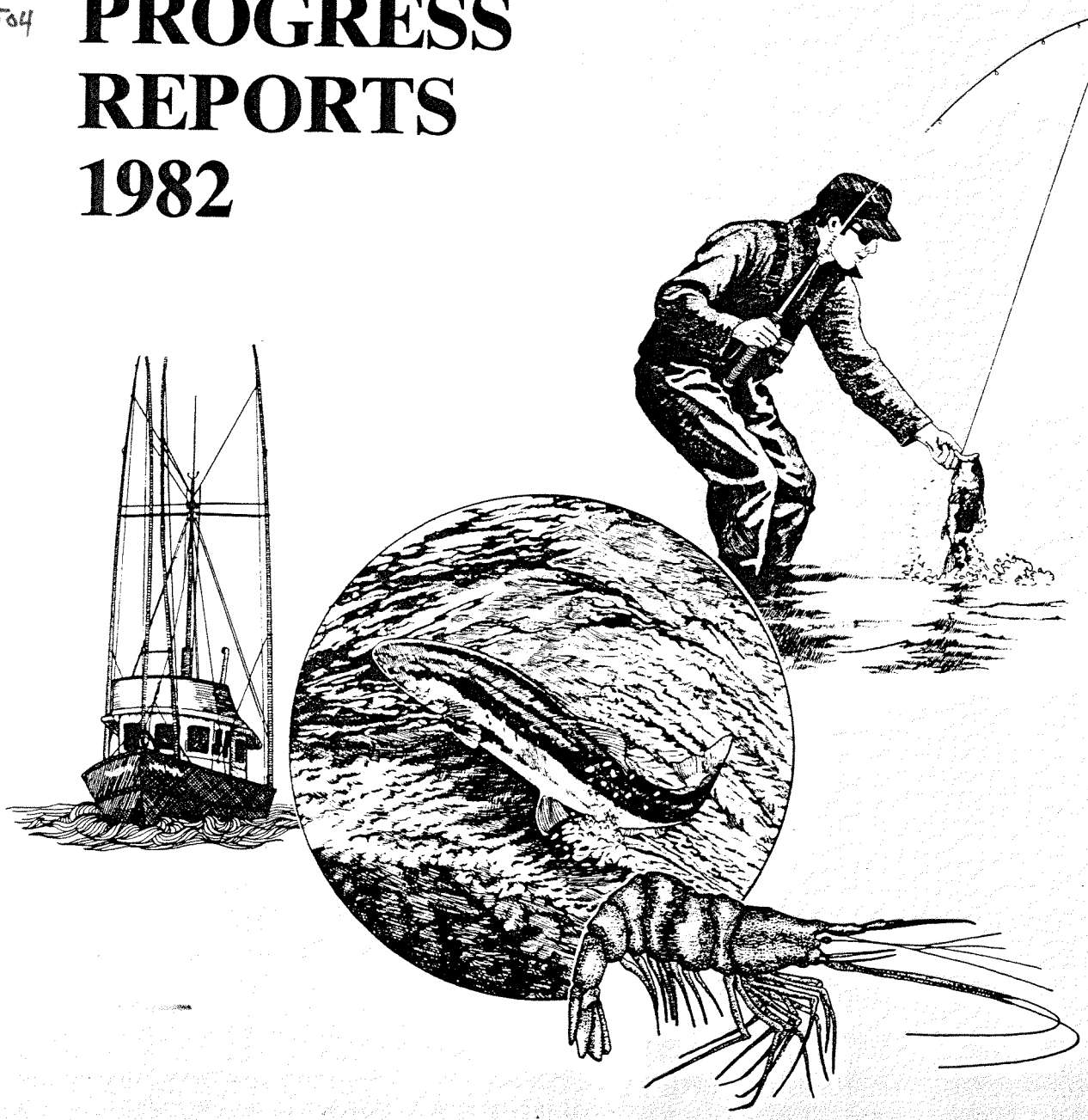
Smith et al
1982

# PROGRESS REPORTS 1982



## FISH DIVISION

### Oregon Department of Fish and Wildlife

Willamette River Salmon Studies

ANNUAL PROGRESS REPORT

FISH RESEARCH PROJECT

OREGON

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Accomplishments in FY 1982 -- Study Objectives completed.

Findings in FY 1982 -- Transporting smolts to lower river areas for release appears to increase fishery contributions in lower river areas and results in straying of adults to many tributaries.

Management Implications -- Releasing smolts from upriver stations into the Lower Willamette can be used as a tool to put more adults into the intensive sport fishery of this area. However, substantial straying of returning adults will result.

*(Spring Chinook Stock Comparative Study - Marion Forks Hatchery)*

Study Objectives, FY 1982 -- Sample fisheries and hatchery returns to collect coded-wire tags. Tag and release 1980-brood Carson and Willamette stock juveniles.

Accomplishments in FY 1982 -- Study Objectives completed.

Findings in FY 1982 -- Returns of North Santiam stock from the 1977-brood were the best since tagging began with the 1974-brood. Comparative percentage adult returns for the 1977-brood substantially favors the North Santiam stock over the Carson stock.

Management Implications -- It appears survival can be increased by incubating and hatching North Santiam stock at Marion Forks Hatchery, rather than transferring these fish between stations to advance development.

*(Oakridge-Dexter Evaluation)*

Study Objectives for FY 1982 -- Grade, tag and release populations of juveniles from Oakridge and Dexter facilities. Sample fisheries and hatchery returns to collect coded-wire tags. Summarize data and continue preliminary data analyses.

Accomplishments in FY 1982 -- Study Objectives completed.

Findings in FY 1982 -- All release groups from the evaluation study are providing adult returns. Spring releases from Oakridge-Dexter have yielded more adults.

Machine grading of smolts soon before release appears to reduce survival. However, grading may benefit smaller smolts by eliminating competition from larger fish.

Management Implications -- We should investigate passive methods of separating juvenile fish by size in standard rearing ponds to increase survival to adults.

*(McKenzie Hatchery Evaluation)*

Study Objectives -- Grade, tag and release populations of juveniles from Oakridge and Dexter facilities. Sample fisheries and hatchery returns to collect coded-wire tags. Summarize data and continue preliminary data analyses.

