falls by brood year, 1962-76[a].

System	1962 Brood			1963 Brood			1964 Brood		
	Adults	Fry	Smolts	Adults	Fry	Smolts	Adults	Fry	Smolts
Tualatin R.		195.0	---			---	635	---	---
Molalla R.		686.1	61.8			19.7	1,500	400.0	---
Pudding R.		---	---			---	523	281.7	14.1
N. Yamhill R.		291.9	---			10.1	300	100.0	29.3
S. Yamhill R.		462.9	---			69.8	900	1,891.4	14.3
Mill Cr. (Salem)		---	---			---	457	---	---
Rickreall Cr.		---	---			---	---	304.9	---
Luckiamute R.		400.0	---			---	---	393.6	---
N. Santiam R.		384.4	---			---	---	---	---
S. Santiam R.		850.0	---			69.0	1,400	1,117.9	74.8
Calapooia R.		502.4	---			---	---	494.7	28.9
Marys R.		350.0	---			---	250	1,178.6	30.0
Long Tom R.		---	---			---	---	300.2	---
McKenzie R.		---	---			---	---	---	74.6
Mohawk R.		500.0	---			10.0	1,350	500.0	---
Fall Cr.		350.0	---			---	---	410.0	---
Coast Fk.		300.0	---			---	400	511.3	---
Middle Fk.		---	---			---	---	200.0	30.3
Total		5,272.7	61.8			178.6	7,715	8,084.3	296.3

[a] *Adults listed are actual numbers released, fry and smolts are listed in 1,000s. Some fed fingerlings are included with fry listings. Cowlitz River (Washington) stock coho are not included.*

Appendix Table 8 (continued).

System	1965 Brood			1966 Brood			1967 Brood		
	Adults	Fry	Smolts	Adults	Fry	Smolts	Adults	Fry	Smolts
Tualatin R.	---	349.7		150	195.3		---	685.7	
Molalla R.	---	846.0		656	431.1		722	1,640.0	
Pudding R.	---	910.7		551	535.7		664	430.1	
N. Yamhill R.	817	291.5		---	336.2		706	---	
S. Yamhill R.	220	797.0		150	712.0		967	306.0	
Mill Cr. (Salem)	363	---		--	---		299	---	
Rickreall Cr.	---	250.6		300	---		---	152.5	
Luckiamute R.	200	389.6		350	208.7		659	224.7	
N. Santiam R.	---	260.7		---	391.6		---	310.9	
S. Santiam R.	---	1,340.7		905	3,273.4		1,808	2,366.1	
Calapooia R.	---	221.2		---	271.3		320	422.6	
Marys R.	246	608.7		200	836.6		1,126	80.0	
Long Tom R.	---	---		---	157.0		---	---	
McKenzie R.	---	696.0		---	---		---	---	
Mohawk R.	---	---		450	397.6		607	279.4	
Fall Cr.	---	---		493	500.0		340	---	
Coast Fk.	---	1,744.8		---	2,014.6		840	---	
Middle Fk.	---	859.4		---	354.6		150	102.9	
Total	1,846	9,465.4[b]		4,205	10,615.7		9,280	7,894.5	

[b] *Does not include 102,994 fry introduced into Corral Creek of the main Willamette.*

Appendix Table 8 (continued).

