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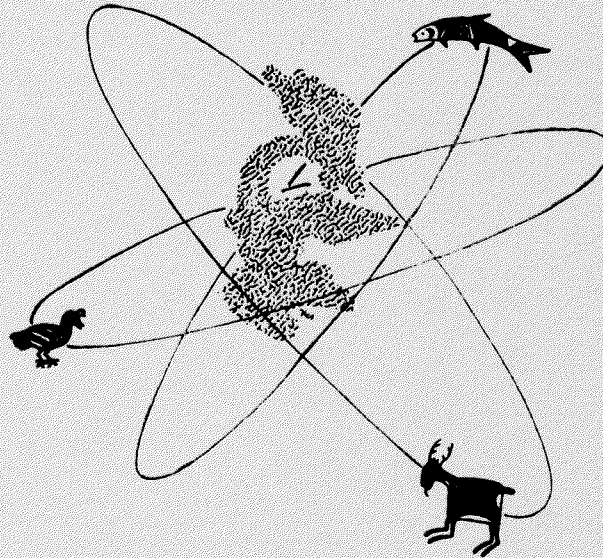


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RESEARCH AND DEVELOPMENT SECTION

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88E25045 Stock Assessment and Enhancement of Fall Salmon Species
in the Willamette River System

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Prepared by: Harold L. Hansen

Oregon Department of Fish and Wildlife
506 S. W. Mill Street
P. O. Box 3503
Portland, Oregon 97208

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ABSTRACT

The cooperative program between the National Marine Fisheries Service and Oregon Department of Fish and Wildlife to develop the natural potential of the Willamette River system to produce runs of fall salmon has been in effect since 1971 on a formal basis. However, an informal program was initiated several years prior to 1971.

Beginning in 1978, emphasis of the program was changed from developmental to evaluation. We initiated studies with releases of coded wire tagged and unmarked juveniles to determine the capability of fall chinook and coho in the Willamette to maintain self-sustained runs, and to significantly contribute to Oregon's recreational and commercial fisheries. Additionally, we initiated a seining study to determine if substantial numbers of juvenile chinook rear in the Willamette and to describe the freshwater life history of these fish.

We believe that if the right salmon stocks or combination of stocks are utilized, there is high potential in the Willamette River to produce self-sustained runs of fall chinook and coho salmon that will provide large numbers of quality fish for commercial and sport fisheries in the ocean and Columbia River and in the sport fishery of the Willamette River.

In 1977, 26,124 early spawning fall chinook returned to the Willamette; this was 4,076 fewer than observed in 1976. We expected a larger run; however, fall chinook runs in the Columbia River system were generally down. We anticipated a return of "wild" 3-year-old late-spawning fall chinook to Row River, but high muddy water precluded completion of spawning ground surveys. However, five 4-year-old adults were found in Mosby Creek, a small tributary of Row River.

The return of early spawning coho was again low with approximately 1,000 adults enumerated over Willamette Falls. Only six late-spawning ad+cwt marked coho returned to the Scoggins Creek Dam collection facility, Tualatin River system, from a release of 40,479 juveniles of the 1974 brood. We calculated 74 additional unmarked late-spawning coho returned to 10 other subsystems of the Willamette from a release of 497,521 juveniles. We believe late-spawning juveniles were released too early and too small to provide a large return.

From seining studies initiated in July 1977, we determined essentially all early spawning juvenile fall chinook migrated from the Willamette River by July of their first year. Late-spawning fall chinook appeared to migrate from the Willamette in the late summer or early fall of their first year. During the summer, spring chinook juveniles were found rearing in large numbers only in the McKenzie and Clackamas rivers and in fair numbers in the main Willamette from the mouth of the McKenzie to Corvallis.

INTRODUCTION

A cooperative program to develop the natural potential of the Willamette River to produce salmon and steelhead has been in effect since 1971. However, an informal program to accomplish that end existed for several years prior to 1971. From 1971 to 1978, 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)¹. This program has concentrated primarily on developing natural 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 employed were described in detail by Sams (1973).

Most of the fall salmon studies conducted until 1978 were largely developmental. We now plan to change from developmental to evaluation studies that will assess the capability of fall chinook and coho salmon in the Willamette to: (1) maintain self-sustained runs and (2) significantly contribute to Oregon's recreational and commercial fisheries. In addition, we will describe the freshwater life history that evolves for these fish. We believe that if the right fall salmon stocks or combination of stocks are utilized, there is a high potential in the Willamette River to produce self-sustained runs of fall chinook and coho that will provide large numbers of quality fish for commercial and sport fisheries in the ocean and Columbia River and the Willamette River sport fishery.

The major emphasis in 1977-78 was directed to exploratory seining to determine numbers, stock and location of juvenile chinook rearing in the upper Willamette. All major tributaries were seined at several locations over time. Smaller tributaries and some streams entering major tributaries were also sampled. In addition plans were developed to evaluate the contribution and return of wild fall chinook spawned above Willamette Falls.

FALL CHINOOK

Background

We introduced early (September-October) and late (November-December) spawning races of fall chinook into the Willamette River. First releases of the early spawning stock (1963 brood) were made from surplus fish reared at Columbia River hatcheries. Since 1970 most of the fish released have been reared in Willamette Basin ponds. From 1970-77 we annually released into the Willamette 5.5 to 12.5 million early spawning fall chinook averaging 4.6-7.2 g/fish. Prior to 1977, essentially all pond production was released above Willamette Falls, except for a release of 313,000 juveniles into the Clackamas River in 1971.

In 1977 critically low flows were forecast for the Willamette River during the downstream migration period, and 10.6 million of the total 11.3 million propagated juveniles were released below Willamette Falls to reduce juvenile mortality due to passage through turbines. In 1978 except for 301,000 ad+cwt

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

marked experimental fish released into Mill Creek and at Willamette Falls, chinook produced in ponds in the Willamette basin were liberated into the Columbia River at Bonneville Hatchery. These fish were released out of the system to aid in determining the capability of the early spawning fall chinook to maintain adequate returns above the falls from natural production.

Counts of early spawning fall chinook over Willamette Falls increased from 1,026 in 1966 to over 30,000 each year from 1974-76. The return of 26,124 in 1977, was lower than expected; however, in 1977 all fall chinook runs in the Columbia River system were low.

We first introduced late-spawning fall chinook in 1972 when 2.3 million juveniles of the 1971-brood Cowlitz Hatchery (Washington) stock were released into Row River, a tributary of the Coast Fork Willamette River. Approximately 0.5 million fish were released in 1973 and 2.5 million in 1974. We estimated spawning populations of 400-500 adults returned to the Row River in 1974, over 1,000 in 1975 and 500 in 1976. We did not estimate the number of late-spawning fall chinook adults in Row River in 1977 because of high muddy water. This stock could not be acquired for release in 1975 and 1977. However, 2 million fish were obtained for release into the Luckiamute system in 1976.

Developmental Activities 1977-78

We calculated an escapement of 25,742 fall chinook adults and 382 jacks over Willamette Falls in fall 1977 (Table 1). We were unable to estimate numbers of early and late-spawning fish. However, color and condition of the fish passing the counting window at the falls indicated most were early spawners. Approximately 6.7 million² propagated juveniles of the 1973 brood, 5.5 million juveniles of the 1974 brood and wild spawned juveniles from 22,237 returning adults in 1973 and 34,189 in 1974 contributed to the run of early spawning fish in 1977. Contributing to the late-spawning adult run in 1977 were 4-year-old hatchery adults due to return to Row River in 1977 and 3-year-old wild-spawned fish. Additionally, 4-year-old adults were due to return to the Luckiamute River from a release of 209,250 juveniles of the 1973 brood.

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 relatively narrow brush-covered stream. From these surveys, we planned to estimate spawning population trends to determine which part of the Willamette system is most capable of sustaining natural production of early spawning fall chinook. From September 29 to October 10, 1977, we counted 6,739 fall chinook redds during aircraft and boat surveys covering 582.9 km of stream above the falls (Table 2). Visibility was good in the Santiam, McKenzie, and Molalla systems, and poor to fair in the Coast Fork, Middle Willamette, main Willamette and Mill Creek (Salem) systems. Surveys appeared to be made at the peak of spawning. Some overlap of fall and spring chinook spawning occurs in the McKenzie River above Interstate 5 bridge, upper areas surveyed in the Clackamas and North and South Santiam rivers and below Dexter Dam on the Middle Fork of the Willamette River.

²This figure based on number of juveniles weighed by displacement and liberated directly below the pond outlet or hauled from the pond. Fish Culture personnel subjectively estimated additional fish emigrated when trapping was terminated.

Table 1. Calculated escapement of fall chinook adults and jacks over Willamette Falls, 1965-77.

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	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

Table 2. Summary of "tule" fall chinook spawning ground surveys in the Willamette River system, 1977^a.

Stream	Km ^b surveyed	No. redds	Redds/km
Willamette River	220.4	505	2.29
M. F. Willamette	27.0	39	1.44
C. F. Willamette	47.8	1	0.02
Row River	12.2	3	0.25
McKenzie River	33.8	304	8.99
Santiam River	18.8	847	45.05
North Santiam	43.0	451	10.49
South Santiam	60.7	2,310	38.06
Crabtree Creek	17.1	55	3.22
Thomas Creek	19.3	47	2.44
Molalla River	42.6	767	18.00
Mill Creek (Salem)	40.2	1,410 ^c	35.07
Grand Total Above Willamette Falls	582.9	6,739	11.56
Clackamas	36.7	180	4.90

^aAll surveys were conducted by aircraft except Mill Creek survey which was made from boats. Surveys were made during September 29-October 10, 1977.

^bSurvey areas extend from the mouth upstream the specified distance except for the main Willamette which is from Newberg upstream to the junction of the Coast and Middle Forks of the Willamette River.

^cIncludes 265 redds in 4.8 km of Shelton Ditch.