Accomplishments in FY 1982 -- Study Objectives completed.

Findings in FY 1982 -- Initial adult returns from evaluation tests are relatively poor. We ascribe part of this lack of success to chronic bacterial kidney disease (BKD) problems.

Management Implications -- The use of prophylatic treatments with antibiotics should be investigated to reduce the incidence of BKD.

*(Downstream-migrant protection tests, PGE's Sullivan Plant)*

Study Objectives for FY 1982 -- Cooperate with PGE biologists in conduct of bypass efficiency testing. Conduct injury testing to quantify amount of injury sustained in passage through the Unit 13 bypass facilities. Identify the location within the system where injuries occur.

Accomplishments in FY 1982 -- Bypass efficiencies were described at low forebay levels for three species of salmonids. Preliminary injury testing was completed.

Findings in FY 1982 -- Calculated bypass efficiencies of the Sullivan Plant fish protection system at low forebay levels were 91.3% for spring chinook, 92.6% for steelhead and 99.5% for fall chiook. Limited testing at high forebay levels indicated reduced bypass efficiency. Overall rates of injury in the turbine screen/penstock area of the bypass ranged from 7% for chinook to 21% for steelhead and fall chinook.

Management Implications -- Until injury rates are controlled and bypass efficiencies at high forebay levels are improved, plant closure remains the best operation to protect fish at the T.W. Sullivan Plant.

*(McKenzie River Studies)*

Study Objectives for FY 1982 -- Collect downstream migrant information at the Leaburg Dam trap. Conduct mortality studies to define site and magnitude of fish losses in the Leaburg and Walterville diversion projects.

Accomplishments in FY 1982 -- Study Objectives completed.

Findings in FY 1982 -- Leaburg Canal appears to be the source of highest losses to juvenile salmon. Smolts which enter Walterville Canal sustain 13% mortality, but it appears that few fish are diverted into this canal at river flows of 1,300 cfs and above. Juvenile anadromous fish migrate

out of the Upper McKenzie River in all months of the year. July, August and September appear to be the low points in downstream migration.

Management Implications -- Leaburg Canal should be screened to reduce losses of juvenile anadromous salmonids. We should conduct further testing to determine need for fish protection at Walterville Canal.

*(Fall Salmon Studies)*

Study Objectives for 1981

Objective 1. Determine the relative magnitude of the natural and propagated portion of the fall chinook run passing Willamette Falls.

Objective 2. Determine the need and value of supplementing the run of fall chinook in the Upper Willamette River with hatchery fish.

Objective 3. Determine the contribution and survival of the Cowlitz and Toutle stocks of coho reared at Columbia River hatcheries and released in the Upper Willamette River at Scoggins Creek.

Accomplishments for 1981 -- Of the 5.9 million fall chinook released into the Upper Willamette River 4.3% were marked Ad-CWT. Samples of returning adults were collected at Willamette Falls for identification, while sample observations attained the required precision for accurate marked:unmarked fish passage estimation. The fall chinook run was monitored for sex and age composition, age-specific length, redd counts and spawning distribution. Fish culture production efficiencies for the pond program were summarized for the first three years of the evaluation study. Recovery data for coho released into Scoggins Creek was compiled and preliminary comparisons were made between the two different stocks tested.

Findings for 1981 -- The 1981 fall chinook run above Willamette Falls was composed of 8,223 fish (46%) from natural production and 9,705 fish (54%) from propagated production. The propagated production contained 577 fish (3%) straying into the Willamette from releases in other areas of the Columbia River.

Age composition for run years 1979-81 revealed a strong year class of the 1978 brood and a weak 1977 brood year class. This was not unexpected as nearly all production from the 1977 brood was from only natural production, whereas with the 1978 brood both natural production plus substantial (4.6 million) propagated fish were released in the system.

Redd distributions show that the following tributaries are the most important (in priority order) spawning grounds for fall chinook in the Willamette Basin: Santiam, South Santiam, Main-stem Willamette from the mouth of McKenzie downstream, Clackamas, Mill Creek (Salem), Molalla, McKenzie below Hendricks Bridge, and the North Santiam below Stayton.

The Stayton Pond fish culture program reared fish in 1981 with a food conversion rate of 1 lb of fish per 1.39 lbs of food at a unit cost of $0.83/lb. This compares with costs of $0.82/lb and $1.01/lb in 1979 and 1980, respectively. In 1979-81, we were able to liberate 95%, 87%, and 95%, respectively, of the fish present in the pond.

When propagated fall chinook are released below the falls (1976 brood) or out-of-system (1977 brood), the run sizes are correspondingly diminished.

Recoveries of Ad+CWT coho reveal that there is no difference in survival between Cowlitz and Toutle stocks when reared to smolt size and released into Scoggins Creek.

Management Implications

1. To maintain maximum fall chinook production from the Willamette River, propagated fish must be released above the falls.
2. Continued marking and tagging will assist identification of this sub-stock in ocean and river fisheries and allow categorization of the run components.
3. There is no total survival difference between Cowlitz and Toutle stocks of coho when released as smolts into Scoggins Creek, a tributary of the upper Willamette River.

## INTRODUCTION

The Oregon Department of Fish and Wildlife (ODFW), guided by the Willamette Basin Fish Management Plan (ODFW 1980), has pursued a goal of achieving a minimum annual run of 100,000 adult Willamette River spring chinook entering the Columbia River by 1985. Results of current research and development studies relating to Willamette River spring chinook will aid in reaching this goal.

Studies with the fall salmon species (coho and fall chinook) seek to determine the extent of natural production, importance of hatchery supplementation, cost/benefit of the program, and compare survivals of stocks that spawn at different times.

Many of our studies with spring chinook seek to develop ways to improve survival of spring chinook smolts released from Willamette River hatcheries.

Results will provide criteria for smolt production, determine effects of off-station releases of hatchery smolts, and define the magnitude and distribution of adult harvest provided by each hatchery. Other studies are intended to show mortality effects associated with emigrant passage through a portion of the McKenzie River that has been diverted through hydro-power generators. Portland General Electric Company (PGE) has major responsibility for evaluating the efficiency of the fish protection system at the T.W. Sullivan Plant at Willamette Falls. This report summarizes current project results in tabulated form. Data were analyzed for brief sections that had immediate management uses.