System	1968 Brood			1969 Brood			1970 Brood		
	Adults	Fry	Smolts	Adults	Fry	Smolts	Adults	Fry	Smolts
Tualatin R.	503	---		500	740.1	---	320	---	---
Molalla R.	912	825.3	---	891	---	---	360	---	---
Pudding R.	632	289.1	120.6	900	222.5	113.0	---	307.6	93.3
N. Yamhill R.	179	---	86.2	429	---	---	---	---	86.3
S. Yamhill R.	1,123	---	---	300	828.5	85.3	---	---	---
Mill Cr. (Salem)	120	41.9	28.4	---	---	46.1	---	---	26.2
Rickreall Cr.	150	---	---	200	---	---	150	---	---
Luckiamute R.	780	518.2	185.8	600	476.5	252.7	---	223.0	165.3
N. Santiam R.	---	---	---	---	442.8	442.8	---	---	---
S. Santiam R.	1,622	1,519.9	206.2	740	803.5	218.3	---	---	193.4
Calapooia R.	566	456.8	119.7	---	780.1	123.3	---	---	118.6
Marys R.	---	357.1	153.0	---	437.4	160.4	---	---	179.7
Long Tom R.	---	---	16.3	---	---	17.6	---	---	14.6
McKenzie R.	---	383.0	28.8	---	---	30.0	---	---	31.1
Mohawk R.	500	---	195.7	350	---	203.2	---	---	211.0
Fall Cr.	---	346.8	48.6	306	---	47.5	---	352.6	27.1
Coast Fk.	---	421.0	64.6	---	406.0	48.2	---	---	70.5
Middle Fk.	---	408.0	---	---	427.7	---	---	---	---
Total	7,090	4,747.1	1,253.9	5,216	5,565.1	1,345.6	830	883.2	1,217.1

Appendix Table 8 (continued).

System	1971 Brood			1972 Brood			1973 Brood		
	Adults	Fry	Smolts	Adults	Fry	Smolts	Adults	Fry	Smolts
Tualatin R.	150	454.4	---	159	182.3	---	---	373.0	94.9
Molalla R.	---	---	286.6	---	480.6	275.4	---	---	---
Pudding R.	450	512.5	---	308	785.1	41.1	171	---	---
N. Yamhill R.	---	---	---	---	---	---	---	---	---
S. Yamhill R.	---	397.2	435.2	208	196.1	483.8	239	---	---
Mill Cr. (Salem)	---	---	---	---	---	---	---	---	---
Rickreall Cr.	150	---	---	164	---	---	152	---	---
Luckiamute R.	150	---	---	160	327.1	20.3	214	---	---
N. Santiam R.	---	---	40.4	---	---	38.4	---	---	---
S. Santiam R.	150	---	338.3	159	99.1	231.8	363	---	---
Calapooia R.	---	---	---	---	---	---	---	---	---
Marys R.	---	---	19.8	---	---	20.3	---	---	---
Long Tom R.	---	---	---	---	---	---	---	---	---
McKenzie R.	---	---	---	---	---	---	---	---	---
Mohawk R.	---	---	21.3	---	---	25.2	---	---	94.9
Fall Cr.	400	---	---	158	---	24.0	---	258.4	---
Coast Fk.	---	---	20.4	---	---	24.9	---	---	---
Middle Fk.	---	---	89.8	---	---	105.1	---	---	---
Total	1,450	1,364.1	1,253.8	1,316	2,070.3	1,266.3	1,319	631.4	189.8

Appendix Table 8 (continued)

System	1974 Brood			1975 Brood			1976 Brood		
	Adults	Fry	Smolts	Adults	Fry	Smolts	Adults	Fry	Smolts
Scoggins Cr.	---	---	---			---		---	---
Tualatin R.	---	183.1	59.9			99.3		204.1	85.2[a]
Molalla R.	---	---	---			---		---	---
Pudding R.	---	345.4	---			---		270.4	---
N. Ymahill R.	---	---	---			---		---	---
S. Yamhill R.	---	---	---			---		---	---
Mill Cr. (Salem	---	---	---			---		---	---
Rickreall Cr.	---	---	---			---		161.3	---
Luckiamute R.	204	158.5	---			---		---	---
N. Santiam R.	---	---	---			---		---	---
S. Santiam R.	---	---	---			---		---	---
Calapooia R.	---	---	---			---		---	---
Marys R.	---	---	---			---		---	---
Long Tom R.	---	---	---			---		---	---
McKenzie R.	---	---	---			---		---	---
Mohawk R.	---	---	---			---		---	---
Fall Cr.	---	---	---			---		---	---
Coast Fk.	---	---	---			---		---	---
Middle Fk.	---	---	---			---		---	---
Total	204	687.0	59.9			99.3		635.8	68.8

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