The total redd count in the Willamette was 97 more than in 1976. Although, we surveyed an additional 28 km in 1977, the average number of redds observed/km was slightly lower in 1977 (11.56) than in 1976 (11.97). Of the 5,329 redds counted above Willamette Falls during the surveys by air, 70% were in the Santiam system including the main stem, North and South Santiam, and Crabtree and Thomas creeks, 10% in the main-stem Willamette, and 14% in the Molalla River. The highest redd count obtained in 1977 was in a 12.2 km section of the South Santiam River where 74.9 redds/km were observed. In 1976 we observed 76.2 redds/km in this section. The most apparent changes of redd distribution from 1976 to 1977 were: (1) in 1977 more redds were observed in the South Santiam (2,310 vs 1,881) and the McKenzie River (304 vs 182); and (2) fewer redds were observed in the main-stem Santiam (847 vs 1,260) and Mill Creek (1,410 vs 1,656). We counted 1,410 redds in Mill Creek during boat surveys and estimated a spawning population of 5,471 adults by using the fish to redd factor of 3.88 obtained by dividing the total redd count above Willamette Falls (6,739) into the total escapement above the falls (26,124).

The total redds observed by boat and air surveys (6,739), expressed as a percentage of females present above Willamette Falls, was 40%. This is based on 64% of the adults passing the falls being females (Table 3). Therefore, 60% of the estimated females passing the falls were not accounted for in terms of redds. In similar surveys during 1974, 1975 and 1976, 59, 50 and 40% of the females, respectively, were unaccounted for in terms of redds. We believe poor visibility encountered in 1977 may have accounted for some redds not being observed.

Table 3. Sex ratios of fall chinook determined from carcasses recovered on the Willamette River and tributaries, September-October 1977.

Stream	Males		Females		Number sampled
	No.	%	No.	%	
Willamette River	20	38	33	62	53
Molalla River	54	40	81	60	135
Santiam River	31	26	87	74	118
South Santiam R.	83	40	125	60	208
North Santiam R.	31	21	120	79	151
McKenzie River	29	28	75	72	104
Mill Creek (Salem)	100	49	103	51	203
Total (above falls)	348	36	624	64	972
Clackamas River	<u>16</u>	<u>40</u>	<u>24</u>	<u>60</u>	<u>40</u>
Grand Total	364	36	648	64	1,012

We obtained scales from carcasses of early spawning fall chinook to determine age composition of the run and assign returning adults to the proper brood year. In examining 1,000 readable scales, we determined the run was composed of 48.5% 3-year-old fish and 50.5% 4-year-old fish (Table 4).

Table 4. Age composition of fall chinook determined from carcasses recovered on the Willamette River and tributaries, September-October 1977.

Stream	Total scale samples	No. of samples regenerated	No. of spring chinook	No. by age				
				2	3	4	5	
Willamette River	53	1	0	43	9	0		
Molalla River	135	2	0	35	96	2		
Santiam River	118	0	0	54	63	1		
South Santiam River	208	0	0	116	91	1		
North Santiam River	151	0	0	40	111	0		
McKenzie River	104	0	7	59	37	0		
Mill Creek (Salem)	203	2	0	123	75	3		
Total	972	5	7	470	482	7		
Percentage				0.10	48.96	50.21	0.73	
Clackamas River	40	0	0	15	23	1		
Grand Total	1,012	5	7	485	505	8		
Percentage				0.20	48.50	50.50	0.80	

Five late-spawning, 4-year-old adults were observed in November in Mosby Creek, a tributary of the Row River. We also observed 18 redds and believe additional adults were present; however, subsequent high muddy water precluded additional surveys to estimate the total spawning population. High flows in November and December also prevented surveys in the Luckiamute system.

Evaluation

Our primary goal for fall chinook in the Willamette River system is to determine the best stock or combination of stocks that will provide a commercial and recreational fishery for Oregon.

Fishery contribution and return

To determine the production capabilities of these stocks, we would release comparable groups of early and late-spawning fish into the Willamette above the falls. Plans in 1978 included releasing 200,000 ad+cwt marked fish of each stock into Mill Creek (Salem) in the spring. However, tagging priorities, bacterial gill disease outbreak in the 1977-brood chinook at Bonneville Hatchery and the inability to rear late-spawning chinook to a desirable size by June 1 required altering release times and numbers of fish in each group. We were able to release only 100,239 ad+cwt marked, early spawning fall chinook into Mill Creek on June 5, 1978, while approximately 150,000 tagged late-spawning stock were released on November 8 and 9, 1978. No further releases are planned.

Recoveries of ad+cwt marked fish by various Pacific Coast agencies will be used to estimate the total catch of each tagged group. A trap will be installed in the fishway located on lower Mill Creek to collect all returning adults. The fish will be killed and the coded wire tags removed to compare returns of each stock. Scales and size data have been or will be obtained from both stocks at the Sullivan Plant downstream migrant trap. These scales will be compared with those taken from adults returning to Mill Creek to compare life history from release to ocean entry.

Natural production of tules

In 1978, we proposed to discontinue releases of propagated fish into the Willamette River beginning with the 1977 brood and continuing at least through the 1981 brood. All unmarked early spawning fall chinook reared in Aumsville and Stayton ponds would be released into the Columbia River above the mouth of the Sandy River. This would permit evaluation of natural production from hatchery and wild adults whose progeny will return as adults in 1980-83, and wild adults only whose progeny will return in 1983-85. Adults returning each year would be enumerated at the Willamette Falls counting facility.

The initial out-system release of propagated juveniles from the rearing ponds was made in 1978. From April-June 1978, we released 5.9 million unmarked juveniles into the Columbia River at Bonneville Hatchery. Additionally, 301,243 ad+cwt marked juveniles were released into the Willamette River. This release included 100,239 fish into Mill Creek to compare fishery contribution and total survival rate with a similar group of late-spawning chinook released in November 1978, and 201,004 fish released in the vicinity of Willamette Falls to determine mortality of juveniles passing through the PGE Sullivan Plant.

During the formulation of this objective, we believed it was necessary to capture and coded wire tag wild-spawned juveniles at Willamette Falls to determine survival rate, total catch, catch distribution and the benefit/cost of maintaining a wild run supplemented with hatchery releases. However, we were subsequently unable to capture the quantity of juveniles at the Sullivan Plant downstream-migrant trap required to make statistically valid conclusions to determine these values. Therefore, we are now proposing to determine the natural production capability of early spawning chinook by a less definitive but more practical method.

Beginning in 1979 with the 1978 brood and for 4 years, we will mark 400,000 juveniles from Stayton Pond and mix these with the production fish in the pond. All pond-reared fish will then be released into the Willamette above the falls. The number of marked fish released from the pond will be estimated at liberation. We will determine the returning spawning population of propagated and wild-spawned adults by the following methods: adipose-marked adults will be enumerated passing the Willamette Falls fishway viewing window. A population estimate of propagated fish will be made based on counts of adipose marked adults and the proportion of adipose marked to unmarked juveniles released into the Willamette system. The difference between the total count at the falls and the estimated number of pond-reared adults will be an estimate of wild-spawned fish passing Willamette Falls.

Downstream fisheries will be sampled to determine the catch of tagged propagated fish. The total catch of pond-reared fish will be estimated by applying the proportion of tagged/untagged fish released from the pond. The catch of wild-spawned fish will be estimated by assuming that the catch/escape-ratios for hatchery and wild-spawned fall chinook are identical. Scale samples will be taken from spawners through the system to distinguish among brood years.

In 1981 we may have difficulty accurately estimating the population because ad+cwt marked, 4-year-old, late-spawning adults will also 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.

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 3-year-olds in 1977. Natural production was to be estimated by counts of bright fish at Willamette Falls and by spawning ground surveys. 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 unable to monitor the Willamette Falls counting window to determine the number of bright fish because of a shortage of manpower. High muddy water in the Row River in fall 1977 precluded estimating the total number of late-spawning adults returning; although, we were able to find five carcasses in Mosby Creek, a small tributary, on one survey in November. We determined the age composition from scales of these carcasses and found only 4-year-old fish. All adults returning to the Row River in 1978 will be from natural production.

We have evidence from our seining in the Row River during 1977 that wild, late-spawning, fall chinook juveniles emigrate in the fall. Since these fish may compete with rearing spring chinook juveniles, no further releases of production groups of this stock are planned until the results of the fishery contribution study are analyzed.

COHO

Background

Historically, the first efforts to increase the coho run in the Willamette began in the early 1950's. In 1956, 1957 and 1959 counts of 2,600, 2,950 and 2,065, respectively, were enumerated passing Willamette Falls. However, efforts to develop this species were largely discontinued and only 512 adults were counted in 1960. Counting at the falls was discontinued from 1961-64.

Beginning with the 1964 brood, we released, above Willamette Falls, large numbers of unfed fry, fingerlings and adult early spawning coho (Columbia River stock) surplus to our hatchery needs. While initial results appeared promising, recent returns have been disappointing. In 1970, 17,902 adults passed above Willamette Falls as a result of these plants. In 1971 we expected returns from a 1.25 million smolt plant, the progeny of 12,400 adults that returned in 1968, and returns from releases of 7,090 adults and 5.7 million fry. The run of 17,410 adults in 1971 was considerably less than expected. Since 1971 returns have steadily decreased to 1,501 in 1974 and 5,922 in 1975 despite continued releases of approximately 1.25 million smolts for 4 additional years (1969-72 broods). Beginning with the 1973 brood we stopped releasing production lots of the Columbia River stock. Although 2,333 adults returned in 1976, we calculated a return of only 927 early spawning adult coho in 1977.

We concluded from the low returns of naturally produced early spawning coho that this stock may not be well suited to the Willamette watershed primarily because adults return when temperatures in most streams are high and flows are low. However, we cannot explain the poor adult returns from smolt plants.