## GENERAL METHODS

### Spring Chinook

Methods employed are described in Smith and Zakel 1981.

### Fall Salmon

Methods employed are described in Hansen and Williams 1979.

## SPRING CHINOOK SMOLT SURVIVAL STUDY - SOUTH SANTIAM HATCHERY

### PURPOSE

This study was designed to test the effects of trucking smolts directly from the hatchery to lower Willamette release sites. We hoped to improve survival by elimination or bypassing sources of juvenile mortality in the river between the hatchery and locations below Willamette Falls. The potential survival benefits and possible modification of homing instinct that this procedure may produce could then be defined. In addition, we released smolts in both spring and fall to determine time of release that would give highest survival rate to adults.

METHODS

We released ungraded groups of smolts marked Ad+CWT of the 1975-78 broods in the spring and fall at South Santiam Hatchery and below Willamette Falls(Smith and Zakel 1981).

RESULTS AND DISCUSSIONS

Preliminary adult return data from this study do not appear to display a consistant pattern (Tables 1, 2, 3 and 4). In some years, release of smolts in the fall promotes adult survival. In other years, we achieve better survival by releasing smolts in the spring. Flow conditions during downstream migration, relative smolt size and disease effects all may affect return of adults. However, preliminary analyses indicate that the standard smolt release criteria, consisting of release in the spring at upstream locations, is the least effective overall treatment tested (Table 5).

Trucking smolts to lower River areas for release primarily increases adult catch in lower river fisheries, but it also results in fewer adult returns to adult collection facilities. Reduced collection of adults from lower river releases of smolts likely results from the tendency of these fish to stray to many tributaries (Smith and Zakel 1981).

SPRING CHINOOK STOCK COMPARATIVE STUDY - MARION FORKS HATCHERY

PURPOSE

This study was prompted by observation of poor adult benefits from smolts produced at Marion Forks Hatchery (Smith and Zakel, 1981). The problem may be partially due to low water temperatures. Cold rearing water at the hatchery precludes fast growth of juveniles. The North Santiam River below Detroit and

Table 1. Freshwater fishery contribution and hatchery return of 1975-brood spring chinook from South Santiam Hatchery.

| Mean smolt size g/fish | fish/lb | Treatment | Smolts released | Return age | Freshwater Fishery catch Actual | Expanded | Hatchery return Origin | Stray | Total | Total Recovery Act. | Exp. | % surv. from Smolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49.9 | 9.1 | Fall release at Foster Dam | 98,256 | 3 | 1 | 22 | 6 | 1 | 7 | 8 | 29 | |
| | | | | 4 | 10 | 105 | 193 | 0 | 193 | 203 | 298 | |
| | | | | 5 | 14 | 79 | 125 | 3 | 128 | 143 | 207 | |
| | | | | 6 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | |
| | | | | Total | 25 | 206 | 325 | 4 | 329 | 355 | 535 | 0.544 |
| 43.2 | 10.5 | Fall release below Willamette Falls | 103,454 | 3 | 1 | 22 | 1 | 0 | 1 | 2 | 23 | |
| | | | | 4 | 30 | 362 | 7 | 20 | 27 | 57 | 389 | |
| | | | | 5 | 29 | 209 | 15 | 28 | 43 | 44 | 252 | |
| | | | | 6 | 1 | 3 | 0 | 0 | 0 | 1 | 3 | |
| | | | | Total | 61 | 596 | 23 | 48 | 71 | 104 | 667 | 0.644 |
| 41.2 | 11.0 | Spring release at Foster Dam | 95,708 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 3 | 41 | 29 | 0 | 29 | 32 | 70 | |
| | | | | 5 | 1 | 8 | 15 | 0 | 15 | 16 | 23 | |
| | | | | 6 | 1 | 8 | 1 | 0 | 1 | 2 | 9 | |
| | | | | Total | 5 | 57 | 45 | 0 | 45 | 50 | 102 | 0.107 |
| 36.9 | 12.2 | Spring release below Willamette Falls | 85,306 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 11 | 102 | 0 | 7 | 7 | 17 | 109 | |
| | | | | 5 | 12 | 87 | 3 | 37 | 40 | 52 | 127 | |
| | | | | 6 | 4 | 16 | 0 | 4 | 4 | 8 | 20 | |
| | | | | Total | 27 | 205 | 3 | 48 | 51 | 77 | 256 | 0.300 |

Table 2. Preliminary freshwater fishery contribution and hatchery return of 1976-brood spring chinook from South Santiam Hatchery.

| Mean smolt size g/fish | Mean smolt size fish/lb | Treatment | Smolts released | Return age | Freshwater Fishery catch Actual | Freshwater Fishery catch Expanded | Hatchery return Origin | Hatchery return Stray | Hatchery return Total | Total Recovery Act. | Total Recovery Exp. | % surv. from Smolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 39.1 | 11.6 | Fall release at Foster Dam | 84,995 | 3 | 0 | 0 | 12 | 0 | 12 | 12 | 12 | |
| | | | | 4 | 10 | 71 | 281 | 5 | 286 | 296 | 357 | |
| | | | | 5 | 14 | 79 | 86 | 6 | 92 | 106 | 171 | |
| | | | | 6 | 0 | 0 | -- | -- | -- | 0 | 0 | |
| | | | | Total | 24 | 150 | 379 | 11 | 390 | 414 | 540 | 0.635 |
| 40.2 | 11.3 | Fall release below Willamette Falls | 84,578 | 3 | 0 | 0 | 2 | 4 | 6 | 6 | 6 | |
| | | | | 4 | 12 | 85 | 18 | 50 | 68 | 80 | 153 | |
| | | | | 5 | 36 | 137 | 11 | 7 | 18 | 54 | 155 | |
| | | | | 6 | 2 | 6 | -- | -- | -- | 2 | 6 | |
| | | | | Total | 50 | 228 | 31 | 61 | 92 | 142 | 320 | 0.378 |
| 56.9 | 8.0 | Spring release at Foster Dam | 69,457 | 3 | 0 | 0 | 2 | 1 | 3 | 3 | 3 | |
| | | | | 4 | 7 | 45 | 179 | 2 | 181 | 188 | 226 | |
| | | | | 5 | 27 | 121 | 107 | 4 | 111 | 138 | 232 | |
| | | | | 6 | 0 | 8 | -- | - | -- | 0 | 0 | |
| | | | | Total | 34 | 166 | 288 | 7 | 295 | 329 | 461 | 0.664 |
| 50.1 | 9.1 | Spring release below Willamette Falls | 64,933 | 3 | 1 | 14 | 0 | 5 | 5 | 6 | 19 | |
| | | | | 4 | 35 | 244 | 9 | 151 | 160 | 195 | 404 | |
| | | | | 5 | 82 | 342 | 17 | 51 | 68 | 150 | 410 | |
| | | | | 6 | 1 | 3 | -- | -- | -- | 1 | 3 | |
| | | | | Total | 119 | 603 | 26 | 207 | 233 | 352 | 836 | 1.287 |