We then began looking for a later spawning stock of coho which would enter tributaries of the Willamette when flows were high 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 497,521 unmarked, late-spawning coho in 10 other Willamette River subsystems above the falls. No marked jacks were observed returning to Scoggins Dam in fall 1976, and only six adults were enumerated in 1977. Low survival may have been due to (1) the small size of the juveniles (18.2 g/fish), (2) unseasonably low stream flow at release and (3) mortality caused by an improperly designed weir in the ladder at Scoggins Dam, the release site.

In 1977 we released 100,916 ad+cwt marked and 193,811 unmarked, late-spawning coho and 99,317 ad+cwt marked, early spawning coho of the 1975 brood into Scoggings Creek below the dam. Unmarked late-spawning coho were released to establish an egg bank at this facility. We have since been assured of receiving an egg supply of this stock and will discontinue the egg bank development. Marked juveniles of the two stocks were released to determine comparative fishery contribution and survival rates.

Developmental Activities, 1977-78

We calculated a return of 1,007 adult coho over Willamette Falls in 1977 (Table 5). Of this total we believe 927 were early spawning and 80 were late-spawning fish. The run of late-spawning coho was estimated by determining the return/release ratio of ad+cwt marked fish at Scoggings Creek Dam (six marked adults returning from a release of 40,479 juveniles) and applying this ratio (1:6,747) to the number of unmarked juveniles (497,521) released into 10 other subsystems of the Willamette in 1976. After estimating late spawners, the remainder were early spawning fish. In using this method of estimating the return of each stock, we assumed that all marked late-spawning adults passing the falls arrived at Scoggings Dam, 65 miles upstream. Releases of 204 adults, 687,000 unfed fry, and 60,000 smolts and natural production from 1,501 adults contributed to the return of early spawners.

Table 5. Calculated escapement of coho adults and jacks over Willamette Falls, 1954-60 and 1965-77.

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

^aTotals through 1960 are corrected for 8-hour daytime passage, they are expanded to include 24-hour passage since 1965.

In 1978 we released 70,000 early spawning fingerlings into Beaver Lake (Abernethy Creek) and 25,000 into Tryon Creek, streams which enter the Willamette below the falls. These fingerlings were surplus to department needs.

Evaluation

Our primary goal with coho in the Willamette River system is to determine the best stock for enhancement that will allow maximum production from natural spawning and contribute to Oregon's commercial and recreational fisheries.

Fishery contribution and return

We will not attempt to complete this segment of the project until the data have been analyzed from the fishery contribution study completed in 1980. If coded wire tagged, late-spawning coho return in good numbers and contribute favorably to the fisheries, we plan to release 350,000 smolts annually into the Luckiamute and Yamhill river systems from 1981 (1979 brood) through 1983 (1981 brood) for future evaluation.

Natural production

We now believe that late- rather than early spawning coho may be better suited to the Willamette, primarily because they return when flows are high and temperatures are low in the tributaries. We believe these conditions are conducive to successful spawning.

We plan to release groups of ad+cwt marked smolts of the early and late-spawning stocks for 3 years and compare fishery contribution rates and adult returns to the Willamette. Tags will be obtained from recreational and commercial fisheries to determine the rates of contribution for each stock. Adipose clipped (tagged) fish will also be enumerated as they pass the viewing window at Willamette Falls. We believe we can separate, by time, the return of each stock. Tags will be recovered in the upstream migrant facility at Scoggins Creek Dam to compare with the visual count at Willamette Falls.

Tests began in spring 1977, when we released 100,916 and 99,317 ad+cwt marked, juvenile coho of the late- and early spawning stocks, respectively, into Scoggins Creek below the dam. However, both groups were released in April when few appeared to be smolted. The late-spawning coho were significantly smaller (15.6 g/fish) at release than the early spawning fish (21.6 g/fish). Only one late-spawning and two early spawning jacks returned to the Scoggins Creek upstream migrant facility in 1977. Consequently, we expect only a small number of adults to return in 1978.

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 (Table 6). Rearing was accomplished at Big Creek Salmon Hatchery, a relatively warm water station. At release, the early and late-spawning coho

were 28.2 and 29.8 g/fish, respectively. We expect the survival of these fish to be better than those from the 1977 release.

Table 6. Releases of juvenile coho of early and late-spawning stocks into the Willamette River system, May-June 1978.

River system	Stream	Number	Brood year	Month stocked	Size g/fish
Early Spawning (Columbia River)					
Tualatin	Scoggins Creek	85,150 ^a	1976	May	28.3
Late Spawning (Cowlitz River)					
Tualatin	Scoggins Creek	83,150 ^b	1976	May	29.8

^a68,801 marked ad+cwt.

^b71,743 marked ad+cwt.

CHINOOK LIFE HISTORY

We initiated a seining study in July 1977 to determine the life history of juvenile chinook rearing in the Willamette River and major tributaries above Willamette Falls. Seining conducted from July 1977 through summer 1978 was exploratory to determine if substantial numbers of juvenile chinook reared in the upper Willamette. The following methods were employed:

A jet sled was utilized for river transportation, and seining in the main river systems was accomplished with a 2.4 x 30.5 m net with 4.8 or 9.5 mm mesh. A 3-man crew, consisting of an anchor man, a lead man in a wet suit, and a man who retrieved the swimmer and seine by rope, was used to fish the net. Captured fish were identified as to kind and number by species, and a sample was measured for length. Scale samples were taken for future use as a reference collection to categorize freshwater life history and stream origin in returning adults. Seining sites were established in the McKenzie, Coast Fork Willamette (including Row River and Mosby Creek), Santiam system (main stem, North and South Forks), Middle Fork Willamette, main Willamette, Clackamas and Molalla rivers. Limited seining was also conducted in Mill Creek (Salem), Luckiamute River, Mill Creek (Mohawk River), Crabtree and Thomas creeks (South Santiam River system) and the Calapooia River. Seining in the smaller tributaries was accomplished with a 15 m or shorter net. Estimating the race to which wild-spawned juveniles belonged was accomplished arbitrarily by length determination. All fish 11.0 cm in length and greater, and captured during the spring, were presumed to be yearling spring chinook; those smaller than 11.0 cm were assumed young-of-the-year spring chinook or fall chinook. This length criterion was established from size composition data of known chinook races. Area of capture, previous spawning of known races in each area, and time of migration also aided in race determination. Scale samples taken during the study will be used to verify differentiation of race. Hatchery-reared spring chinook were identified by dorsal and caudal fin erosion. Unmarked hatchery-reared fall chinook were not released above the falls in 1977 or 1978.

We attempted to quantify our seining data by determining the average number of juvenile chinook caught/seine haul on each trip to each river system. However, variable flow conditions, stream topography, size of the individual watershed, total number of watersheds and available seining sites precluded acquiring good quantitative data. However, we were able to make the following general conclusions about juvenile chinook:

- (1) Essentially all early spawning fall chinook had left the Willamette system by July of their first year.
- (2) Spring chinook were abundant in the McKenzie system.
- (3) The Santiam system was essentially devoid of chinook by July, except a few spring chinook were found to be rearing from Foster to Sweet Home in the South Santiam.
- (4) The Middle Willamette was essentially devoid of chinook.
- (5) The main Willamette contained chinook from the mouth of the McKenzie River to Harrisburg, and from Harrisburg to Corvallis, chinook numbers declined progressively downstream. Essentially no chinook were found from Corvallis to Salem. We suspect that chinook rearing in the main Willamette in the summer were produced primarily in the McKenzie River.
- (6) Coast Fork Willamette (including Row River and Mosby Creek) contained juvenile fish which we suspect were the Cowlitz River stock of fall chinook. These fish apparently began emigrating in the fall since substantially fewer were observed then.
- (7) No chinook were observed in the Calapooia River in 1977.
- (8) The Clackamas and McKenzie rivers were the only areas sampled in the Willamette system that contained substantial numbers of juvenile chinook rearing through the summer months.

A discussion by river system follows:

Middle Fork Willamette

We seined the Middle Fork Willamette from Dexter Dam to its confluence with the Coast Fork Willamette (Fig. 1) in July, August and September 1977. On 6 days during this period, we made 43 seine sets and caught a total of 12 juvenile chinook. We believe these were spring chinook. Most of the adult chinook observed spawning in this area in fall 1976 and 1977 were spring fish.

Seining in 1978 was confined to the area from Jasper to the mouth. On April 4, we caught an average of 109.3 juvenile chinook/seine haul with a mean length of 17.4 cm; these apparently were spring chinook smolts released from Dexter Pond or Willamette Hatchery in mid March. On May 2, we sampled this same area and caught only five smolts, indicating most of the hatchery released fish had emigrated. Additionally, we captured 45 juveniles averaging 7.6 cm long. We believe these 0-age fish were spring chinook juveniles. On May 16, June 19, July 20 and August 21 we caught a combined total of 37 juvenile chinook. Of this total, 29, including 10 spring chinook smolts of

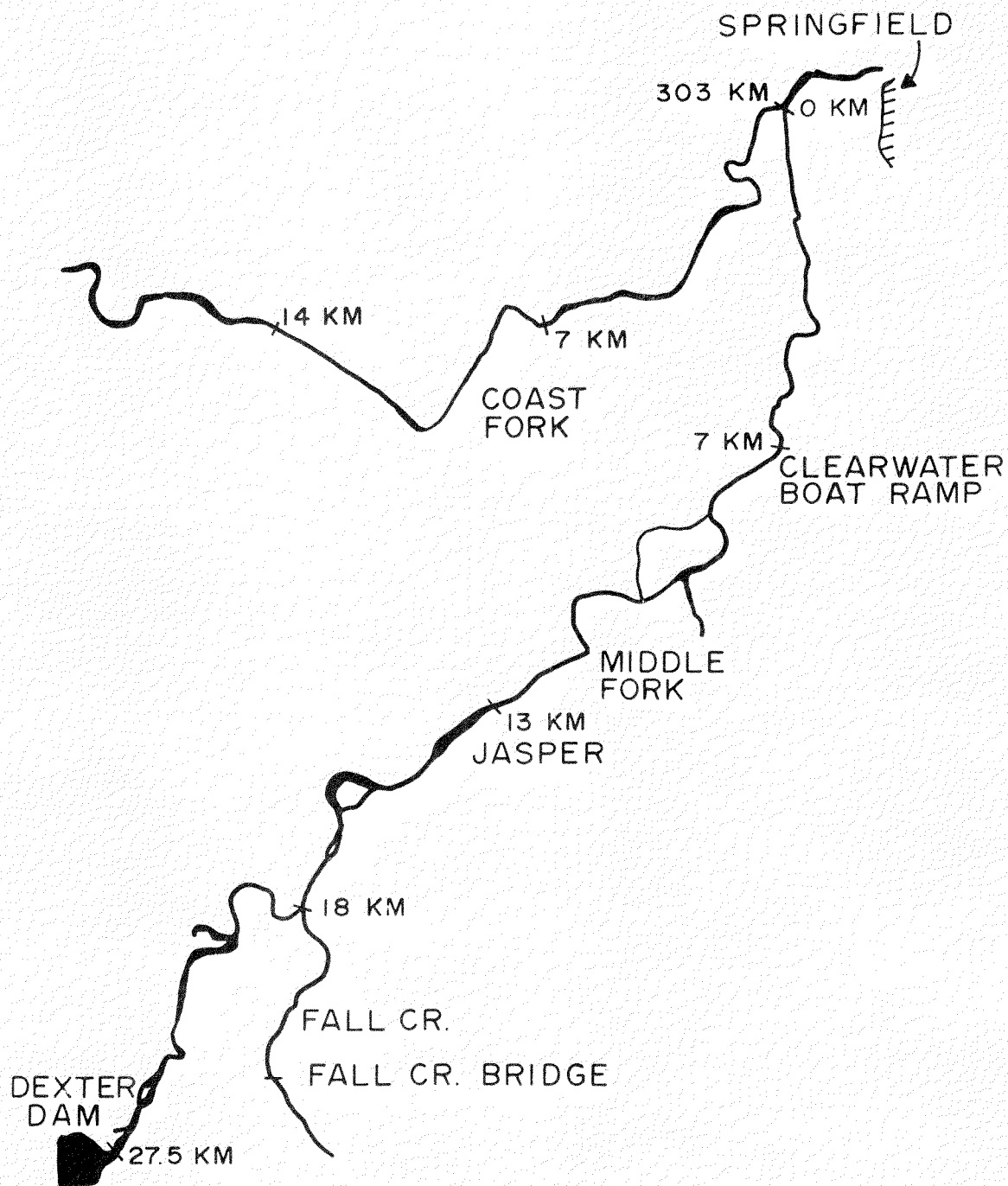


Fig. 1. Distances and landmarks of the Middle Fork and Lower Coast Fork, Willamette River system.

unknown origin, were collected in the May sample. It is apparent from samples taken in both years that few juvenile chinook rear in this area during the summer.

Coast Fork Willamette

Main stem

We began seining in the lower end of the Coast Fork (Fig. 1) on July 21, 1977, and caught 21 juvenile chinook that were 8.7 cm long and appeared to be the progeny of late-spawning fall chinook. We estimated 500 late-spawning chinook returned to the Coast Fork Willamette, including Row River and Mosby Creek in fall 1976. On 5 days between August 11 and September 16, we caught only seven chinook in 33 seine hauls from the main stem of the river. On August 11, we observed a water temperature of 23.3°C (74°F).

In 1978 we seined the lower Coast Fork Willamette on April 3 and caught an average of 9.5 juveniles/seine haul averaging 4.9 cm long; these appeared to be late-spawning fall chinook. However, because of high muddy water in fall 1977, we were unable to survey to determine the extent of spawning. On April 3, we also caught two apparently wild spring chinook averaging 14.4 cm long. The average catches/seine haul on May 2, June 19 and July 20 were 2.5, 2.3 and 0 juveniles, respectively. On July 20 we observed a water temperature of 24.4°C (76°F). We suspect that high temperatures during the summer in the Coast Fork Willamette are not ideal for rearing and result in low juvenile chinook populations.

Row River

We seined the Row River (Fig. 2) on August 17 and September 6, 1977, and caught an average of 1.2 and 5.5 juvenile chinook, respectively, per seine haul. We believe these juveniles were late-spawning chinook because 35 redds of late-spawning chinook were observed in this river during fall 1976. Additionally, juveniles caught on August 17 only averaged 9.8 cm long, while suspected spring chinook caught in the McKenzie River and main-stem Willamette during the same period averaged 11.5 and 11.6 cm in length, respectively. Since the late-spawning fall chinook spawn approximately 2 mo later than Willamette spring chinook, we expect the fall chinook juveniles will be smaller on any given date. On September 23 and October 24 we were able to capture a combined total of only 10 chinook. We suspect the bulk of the late-spawning juveniles emigrated prior to September 23.

We seined the Row River on March 9, 1978, but observed no juvenile chinook. However, late-spawning chinook juveniles may not be free swimming by this date. On April 19, we caught 16 suspected late-spawning juveniles in two seine hauls. These fish averaged 4.7 cm long. Although we were unable to find evidence of spawning in 1977, because of high muddy water, propagated 4-year-old late-spawning adults were due to return to the Row River. On July 24, 1978, we captured an average of 10 juveniles/seine haul having a mean length less than 11.0 cm. Additionally, 3.3 juveniles per seine haul averaging more than 11.0 cm were collected. The identity of these larger fish is unknown; however, late-spawning chinook juveniles should not grow this large by late July. It is possible they were the progeny of spring chinook which reared in Cottage Grove Reservoir and on return spawned in Row River because of its

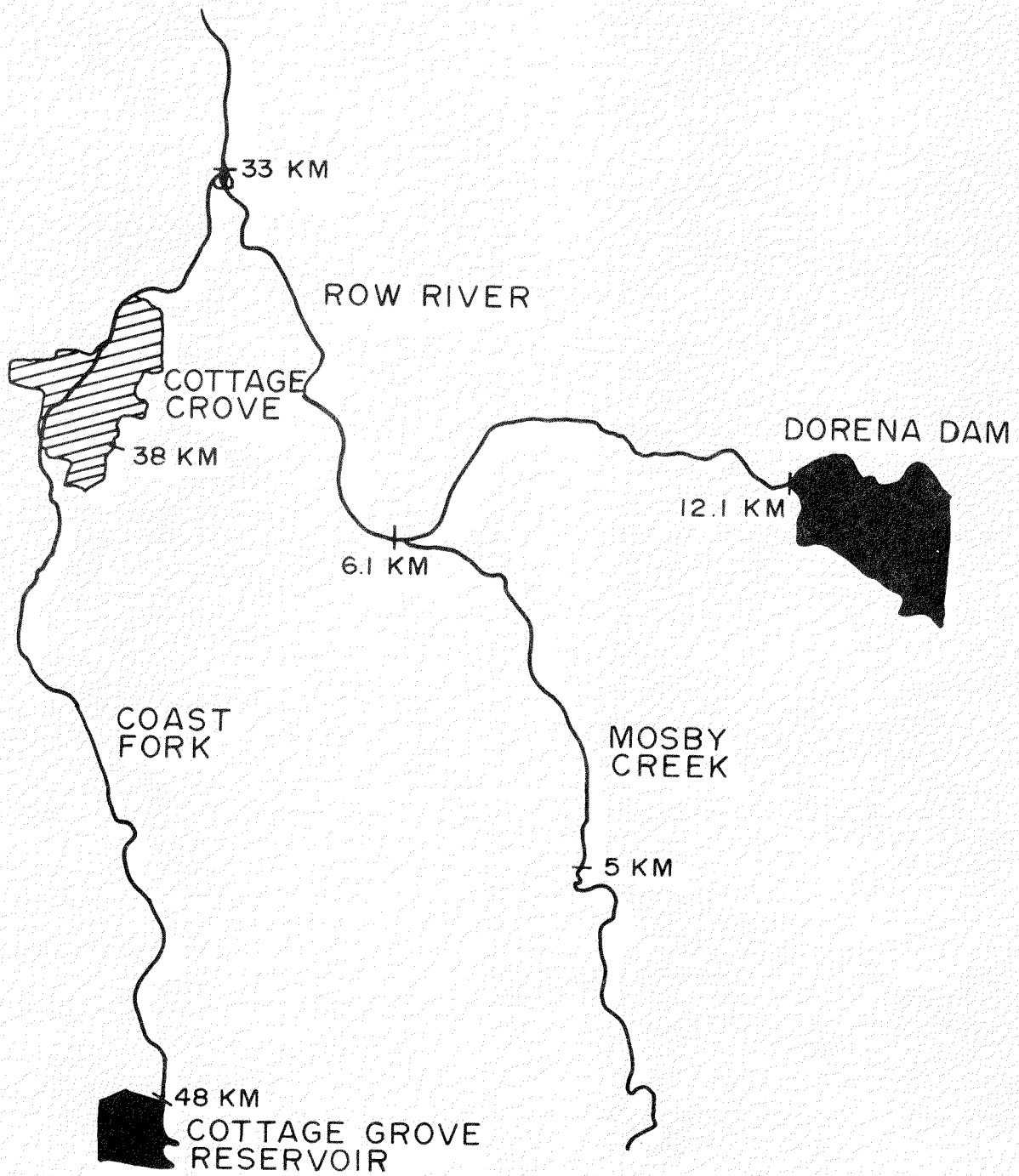


Fig. 2. Distances and landmarks of the Upper Coast Fork, Row River and Mosby Creek, Willamette River system.

better water quality than that in the Coast Fork. On August 9, only eight chinook were captured, of which four were more than 11.0 cm. On August 14, August 30 and September 6, we captured a combined total of seven juvenile chinook. We believe in 1978 the majority of juvenile chinook emigrated from Row River between July 24 and August 9. No water temperatures above 16.1°C (61°F) were observed from June 28 to September 6. Therefore, it appeared that excessive water temperatures did not influence emigration.