Table 3. Preliminary freshwater fishery contribution and hatchery return of 1977-brood spring chinook from South Santiam Hatchery.

| Mean smolt size g/fish | fish/lb | Treatment | Smolts released | Return age | Freshwater Fishery catch Actual | Freshwater Fishery catch Expanded | Hatchery return Origin | Hatchery return Stray | Hatchery return Total | Total Recovery Act. | Total Recovery Exp. | % surv. from Smolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 57.2 | 7.9 | Fall release at Foster Dam | 95,484 | 3 | 0 | 0 | 9 | 0 | 9 | 9 | 9 | |
| | | | | 4 | 10 | 59 | 104 | 4 | 108 | 118 | 167 | |
| | | | | 5 | 6 | 23 | -- | - | -- | 6 | 23 | |
| | | | | 6 | -- | -- | -- | -- | -- | -- | -- | |
| | | | | Total | 16 | 82 | 113 | 4 | 117 | 133 | 199 | 0.208 |
| 60.6 | 7.5 | Fall release below Willamette Falls | 66,099 | 3 | 1 | 7 | 2 | 4 | 6 | 7 | 13 | |
| | | | | 4 | 20 | 130 | 34 | 13 | 47 | 67 | 177 | |
| | | | | 5 | 29 | 139 | -- | -- | -- | 29 | 139 | |
| | | | | 6 | -- | -- | -- | -- | -- | -- | -- | |
| | | | | Total | 50 | 276 | 36 | 17 | 53 | 103 | 329 | 0.498 |
| 51.8 | 8.8 | Spring release at Foster Dam | 96,952 | 3 | 0 | 0 | 1 | 1 | 3 | 3 | 3 | |
| | | | | 4 | 7 | 46 | 53 | 0 | 53 | 60 | 99 | |
| | | | | 5 | 11 | 59 | -- | - | -- | 11 | 59 | |
| | | | | 6 | -- | -- | -- | - | -- | -- | -- | |
| | | | | Total | 18 | 105 | 54 | 1 | 55 | 73 | 160 | 0.165 |
| 49.8 | 9.1 | Spring release below Willamette Falls | 104,183 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 8 | 57 | 2 | 6 | 8 | 16 | 65 | |
| | | | | 5 | 15 | 90 | -- | - | - | 15 | 90 | |
| | | | | 6 | -- | -- | -- | - | - | -- | -- | |
| | | | | Total | 23 | 147 | 2 | 6 | 8 | 31 | 155 | 0.149 |

Table 4. Preliminary freshwater fishery contribution and hatchery return of 1978-brood spring chinook from South Santiam Hatchery.

| Mean smolt size g/fish | fish/lb | Treatment | Smolts released | Return age | Freshwater Fishery catch Actual | Expanded | Hatchery return Origin | Stray | Total | Total Recovery Act. | Exp. | % surv. from Smolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48.9 | 9.3 | Fall release at Foster Dam | 102,094 | 3 | 1 | 8 | 5 | 0 | 5 | 6 | 13 | |
| | | | | 4 | 1 | 9 | - | - | - | 1 | 9 | |
| | | | | 5 | - | - | - | - | - | - | -- | |
| | | | | 6 | - | - | - | - | - | - | -- | |
| | | | | Total | 2 | 17 | 5 | 0 | 5 | 7 | 22 | 0.022 |
| 52.0 | 8.7 | Fall release below Willamette Falls | 69,814 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 0 | 0 | - | - | - | 0 | 0 | |
| | | | | 5 | - | - | - | - | - | - | - | |
| | | | | 6 | - | - | - | - | - | - | - | |
| | | | | Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.000 |
| 84.8 | 5.4 | Spring release at Foster Dam | 59,352 | 3 | 0 | 0 | 6 | 0 | 6 | 6 | 6 | |
| | | | | 4 | 6 | 39 | - | - | - | 6 | 39 | |
| | | | | 5 | - | -- | - | - | - | - | -- | |
| | | | | 6 | - | -- | - | - | - | - | -- | |
| | | | | Total | 6 | 39 | 6 | 0 | 6 | 12 | 45 | 0.076 |
| 76.4 | 5.9 | Spring release below Willamette Falls | 60,609 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 4 | 35 | - | - | - | 4 | 35 | |
| | | | | 5 | - | -- | - | - | - | - | -- | |
| | | | | 6 | - | -- | - | - | - | - | -- | |
| | | | | Total | 4 | 35 | 0 | 0 | 0 | 4 | 35 | 0.058 |

Big Cliff dams is very cold throughout much of the year, particularly in thespring when peak salmon migrations occur. We know this cold water retards upstream movement of adults; juvenile salmon emigration may also be affected. We introduced a cold-water adapted strain of spring chinook to Marion Forks Hatchery to compare with the existing stock.