Mosby Creek

In 1977 we seined Mosby Creek (Fig. 2), a tributary of Row River, on August 18, and caught 3.0 juvenile chinook/seine haul. We believe these juveniles were from the late-spawning stock because they averaged only 8.0 cm long. In addition, 41 redds from late-spawning adults were observed in this creek in 1976. On September 23 and October 21 we caught 2.5 and 2.1 juvenile chinook/seine haul, respectively. In 1977 the trend of seining catches, by time, indicated slightly fewer juveniles were present in the fall than summer; however, we were unable to show timing of emigration.

We seined Mosby Creek on March 9 and April 5, 1978, and found no juvenile chinook. On April 19, we caught 24.5 chinook juveniles/seine haul averaging 5.0 cm long. These juveniles appeared to be of late-spawning stock, primarily because of their small size on this date. Zero-age spring and early spawning fall chinook in the McKenzie and South Santiam rivers averaged 6.5 and 7.9 cm in length, respectively, by April 19. In addition, 18 redds from late-spawning adults were observed in Mosby Creek in 1977. Subsequent seining on June 28, July 19 and August 8 and 30 produced a maximum catch of only two juvenile chinook on any date. No explanation can be offered for the scarcity of juvenile chinook after April 19. However, on August 30, we caught 372 nonsalmonids in four seine hauls; many were squawfish and it is possible they eliminated most of the juvenile chinook.

Main-stem Willamette River

We seined the Willamette River from Harrisburg to the McKenzie River mouth (Fig. 3) on 5 days from July 13 to August 22, 1977. The average number of juvenile chinook captured/seine haul/sampling day varied from 3.0 to 7.5. We believe these juveniles were spring chinook which probably originated from the McKenzie River. We seined on 4 days between July 13 and September 22 (from Harrisburg to Corvallis) and caught an average of 0.3 to 1.5 juvenile chinook/seine haul/sampling day. Few chinook were captured below Corvallis in 1977.

In 1978 seining in the main-stem Willamette was conducted primarily from Harrisburg to McKenzie River mouth. On April 6 and 25 and May 9, we caught an average of 32.6, 242.0 and 60.0 juveniles/seine haul, respectively. These juveniles were less than 11.0 cm in length and probably were early spawning fall chinook. In addition, we observed 160 fall chinook redds in this section of the river in 1977. On June 20, we captured an average of only 2.2 juveniles/seine haul. It was apparent that early spawning juvenile fall chinook had emigrated from this area prior to June 20.

From Harrisburg to the McKenzie River mouth, we also caught 28 juvenile chinook from April to June that were larger than 11.0 cm long. Of this total, 17 were wild chinook smolts, 10 were unmarked hatchery fish and 1 was a spray-dyed hatchery smolt.

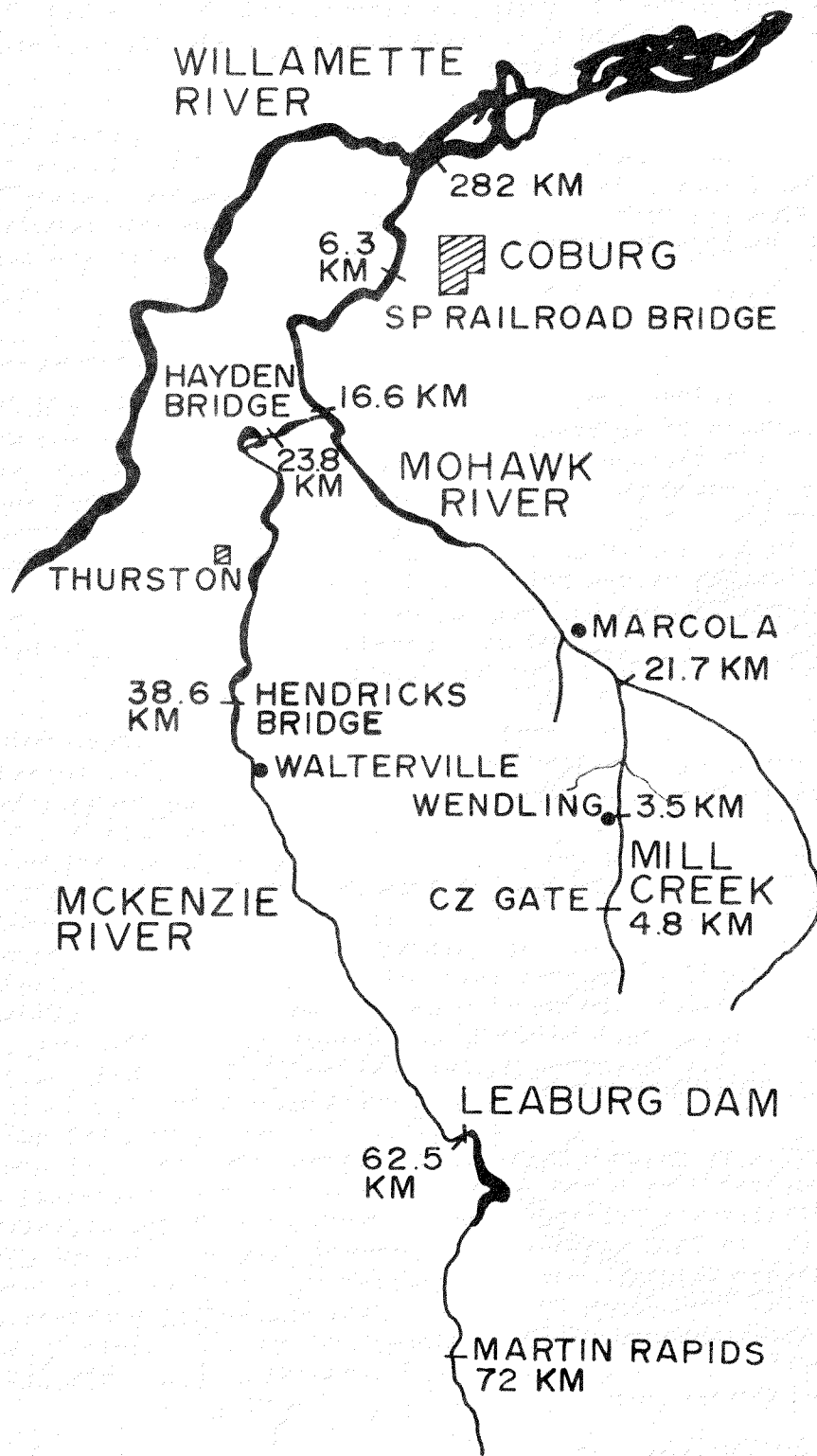


Fig. 4. Distances and landmarks of the McKenzie River, Mohawk River and Mill Creek (Mohawk River), Willamette River system.

Santiam River

Main stem

We seined the Santiam main stem (Fig. 5) on July 14 and August 4 and 12, 1977, and caught a total of 13 juvenile chinook in 37 seine hauls. It appeared that few juvenile chinook were rearing in this area during the summer.

On May 4, 1978, we caught an average of 35.7 chinook/seine haul averaging 8.8 cm long and were apparent fall chinook. Additionally, we observed 847 fall chinook redds in fall 1977 in the Santiam main stem. We also caught yearling chinook including two unmarked hatchery, eight adipose marked, two RV marked and one wild fish. On June 13, we caught only 2.0 fish/seine haul, less than 11 cm long, and 0.1 fish/seine haul more than 11.0 cm in length indicating that the majority of the fall chinook previously present had emigrated. On July 13 and August 17, the average catch/seine haul was 0.3 and 0.2 juveniles, respectively. These samples confirmed the 1977 findings that few chinook rear in this area during the summer.

South Santiam

We seined the South Santiam River from the mouth up to Crabtree Creek (Fig. 5) two times each in July and August 1977. The average number of juvenile chinook caught/seine haul varied from 0.5 to 0.6. We concluded that few juvenile chinook were rearing in this section of the river in July and August 1977.

In spring 1978, we concentrated seining from the mouth of the river to Crabtree and caught large numbers of apparent juvenile fall chinook. We counted a total of 2,310 fall chinook redds in the South Santiam River in 1977, including 2,115 from the mouth to Crabtree. On April 17 and May 4, 1978, we caught an average of 21.0 and 58.0 juveniles, respectively, per seine haul. Juvenile chinook caught on April 17 and May 4 averaged 7.4 cm and 8.4 cm in length, respectively. We also caught yearling chinook smolts, including three wild, one hatchery unmarked and four adipose marked hatchery fish. On June 12, July 12 and 26 and August 23, we captured a total of one fish. We believe the fall chinook emigration in 1978 had taken place sometime between May 4 and June 12 in this section of the river.

From Crabtree Creek upstream to Lebanon Dam, we seined in July and August 1977, and captured a total of only one juvenile chinook in 17 sets. In spring 1978, we caught an average of 12.5 and 30.1 apparent fall chinook juveniles/seine haul, in this area on March 30 and May 3, respectively. Seining on July 12 and 26 and August 23 produced a total catch of one spring chinook. Seining in 1977 and 1978, indicated that few juvenile chinook rear during the summer in this river section.

We seined in the South Santiam River between Lebanon and Foster dams in August and September 1977. From Foster Dam to Sweet Home, we caught a total of 20 juvenile chinook which averaged 13.5 cm in length. These fish appeared to be juvenile spring chinook. In 1978 we did not seine this upper section of the river.

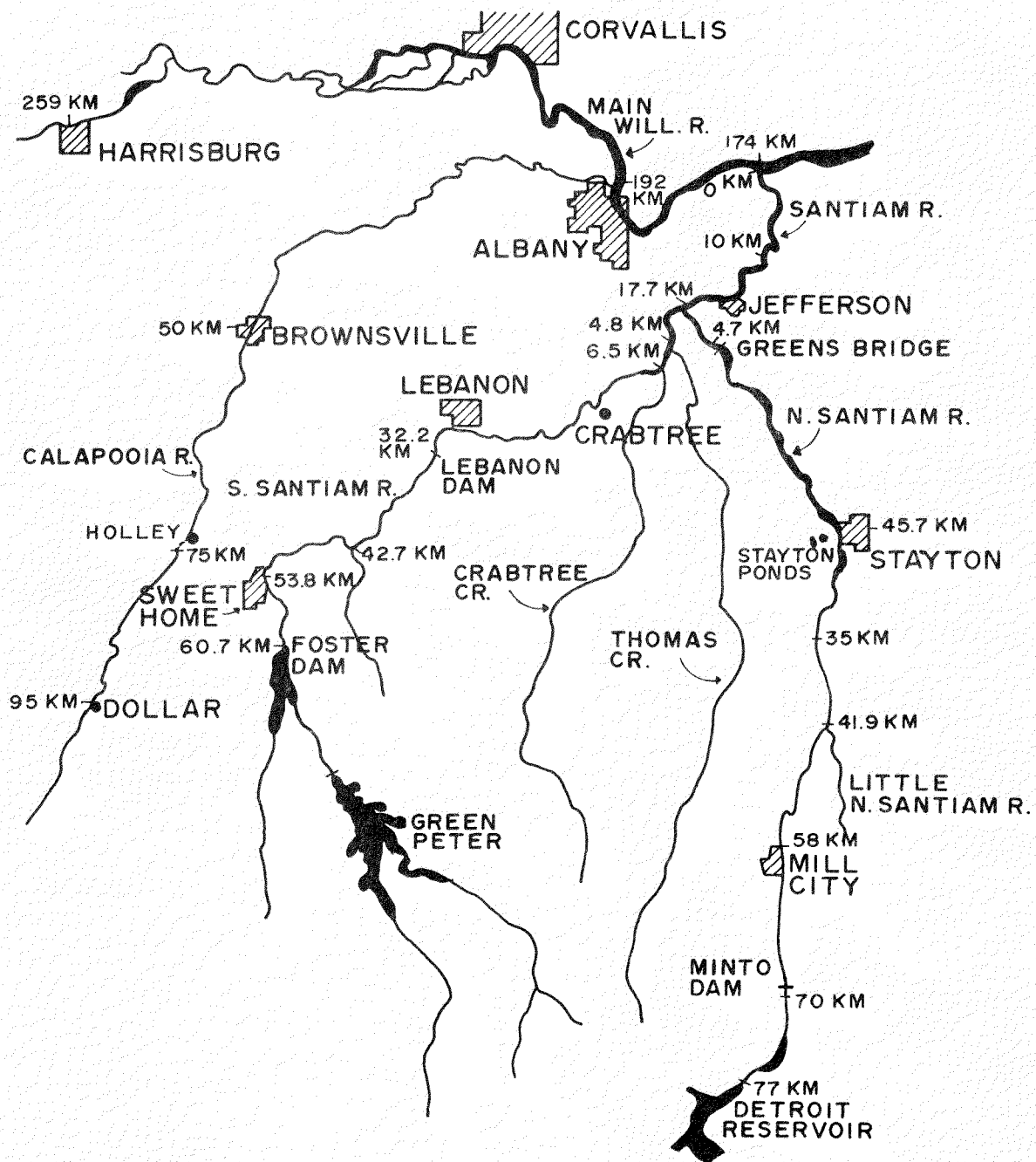


Fig. 5. Distances and landmarks of the Santiam River (main-stem North and South Forks), Thomas and Crabtree creeks and Calapooia River, Willamette River system).

North Santiam

We seined the North Santiam River from Stayton to the mouth (Fig. 5) in July, August and September of 1977. Few juvenile chinook were found rearing in this section of the river during these months. However, on July 6 and September 9 we caught 9.5 and 0.8 juvenile chinook, respectively, per seine haul below the outlet of Stayton Pond. We suspect most of these juveniles were fall chinook that originated from the pond. From Green's Bridge to the mouth, we caught only 1.6, 0.1 and 0.4 juvenile chinook/seine haul on July 18, August 8 and 23, respectively. It appeared that in 1977 few juvenile chinook reared in the lower North Santiam River during the summer.

In 1978 we seined the lower river from the mouth to Green's Bridge and caught large numbers of apparent juvenile fall chinook which were less than 11.0 cm in length. We observed 451 fall chinook redds in the North Santiam River from the mouth to the Little North Fork in fall 1977. Average catch of juveniles/seine haul varied between 32.0 and 47.3 on 5 seining days from March 28 to May 8. On June 8 the catch rate lowered to 19.1 juveniles/seine haul. Seine hauls on July 10 captured a total of three juvenile chinook, while no chinook were observed in sets made on August 22. We believe the bulk of the fall chinook emigrated between May 8 and June 8. We concluded few juvenile chinook rear in the lower North Santiam River in the summer.

On March 28, 1978, from Green's Bridge to the mouth, we also captured 382 spring chinook, all more than 11.0 cm long, in five seining sets. These fish included 188 ad+cwt and 67 RV marked fish, 126 hatchery fish and 1 wild fish. On April 17, in one seining set, we captured 141 ad+cwt, 64 RV marked hatchery fish and 87 unmarked hatchery fish. However, on May 8 we only caught 26 ad+cwt and two RV marked hatchery fish, and 17 unmarked hatchery fish in seven sets, indicating most of the hatchery fish had previously emigrated. Hatchery-reared spring chinook were released into the North Santiam River in mid March 1978.

We seined the upper North Santiam River just below Minto Dam on August 1 and September 14, 1977, and caught one apparent juvenile spring chinook. No seining was done in this area in 1978. Although seining sites, for obtaining adequate samples, are difficult to find in this river section, it appeared that few chinook were present during the summer months.

Molalla River

We seined the lower Molalla (Fig. 6) in six different areas on August 19, 1977, but were unable to capture any juvenile chinook. However, on this date just above and below the mouth of the North Fork, we caught 25.5 apparent juvenile spring chinook/seine haul. Some spring chinook spawn in the Molalla River annually, but the number is unknown. Sets made on August 22 in this same general area produced an average of 3.7 chinook/haul.

In 1978 seining was concentrated in the area from the mouth up to Wagon Wheel Park. On January 24 we caught two juvenile chinook in four sets. The catch/seine haul on March 22, April 11 and 26 and May 11 averaged 13.7, 13.3, 13.5 and 1.8 juvenile chinook, respectively. The juveniles caught on March 22 averaged 5.4 cm long. We observed 767 fall chinook redds in the Molalla River in 1977, and believe the juvenile chinook caught during the above

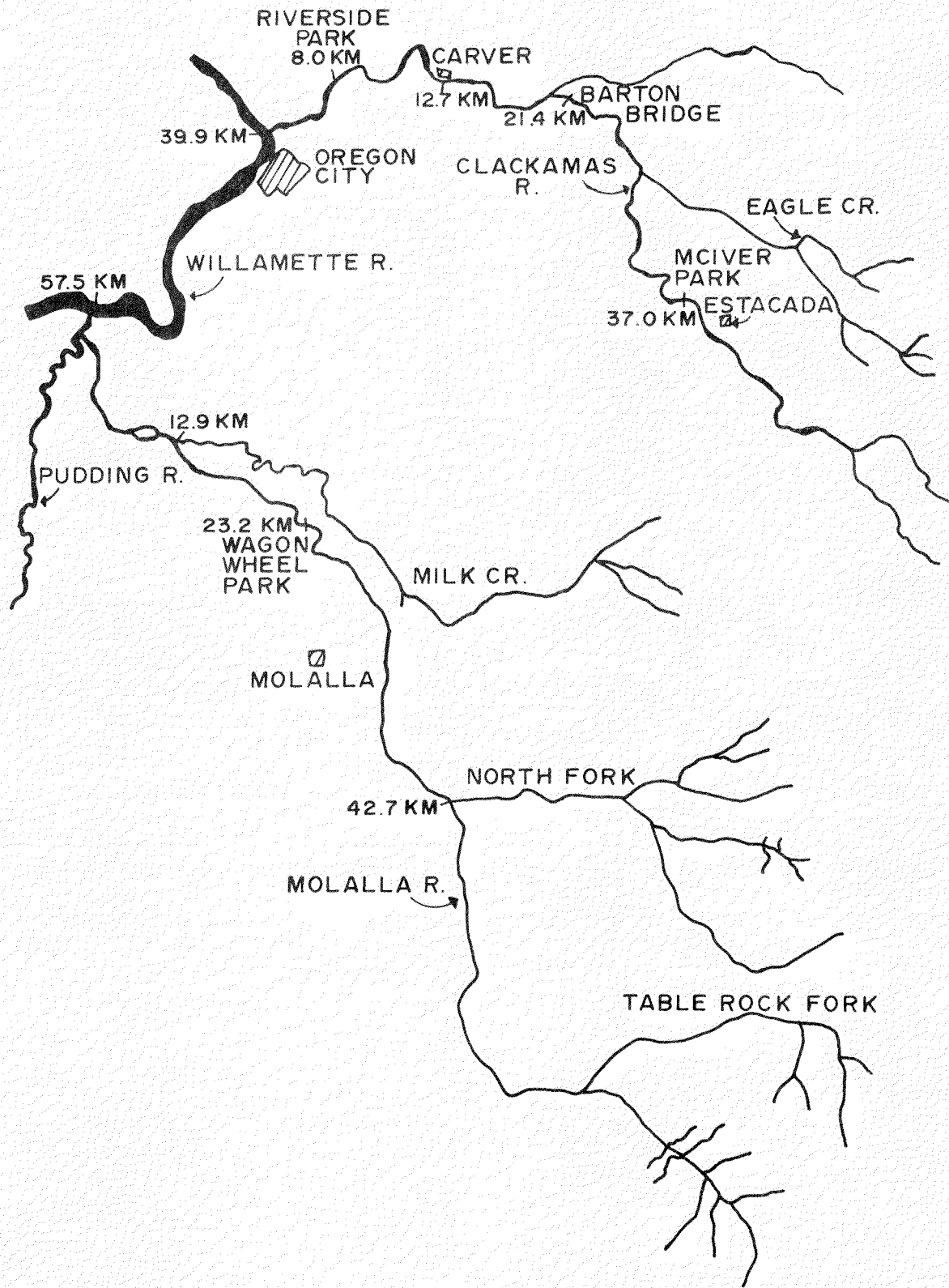


Fig. 6. Distances and landmarks of the Clackamas and Molalla rivers, Willamette River system.