Table 5. Preliminary returns of South Santiam smolts marked Ad+CWT, through July 1982.

| Smolt release treatment | Adult contribution & return rates by brood | | | | Total % | Preliminary benefit ratio[c] |
|---|---|---|---|---|---|---|
| | a 1975 | a 1976 | b 1977 | b 1978 | | |
| Fall Foster | 0.54 | 0.64 | 0.21 | 0.02 | 1.41 | 1.38 |
| Fall Below | 0.64 | 0.38 | 0.50 | 0.00 | 1.52 | 1.49 |
| Spring Foster | 0.11 | 0.66 | 0.17 | 0.08 | 1.02 | 1 |
| Spring Below | 0.30 | 1.29 | 0.15 | 0.06 | 1.80 | 1.76 |

[a]Returns substantially complete.
[b]Partial returns only.
[c]Ratio of adult contribution and return in freshwater compared to standard smolt-release criteria (spring release at upriver locations).

## METHODS

Methods employed are described in Smith and Zakel 1981.

## RESULTS AND DISCUSSION

Initial adult returns from the release of tagged 1976- and 1977-brood smolts appear in Tables 6 and 7. Adult contributions of the 1977 brood North Santiam stock are the best in recent years. Prior to the rearing and release of the 1977 brood, several generations of juveniles liberated from Marion Forks had been shipped into the hatchery from other stations where warmer water was used to advance growth during early developmental stages. The 1977

Table 6. Preliminary freshwater recoveries of tagged adults, Carson/Willamette stock comparative study, Marion Forks Hatchery, 1976 brood.

| Mean smolt size g/fish | fish/lb | Treatment | Smolts released | Return age | Freshwater Fishery catch Actual | Expanded | Hatchery return Origin | Stray | Total | Total Recovery Act. | Exp. | % surv. from Smolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17.6 | 25.8 | Fall release Carson stock | 93,691 | 3 | 1 | 14 | 0 | 0 | 0 | 1 | 14 | |
| | | | | 4 | 1 | 7 | 4 | 1 | 5 | 6 | 12 | |
| | | | | 5 | 1 | 3 | 14 | 0 | 14 | 15 | 17 | |
| | | | | 6 | 0 | 0 | -- | - | -- | -- | -- | |
| | | | | Total | 3 | 24 | 18 | 1 | 19 | 22 | 43 | 0.049 |
| 30.8 | 14.7 | Spring release Carson stock | 144,770 | 3 | 1 | 14 | 1 | 0 | 1 | 2 | 15 | |
| | | | | 4 | 3 | 21 | 6 | 1 | 7 | 10 | 28 | |
| | | | | 5 | 2 | 11 | 24 | 4 | 28 | 30 | 39 | |
| | | | | 6 | 0 | 0 | -- | - | -- | 0 | 0 | |
| | | | | Total | 6 | 46 | 31 | 5 | 36 | 42 | 82 | 0.057 |
| 36.3 | 12.5 | Spring release North Santiam stock | 148,831 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 3 | 21 | 1 | 1 | 2 | 5 | 23 | |
| | | | | 5 | 3 | 8 | 4 | 3 | 7 | 10 | 15 | |
| | | | | 6 | 0 | 0 | - | - | 0 | 0 | 0 | |
| | | | | Total | 6 | 29 | 5 | 4 | 9 | 15 | 38 | 0.026 |

Table 7. Preliminary freshwater recoveries of tagged adults, Carson/Willamette stock comparative study, Marion Forks Hatchery, 1977 brood.

| Mean smolt size g/fish | Mean smolt size fish/lb | Treatment | Smolts released | Return age | Freshwater Fishery catch Actual | Freshwater Fishery catch Expanded | Hatchery return Origin | Hatchery return Stray | Hatchery return Total | Total Recovery Act. | Total Recovery Exp. | % surv. from Smolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.7 | 23.0 | Fall release Carson stock | 92,888 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 10 | 52 | 9 | 0 | 9 | 19 | 61 | |
| | | | | 5 | 1 | 9 | - | - | - | 1 | 9 | |
| | | | | 6 | -- | -- | - | - | - | -- | -- | |
| | | | | Total | 11 | 61 | 9 | 0 | 9 | 20 | 70 | 0.075 |
| 28.4 | 16.0 | Spring release Carson stock | 144,292 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 2 | 16 | 22 | 4 | 26 | 28 | 42 | |
| | | | | 5 | 14 | 83 | -- | - | -- | 14 | 83 | |
| | | | | 6 | -- | -- | -- | - | -- | -- | -- | |
| | | | | Total | 16 | 99 | 22 | 4 | 26 | 42 | 125 | 0.087 |
| 25.9 | 17.5 | Spring release North Santiam stock | 148,572 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 34 | 236 | 118 | 20 | 138 | 172 | 374 | |
| | | | | 5 | 113 | 592 | -- | -- | -- | 113 | 592 | |
| | | | | 6 | -- | -- | -- | -- | -- | -- | -- | |
| | | | | Total | 147 | 828 | 118 | 20 | 138 | 285 | 966 | 0.650 |

brood was spawned, incubated and reared entirely at Marion Forks, which may account for the sudden improvement of adult return. Fish incubated and reared entirely at Marion Forks appear to experience relatively few disease problems.

## OAKRIDGE-DEXTER HATCHERY EVALUATION

### PURPOSE

This study was designed to define an effective salmon-rearing program at the Oakridge-Dexter hatchery complex. We also hoped to determine effective size and time of release criteria for hatchery-reared spring chinook smolts (Smith and Zakel 1981).

### METHODS

Methods employed in this study are described in Smith and Zakel 1981. Release of tagged 1980-brood smolts in fall 1981 and spring 1982 completed the test schedule for smolt liberations.

### RESULTS AND DISCUSSIONS

Incomplete tag recovery information for the 1977 brood indicates that all groups of smolts are providing returns of adults (Table 8). Best-surviving groups were released in the spring. Ungraded smolts reared at Oakridge to 12 fish/lb and medium smolts reared at Dexter to 8 fish/lb for spring release have both contributed over 1% adult returns to freshwater. The most effective group of fall-released smolts of 1977 brood were the ungraded fish released from Dexter, despite the mortality of large fish within the treatment.

Table 8. Preliminary freshwater recoveries of tagged adults, Oakridge-Dexter grading and selective release study, 1977 brood.

| Mean smolt size g/fish | fish/lb | Treatment | Smolts released | Return Age | Freshwater Fishery catch Actual | Freshwater Fishery catch Expanded | Hatchery return Origin | Hatchery return Stray | Hatchery return Total | Total returns Act | Total returns Exp | % Survival from smolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49.3 | 9.2 | Fall release Dexter Ungraded[a] | 22,989 | 3 | 0 | 0 | 5 | 0 | 5 | 5 | 5 | |
| | | | | 4 | 8 | 49 | 102 | 1 | 103 | 111 | 152 | |
| | | | | 5 | 6 | 39 | -- | - | -- | 6 | 39 | |
| | | | | 6 | - | -- | -- | - | -- | -- | -- | |
| | | | | Total | 14 | 88 | 107 | 1 | 108 | 122 | 196 | 0.853 |
| 60.5 | 7.5 | Fall release Oakridge Graded Large | 23,974 | 3 | 0 | 0 | 6 | 0 | 6 | 6 | 6 | |
| | | | | 4 | 8 | 30 | 80 | 0 | 80 | 88 | 110 | |
| | | | | 5 | 7 | 31 | -- | - | -- | -- | -- | |
| | | | | 6 | - | -- | -- | - | -- | -- | -- | |
| | | | | Total | 15 | 61 | 86 | 0 | 86 | 101 | 147 | 0.613 |
| 31.3 | 14.5 | Fall release Oakridge Graded Medium | 28,845 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 1 | 8 | 47 | 0 | 47 | 48 | 45 | |
| | | | | 5 | 3 | 20 | -- | - | -- | 3 | 20 | |
| | | | | 6 | - | -- | -- | - | -- | -- | -- | |
| | | | | Total | 4 | 28 | 47 | 0 | 47 | 51 | 75 | 0.260 |
| 17.9 | 25.3 | Fall release Oakridge Graded Small | 29,375 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 1 | 8 | 15 | 0 | 15 | 16 | 23 | |
| | | | | 5 | 8 | 39 | -- | - | -- | 8 | 39 | |
| | | | | 6 | - | -- | -- | - | -- | -- | -- | |
| | | | | Total | 9 | 47 | 15 | 0 | 15 | 24 | 62 | 0.211 |
| 37.8 | 12.0 | Spring release Oakridge Ungraded | 30,190 | 3 | 0 | 0 | 5 | 0 | 5 | 5 | 5 | |
| | | | | 4 | 9 | 69 | 174 | 0 | 174 | 163 | 243 | |
| | | | | 5 | 17 | 85 | -- | - | -- | 17 | 85 | |
| | | | | 6 | -- | -- | -- | - | -- | -- | -- | |
| | | | | Total | 26 | 154 | 179 | 0 | 179 | 205 | 333 | 1.103 |
| 90.8 | 5.0 | Spring release Oakridge Graded Large | 32,835 | 3 | 0 | 0 | 5 | 0 | 5 | 5 | 5 | |
| | | | | 4 | 4 | 28 | 136 | 1 | 137 | 141 | 165 | |
| | | | | 5 | 7 | 35 | -- | - | -- | 7 | 35 | |
| | | | | 6 | - | -- | -- | - | -- | -- | -- | |
| | | | | Total | 11 | 63 | 141 | 1 | 142 | 153 | 205 | 0.624 |
| 56.8 | 8.0 | Spring release Dexter Graded Medium | 29,463 | 3 | 0 | 0 | 6 | 0 | 6 | 6 | 6 | |
| | | | | 4 | 10 | 76 | 158 | 0 | 158 | 168 | 234 | |
| | | | | 5 | 18 | 85 | -- | - | -- | 18 | 85 | |
| | | | | 6 | -- | -- | -- | - | -- | -- | -- | |
| | | | | Total | 28 | 161 | 164 | 0 | 164 | 192 | 325 | 1.103 |
| 32.4 | 14.0 | Spring release Dexter Graded Small | 30,927 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | 4 | 7 | 53 | 93 | 0 | 93 | 100 | 146 | |
| | | | | 5 | 26 | 141 | -- | - | -- | 26 | 141 | |
| | | | | 6 | -- | -- | -- | - | -- | -- | -- | |
| | | | | Total | 33 | 194 | 93 | 0 | 93 | 126 | 287 | 0.928 |

[a]Many of the larger smolts in this treatment susbtained post-tagging mortality.

Initial tag recoveries from 1978-brood releases appear in Table 9. While the point estimate of adult survival for the ungraded 1978-brood smolts released from Dexter in the fall currently stands at 0.127%, the 95% confidence interval based on estimates of tagged fish remaining in the pond at time of release ranges from 0.041% to 0.203%. Based on the excellent size and physical condition of these fish at release, we think it likely that the actual survival rate lies closer to the higher end of this range.

## McKENZIE HATCHERY EVALUATION

### PURPOSE

This study was patterned after the Oakridge/Dexter tests, involving groups of tagged smolts graded by size and released in both fall and spring. The variables examined were size and time of release. Only one rearing location (McKenzie Hatchery) was tested. The purpose of the test was to define smolt production and release criteria that maximize adult benefits.

### METHODS

Methods employed in this study are presented in Smith and Zakel 1981. The release of tagged 1980-brood smolts in fall 1981 and spring 1982 completes the third of a scheduled four-brood series of smolt liberations.

### RESULTS AND DISCUSSION

The 1978 brood of smolts tagged and released at McKenzie Hatchery were heavily infected with bacterial kidney disease (BKD). This may account for the initial poor returns from smolts relesed in the spring at this station (Table 10). Highest survival for the 1978 brood appears to be related to ungraded smolts released in the fall.