seining periods were fall chinook. It was apparent from the seine catches by date that fall chinook juveniles had emigrated from the Molalla between April 26 and May 11. However, high water resulting from heavy rains during this period may have influenced emigration. We caught only one juvenile chinook on June 27. This fish was 13.4 cm in length and appeared to be a spring chinook. No juvenile chinook were captured on August 8. On August 29, we seined the area near the mouth of the North Fork where spring chinook juveniles were in 1977. However, no chinook were observed.

Clackamas River

In 1977 we seined the Clackamas (Fig. 6) above Carver and Barton bridge on August 26, and observed 24.0 and 26.0 juvenile chinook/seine haul, respectively. These fish ranged from 7.6-13.3 cm in length and appeared to be spring chinook since fall chinook juveniles would have migrated by this date. On September 1, we seined in eight different areas from Barton to McIver Park, but observed a total of only 10 juvenile chinook.

In 1978 we seined from just above the mouth to Carver on April 11, June 15, July 17 and August 15 and caught an average of 33.3, 8.5, 9.5 and 1.5 0+ age juvenile chinook/seine haul, respectively. The average length of these fish ranged from 4.5 cm on April 11 to 11.8 cm on August 15. Since both spring and fall chinook spawn in the river below PGE's River Mill Dam it is unknown how many of the fish caught in April were fall fish. We believe the juveniles caught on June 15 and later were spring chinook since the fall chinook would have migrated by this time. It was apparent in both 1977 and 1978 that spring chinook juveniles were rearing in the Clackamas below Carver during the summer months.

In 1978 we caught an average of 19.0 and 4.0 yearling spring chinook smolts/seine haul on April 11 and June 15, respectively. We were unable to differentiate between wild and hatchery smolts. No smolts were caught after mid June.

Minor Streams

Mill Creek (Mohawk River)

We seined Mill Creek (Fig. 4) on July 5 and 14, 1978. No juvenile chinook were observed in this stream on either date.

Calapooia River

On August 10, 1977, we made seven seine hauls in a section of the Calapooia upstream from Dollar (Fig. 5), but no chinook were observed. This river was not seined in 1978.

Crabtree Creek (South Santiam River)

On April 18, 1978, we caught 34 juvenile chinook in two sets made 6.4 km above the mouth of Crabtree Creek (Fig. 5). These fish averaged 7.0 cm in length. We counted 55 fall chinook redds on an aerial survey in 1977 and therefore believe the juveniles collected in 1978 were fall chinook.

Thomas Creek (South Santiam River)

We seined Thomas Creek (Fig. 5) on April 8, 1978, from km 0.4 to 4.8 and caught a total of 17 juvenile chinook in four sets. These juveniles averaged 7.9 cm in length and were apparently fall chinook. We previously counted 47 fall chinook redds in this creek in 1977.

Little Luckiamute River (Luckiamute River)

There were 131,250 juvenile Cowlitz River (Washington) late spawning stock fall chinook released into the Little Luckiamute (Fig. 7) in May 1974. We expected adults to return in 1976 and 1977 from this release. However, we were unable to find any adults or redds during spawning ground surveys in either year. On August 25, 1977, we made 10 seine hauls in an area from Falls City to Bridgeport School but observed no juvenile chinook. In 1978 we made 10 seine hauls in the same area on June 26 but again no chinook juveniles were caught.

Luckiamute River

In 1977 we made 11 seine hauls from Fisherman's Camp to Peedee (Fig. 7) on September 2, but no chinook juveniles were observed. There were 209,250 juveniles of the 1973 brood late spawning fall chinook released into this system in May 1974, which should have returned as 3+-year-old adults to spawn in 1976. Although no juvenile chinook were observed in 1977, it is possible the progeny of this brood were in the river during the summer but emigration had occurred prior to September 2. In 1978 we seined just above the mouth on July 13 but were unable to catch any juvenile chinook.

Mill Creek (Salem)

We seined in 10 areas from the mouth to Aumsville (Fig. 8) on June 21, 1978. No juvenile chinook were caught.

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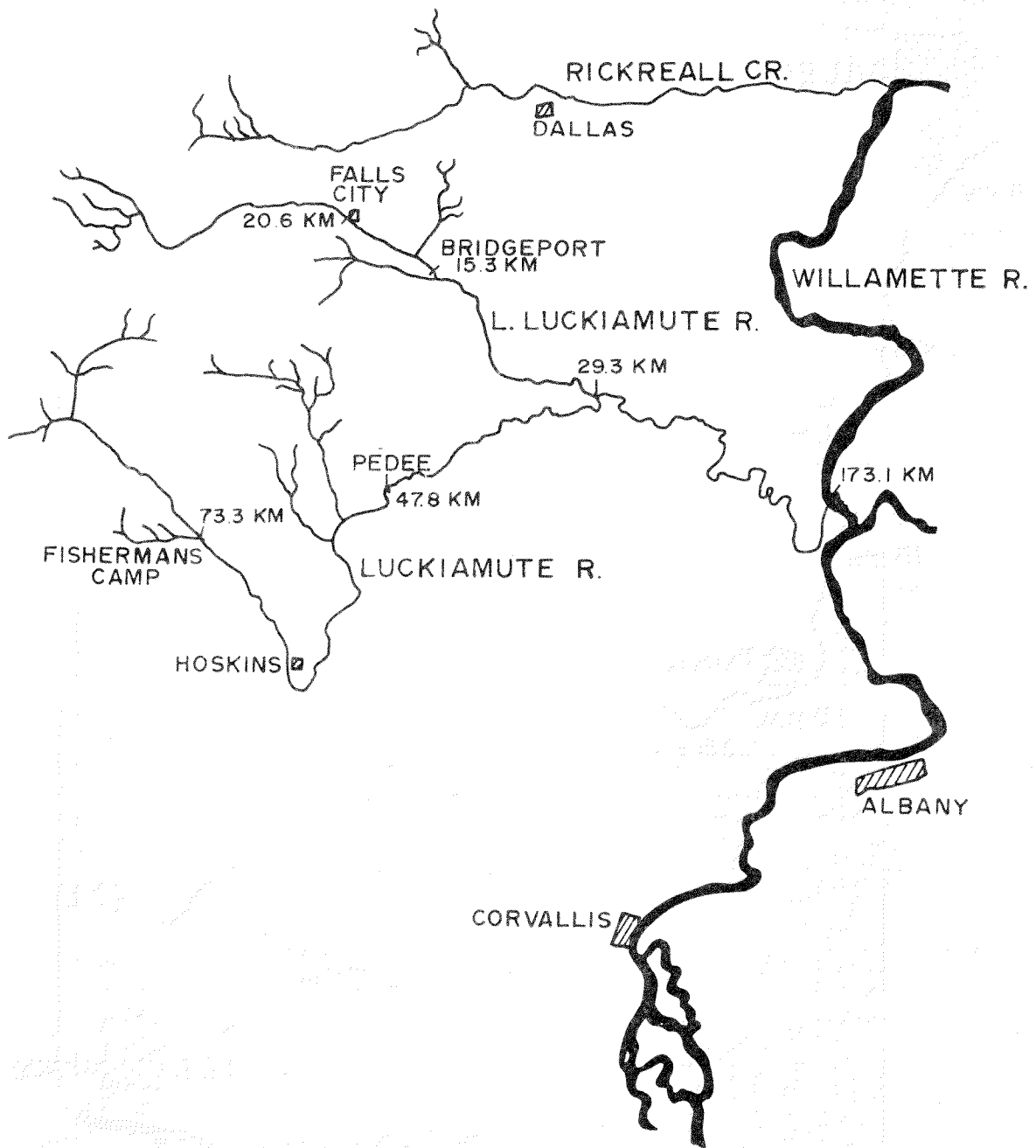


Fig. 7. Distances and landmarks of the Luckiamute and Little Luckiamute rivers, Willamette River system.

Appendix Table I. Cowlitz River stock juvenile fall chinook released into the Willamette River system, 1972-78.

Brood year	Release date	Number released	Release site	Size (grams/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
"	"	131,250	L. Luckiamute R.	3.5
"	"	78,000	Luckiamute R.	"
"	"	109,153 ^a	Green Peter Res.	3.9
1974		(no fish available)		
1975	5/76	262,340	L. Luckiamute R.	3.5
"	"	2,040,328	Luckiamute R.	3.7
1977 ^b	11/78	150,000	Mill Cr. (Salem)	19.7

a

Experimental release to determine if this stock would migrate from reservoir.

b

Proposed release and ad+cwt marked.

Appendix Table 2. A summary of surveys by aircraft and the Mill Creek Boat survey to observe fall chinook salmon spawning in the Willamette River system, September 29-October 10, 1977.