Table 9. Preliminary freshwater recoveries of tagged adults, Oakride-Dexter grading and selective release study, 1978 brood.

| Mean smolt size g/fish | fish/lb | Treatment | Smolts released | Return Age | Freshwater Fishery Catch Actual | Expanded | Hatchery return Origin | Stray | Total | Total returns Act | Exp | % Survival from smolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 79.6 | 5.7 | Fall release | 14,919 | 3 | 0 | 0 | 7 | 0 | 7 | 7 | 7 | |
| | | Dexter | | 4 | 2 | 12 | - | - | - | 2 | 12 | |
| | | Ungraded[a] | | 5 | - | -- | - | - | - | - | -- | |
| | | | | 6 | - | -- | - | - | - | - | -- | |
| | | | | Total | 2 | 12 | 7 | 0 | 7 | 9 | 19 | 0.127 |
| 52.2 | 8.7 | Fall release | 31,309 | 3 | 0 | 0 | 4 | 0 | 4 | 4 | 4 | |
| | | Oakridge | | 4 | 9 | 70 | - | - | - | 7 | 59 | |
| | | Graded | | 5 | - | -- | - | - | - | - | -- | |
| | | Large | | 6 | - | -- | - | - | - | - | -- | |
| | | | | Total | 9 | 70 | 4 | 0 | 4 | 13 | 74 | 0.236 |
| 15.8 | 28.7 | Fall release | 30,823 | 3 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | |
| | | Oakridge | | 4 | 3 | 26 | - | - | - | 3 | 26 | |
| | | Graded | | 5 | - | -- | - | - | - | - | -- | |
| | | Small | | 6 | - | -- | - | - | - | - | -- | |
| | | | | Total | 3 | 26 | 1 | 0 | 1 | 4 | 27 | 0.088 |
| 28.6 | 15.9 | Fall release | 31,303 | 3 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | |
| | | Oakridge | | 4 | 7 | 59 | - | - | - | 7 | 59 | |
| | | Graded | | 5 | - | -- | - | - | - | - | -- | |
| | | Medium | | 6 | - | -- | - | - | - | - | -- | |
| | | | | Total | 7 | 59 | 1 | 0 | 1 | 8 | 60 | 0.192 |
| 33.1 | 13.7 | Fall release | 30,873 | 3 | 0 | 0 | 2 | 0 | 2 | 2 | 2 | |
| | | Oakridge | | 4 | 9 | 77 | - | - | - | - | -- | |
| | | Ungraded | | 5 | - | -- | - | - | - | - | -- | |
| | | | | 6 | - | -- | - | - | - | - | -- | |
| | | | | Total | 9 | 77 | 2 | 0 | 2 | 11 | 79 | 0.256 |
| 59.7 | 7.6 | Spring release | 30,738 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Oakridge | | 4 | 14 | 102 | - | - | - | 14 | 102 | |
| | | Ungraded | | 5 | -- | -- | - | - | - | -- | -- | |
| | | | | 6 | -- | -- | - | - | - | -- | -- | |
| | | | | Total | 14 | 102 | 0 | 0 | 0 | 14 | 102 | 0.332 |
| 103.2 | 4.4 | Spring release | 28,955 | 3 | 1 | 8 | 4 | 0 | 4 | 5 | 12 | |
| | | Oakridge | | 4 | 14 | 108 | - | - | - | 14 | 108 | |
| | | Graded | | 5 | -- | -- | - | - | - | -- | -- | |
| | | Large | | 6 | -- | -- | - | - | - | -- | -- | |
| | | | | Total | 15 | 116 | 4 | 0 | 4 | 19 | 120 | 0.414 |
| 49.9 | 9.1 | Spring release | 30,726 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Dexter | | 4 | 24 | 169 | - | - | - | 24 | 169 | |
| | | Graded | | 5 | -- | -- | - | - | - | -- | -- | |
| | | Medium | | 6 | -- | -- | - | - | - | -- | -- | |
| | | | | Total | 24 | 169 | 0 | 0 | 0 | 24 | 169 | 0.550 |
| 28.4 | 16.0 | Spring release | 39,924 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | Dexter | | 4 | 9 | 61 | - | - | - | 9 | 61 | |
| | | Graded | | 5 | - | -- | - | - | - | - | -- | |
| | | Small | | 6 | - | -- | - | - | - | - | -- | |
| | | | | Total | 9 | 61 | 0 | 0 | 0 | 9 | 61 | 0.230 |

[a]Many tagged fish escaped through large-mesh screens at Dexter before the screens were replaced. In-pond sampling at time of release indicated only about 15,000 remained (95% CI = 9,356 to 22,194).

Table 10. Preliminary freshwater recoveries, McKenzie Hatchery Evaluation, 1978 brood.[a]

| Mean smolt size g/fish | fish/lb | Treatment | Return age | Freshwater Fishery catch Actual | Expanded | Hatchery return Origin | Stray | Total | Total Recovery Act. | Exp. | % surv. from Smolts |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 79.6 | 5.7 | Fall release Graded Large | 3 | 0 | 0 | 2 | 0 | 2 | 2 | 2 | |
| | | | 4 | 6 | 31 | - | - | - | 6 | 31 | |
| | | | 5 | - | -- | - | - | - | - | -- | |
| | | | 6 | - | -- | - | - | - | - | -- | |
| | | | Total | 6 | 31 | 2 | 0 | 2 | 8 | 33 | 0.105 |
| 30.7 | 14.8 | Fall release Graded Medium | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | 4 | 0 | 0 | - | - | - | 0 | 0 | |
| | | | 5 | - | - | - | - | - | - | - | |
| | | | 6 | - | - | - | - | - | 0 | 0 | |
| | | | Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.000 |
| 65.8 | 6.9 | Fall release Ungraded | 3 | 1 | 8 | 0 | 0 | 0 | 1 | 8 | |
| | | | 4 | 6 | 52 | - | - | - | 6 | 52 | |
| | | | 5 | - | -- | - | - | - | - | -- | |
| | | | 6 | - | -- | - | - | - | - | -- | |
| | | | Total | 7 | 60 | 0 | 0 | 0 | 7 | 60 | 0.178 |
| 137.6 | 3.3 | Spring release Graded Large | 3 | 0 | 0 | 2 | 0 | 2 | 2 | 2 | |
| | | | 4 | 1 | 9 | - | - | - | 1 | 9 | |
| | | | 5 | - | - | - | - | - | - | - | |
| | | | 6 | - | - | - | - | - | - | - | |
| | | | Total | 1 | 9 | 2 | 0 | 2 | 3 | 11 | 0.036 |
| 42.0 | 10.8 | Spring release Graded Medium | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | 4 | 0 | 0 | - | - | - | 0 | 0 | |
| | | | 5 | - | - | - | - | - | - | - | |
| | | | 6 | - | - | - | - | - | - | - | |
| | | | Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.000 |
| 116.4 | 3.9 | Spring release Ungraded | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | 4 | 3 | 14 | - | - | - | 3 | 14 | |
| | | | 5 | - | -- | - | - | - | - | -- | |
| | | | 6 | - | -- | - | - | - | - | -- | |
| | | | Total | 3 | 14 | 0 | 0 | 0 | 3 | 14 | 0.048 |

[a]These fish heavily infected with BKD.