River	River section		Redds	Length Avg. no. of reach of redds/ (km)	Date	Visibility
	Reference points	River kilometers				
Willamette R.	Newberg to Wheatland Ferry	80.5-115.7	1	35.2	9/20	Fair
	Wheatland Ferry to Salem	115.7-135.2	23	19.5	"	"
	Salem to Independence	135.2-154.6	4	19.4	"	"
	Independence to Albany	154.6-192.0	10	37.4	9/30	"
	Albany to Marys R.	192.0-212.6	12	20.6	"	"
	Marys R. to American Can Co. (concrete water intake structure)	212.6-237.2	81	24.6	"	"
Middle Fork Willamette R.	American Can Co. water intake to Harrisburg	237.2-259.4	199	22.2	"	"
	Harrisburg to McKenzie R.	259.4-281.3	160	21.9	"	"
	McKenzie R. to Jct. Coast and Middle Forks	281.3-300.9	15	19.6	"	"
	TOTAL		505	220.4	2.29	
Coast Fork Willamette R.	Mouth to Fall Cr.	0.0-18.2	11	18.2	9/30	Poor
	Fall Cr. to Dexter Dam	18.2-27.0	28	8.8	"	Good
Row R.	TOTAL		39	27.0	1.44	
	Mouth to Row R.	0.0-33.3	0	33.3	9/30	Poor
TOTAL	Row R. to Cottage Grove Res.	33.3-47.8	1	14.5	"	"
	TOTAL		1	47.8	0.02	
TOTAL	Mouth to Dorena Dam	0.0-12.2	3	12.2	9/30	Poor
	TOTAL		3	12.2	0.25	

Appendix Table 2 (cont'd)

River	River section		Redds	Length (km)	Avg. no. of reach of redds/ km	Date	Visibility
	Reference points	River kilometers					
Mill Cr. (boat survey)	Mouth to Junct. of Stayton Ditch	0.0-35.4	1,410 ^a	40.2	35.07	9/29- 10/10	Fair
	TOTAL		1,410	40.2	39.83		
McKenzie R.	Mouth to Interstate 5 br.	0.0-7.1	86	7.1	12.11	9/30	Good
	Interstate 5 br. to Mohawk R.	7.1-17.2	87	10.1	8.61	"	"
	Mohawk R. to Hendricks Br.	17.2-33.8	131	16.6	7.90	"	"
TOTAL		304	33.8	8.99			
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	200	5.1	39.22	9/29	Good
	OERR br. to Interstate 5 br.	5.1-10.3	213	5.2	40.96	9/30	"
	Interstate 5 br. to Jefferson Br.	10.3-15.4	226	5.1	44.31	10/4	"
	Jefferson Br. to Junct. of N. & S. Santiam R.	15.4-18.8	208	3.4	61.18	"	"
TOTAL		847	18.8	45.05			

^a Includes 265 redds found in 4.8 km of Shelton Ditch.

Appendix Table 2 (cont'd)

River	River section		Redds	Length of reach of redds/ (km)	Avg. no. km	Date	Visibility
	Reference points	River kilometers					
North Santiam R.	Mouth to first hwy. br.	0.0-4.7	103	4.7	21.91	9/29	Good
	Hwy br. to SPRR br.	4.7-17.9	341	13.2	25.83	"	"
	SPRR br. to Stayton Br.	17.9-26.9	65	9.0	7.22	"	"
	Stayton Br. to L. N. Fork	26.9-43.0	42	17.0	2.47	"	"
	TOTAL		451	43.0	10.49		
South Santiam R.	Mouth to Crabtree hwy. br.	0.0-12.2	914	12.2	74.92	9/29	Good
	Crabtree hwy. br. to Lebanon br.	12.2-29.4	1,201	17.2	69.83	"	"
	Lebanon br. to Lebanon Dam	29.4-33.5	110	4.1	26.83	"	"
	Lebanon Dam to Foster Dam	33.5-60.7	85	27.2	3.13	"	"
	TOTAL		2,310	60.7	38.06		
Thomas Cr.	Mouth to county rd. br.	0.0-3.5	32	3.5	9.14	9/29	Good
	County rd. br. to covered br. above Scio	3.5-19.3	15	15.8	0.95	"	Fair to Poor
	TOTAL		47	19.3	2.44		
Crabtree Cr.	Mouth to SPRR br.	0.0-6.0	23	6.0	3.83	9/29	Good
	SPRR br. to transmission lines	6.0-15.9	24	9.9	2.42	"	"
	Transmission lines upstream	15.9-17.1	8	1.2	6.67	"	"
		1.2 km					
	TOTAL		55	17.1	3.22		
Molalla R.	Mouth to Hwy. 99E br.	0.0-5.8	34	5.8	5.86	10/3	Good
	Hwy. 99 E br. to Goods Br.	5.8-9.7	68	3.9	1.74	"	"
	Goods Br. to SPRR br.	9.7-16.3	142	6.6	21.52	"	"
	SPRR br. to Hwy. 213 Br.	16.3-23.2	179	6.9	25.94	"	"

Appendix Table 4. Sex ratios of early spawning fall chinook, Willamette River system, 1970-77^a.

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 ^b	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

^a

Includes Clackamas River.

^b

Sex ratios taken on Mill Creek tag and recovery carcass survey.

Appendix Table 5. Releases of adults, fry-fingerlings, and smolts contributing to returning coho adults, Willamette River system, 1965-77.

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

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.

Appendix Table 6. Releases of fry, fingerlings, and pond-reared fall chinook contributing to returning adults, Willamette River system, 1965-77.

Year	Adults ^a returning	Number of returns by age class		Releases contributing to 3's (millions)			Releases contributing to 4's (millions)		
		3's	4's	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	27,592	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

^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 7. Age composition of early spawning fall chinook, Willamette River system, 1970-77^a.

Year		Number by age				Total
		2	3	4	5	
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

^a Includes Clackamas River.

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 1,000's. Some fed fingerlings are included with fry listings. Cowlitz River (Washington) stock coho are not included.

Appendix Table 8 (cont'd)

System	1965 brood		1966 brood		1967 brood	
	Adults	Fry	Adults	Fry	Adults	Fry
Tualatin R.	--	349.7	150	195.3	722	685.7
Molalla R.	--	846.0	656	431.1	664	1,640.0
Pudding R.	--	910.7	551	535.7	706	430.1
N. Yamhill R.	817	291.5	--	336.2	--	--
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	389.4	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	893.6
Middle Fk.	--	859.4	--	354.6	150	102.9
Total	1,846	9,465.4 ^b	4,205	10,615.7	9,208	7,894.5

b

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

Appendix Table 8 (cont'd)

System	1968 brood			1969 brood			1970 brood		
	Adults	Fry	Smolts	Adults	Fry	Smolts	Adults	Fry	Smolts
Tualatin R.	506	--	--	500	740.1	--	320	--	--
Molalla R.	912	825.3	--	891	--	--	360	--	--
Pudding R.	632	829.1	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	--	28.4	300	828.5	85.3	--	--	--
Mill Cr. (Salem)	120	41.9	--	--	--	46.1	--	--	26.2
Rickreall Cr.	150	--	185.8	200	--	--	150	--	--
Luckiamute R.	780	518.2	--	600	476.5	252.7	--	223.0	165.3
N. Santiam R.	--	--	--	--	442.8	--	--	--	--
S. Santiam R.	1,622	1,159.9	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	5,747.1	1,253.9	5,216	5,565.1	1,345.6	830	883.2	1,217.1

Appendix Table 8 (cont'd)

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.	--	--	288.6	--	480.6	275.4	--	--	--
Pudding R.	450	512.5	--	308	785.1	41.1	171	--	--
N. Yamhill R.	--	--	--	--	--	--	239	--	--
S. Yamhill R.	--	397.2	435.2	208	196.1	483.8	--	--	--
Mill Cr. (Salem)	--	--	--	--	--	--	152	--	--
Rickreall Cr.	150	--	--	164	--	--	214	--	--
Luckiamute R.	150	--	--	160	327.1	20.3	--	--	--
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.	--	--	--	--	--	--	--	--	94.9
Mohawk R.	--	--	21.3	--	--	25.2	--	--	--
Fall Cr.	400	--	--	158	--	--	--	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	1,139	631.4	189.8

Appendix Table 8 (cont'd)

System	1974 brood		1975 brood		1976 brood	
	Adults	Fry	Adults	Fry	Adults	Fry
Tualatin R.	--	183.1	--	99.3	--	204.1
Molalla R.	--	--	--	--	--	--
Pudding R.	--	345.4	--	--	--	270.4
N. Yamhill R.	--	--	--	--	--	--
S. Yamhill R.	--	--	--	--	--	--
Mill Cr. (Salem)	--	--	--	--	--	--
Rickreall Cr.	--	--	--	--	--	--
Luckiamute R.	204	158.5	--	--	--	--
N. Santiam R.	--	--	--	--	--	161.3
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

Appendix Table 9. Early spawning juvenile fall chinook (Columbia River stock) released into the Willamette River system from Willamette basin ponds, 1967-77 broods.

Brood	Molalla River	Mill Creek	North Santiam R.	South Santiam R.	Willamette R. ^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	4,880,090	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 ⁱ	186,000	--	10,788,305	11,233,380
1977	--	100,239 ^j	--	--	201,004 ^j	301,243 ^k

^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 mortality.

^h Fish culture personnel subjectively estimated 5,380,000 additional fish migrated from the ponds after trucking terminated. We believe most of the fish were pond mortality.

Appendix Table 9 (cont'd)

- i* Ad+cwt and released into Mill Creek to determine fishery contribution.
- j* Ad+cwt and released into Willamette Falls forebay and tailrace to determine turbine mortality.
- k* An additional 5,856,856 unmarked juveniles released into the Columbia River at Bonneville Hatchery.



Post Office Box 3503
Portland, Oregon 97208