## DOWNSTREAM-MIGRANT PROTECTION TESTS

## PGE's SULLIVAN PLANT

### PURPOSE

PGE installed a louver-guidance system in their P.T. Sullivan hydroelectric plant designed to divert downstream migrant salmonids along the face of the powerhouse, past 12 turbine intakes and into Unit 13, the last turbine. A profile wire screen installed in the penstock of Unit 13 diverts fish entering this unit into a bypass pipe, which empties into either the plant tailrace or a fish sampler. Tests were conducted to determine (1) bypass efficiency of the guidance system and (2) the injury rate for slamonids passing through the Unit 13 bypass.

### METHODS

PGE personnel continued tests to evaluate their fish protection system in 1982. One series of tests measured the efficiency of the louver-guidance facility. These "bypass" tests entailed releasing marked populations of anadromous fish into the forebay and counting smolts which subsequently entered the Unit 13 bypass sampler. These tests were repeated at various forebay levels, as available, to aid in defining effects of head on bypass efficiency. Marked smolt populations were also introduced directly into the Unit 13 penstock to determine how many of these fish were shunted from the turbine chamber into the bypass pipe and sampler via the bar screen (calibration rate). Estimated bypass efficiencies were calculated by dividing bypass rate by calibration rate.

ODFW personnel examined migrating smolts which entered the Sullivan Plant sampler, estimated injury sustained in transit through the downstream migrant-protection system, and conducted tests designed to quantify the sources and severity of injuries observed. Uninjured fish were collected in

the Sullivan Plant sampler, distinctly marked, held overnight and released into the Unit 13 turbine intake and into the bypass discharge to measure relative injury caused by the penstock screen. Recaptured fish were then subjectively rated by injury sustained in transit. Fish that showed at least 10% scale loss were designated as injured.

## RESULTS AND DISCUSSION

When populations of test fish were released directly into the turbine penstock, a high percentage of these fish were deflected into the sampler box, away from the turbine blades (Cramer 1982; Table 11). Similar populations of fish released at the forebay headracks were recaptured at rates of 81-90% when the forebay levels were low (elev. 52' and below), and the 1982 tests again indicated that this recapture efficiency may be reduced with high forebay (elev. 53' and above) levels (Table 12). Calculated bypass efficiencies indicate that over 90% of the fish which enter the Sullivan Plan at low forebay levels are transported to the entrance of Unit 13 (Table 13). We still have insufficient data to make judgements about effects of high forebay levels on bypass efficiency.

Overall injury rates ranged from 24% to 50%, and a high proportion of this injury usually appeared to occur in the sampler box (Table 14). Insufficient data were obtained to describe differential injury effects of higher forebay levels or debris load on the penstock screen, although we suspect these factors could affect physical condition of the bypassed smolts.

Table 11. Summary of capture efficiency (calibration) tests in the Unit 13 screen and trap, PGE's Sullivan Plant, spring, 1982.

| Species Tested | Rates of Recapture | |
|---|---|---|
| | Low Forebay Conditions | High Forebay Conditions |
| Spring Chinook | 98.2% | 99.3% |
| Steelhead | 88.0% | -- |
| Fall Chinook | 96.4% | -- |

Table 12. Average percentage recapture for groups of test fish released at the Sullivan Plant headracks, spring, 1982.

| Species Tested | Rates of Recapture | |
|---|---|---|
| | Low Forebay Conditions | High Forebay Conditions |
| Spring Chinook | 89.7% | 79.8% |
| Steelhead | 81.5% | -- |
| Fall Chinook | 95.9% | -- |

Table 13. Calculated bypass efficiencies for groups of test fish released into the Sullivan Plant forebay, spring, 1982.

| Species Tested | Rates of Recapture | |
|---|---|---|
| | Low Forebay Conditions | High Forebay Conditions |
| Spring Chinook | 91.3% | 80.3% |
| Steelhead | 92.6% | -- |
| Fall Chinook | 99.5% | -- |

Table 14. Preliminary summary of injury tests, PGE fish protection system, spring 1982.

| Species | Date of Test | Forebay Level | Injury Assigned to Turbine Screen | Injury Assigned to Sampler Box | Total Injury |
|---|---|---|---|---|---|
| Spring Chinook | Mar. 25 | Low | 9.7% | 33.2% | 42.9% |
| | Apr. 14 | High | 7.0% | 38.3% | 45.3% |
| Steelhead | May 25 | Low | 21.0% | 29.0% | 50.0% |
| | June 3 | Low | 21.3% | 32.5% | 53.8% |
| | June 4 | Low | 13.5% | 61.9% | 75.4% |
| Fall Chinook | May 26 | Low | 16.1% | 8.5% | 24.6% |
| | June 3 | Low | 21.3% | 39.2% | 60.5% |

## McKENZIE RIVER STUDIES

### PURPOSE

We began investigating the fish mortality effects of hydropower diversions on the McKenzie River in fall, 1980. Objectives of the study were to determine (1) timing of fish movement out of the upper McKenzie River and (2) fish mortality sustained by chinook smolts while passing through the portion of the river affected by power diversions.

### METHODS

A downstream-migrant trap at Leaburg Dam was operated daily to monitor fish movement out of the upper McKenzie River. In late March 1982, we cold-branded five groups of about 30,000 each spring chinook smolts and released these groups at five locations in and around the Eugene Water and Electric Board (EWEB) hydropower complex on the McKenzie River (locations A-E, Fig. 1). From April 1 through May 11, fish counters sampled downstream migrants from these releases as they entered PGE's Sullivan Plant sampler at Willamette Falls. Relative survival rates of each group were calculated by comparing relative quantities of migrants from each release group.

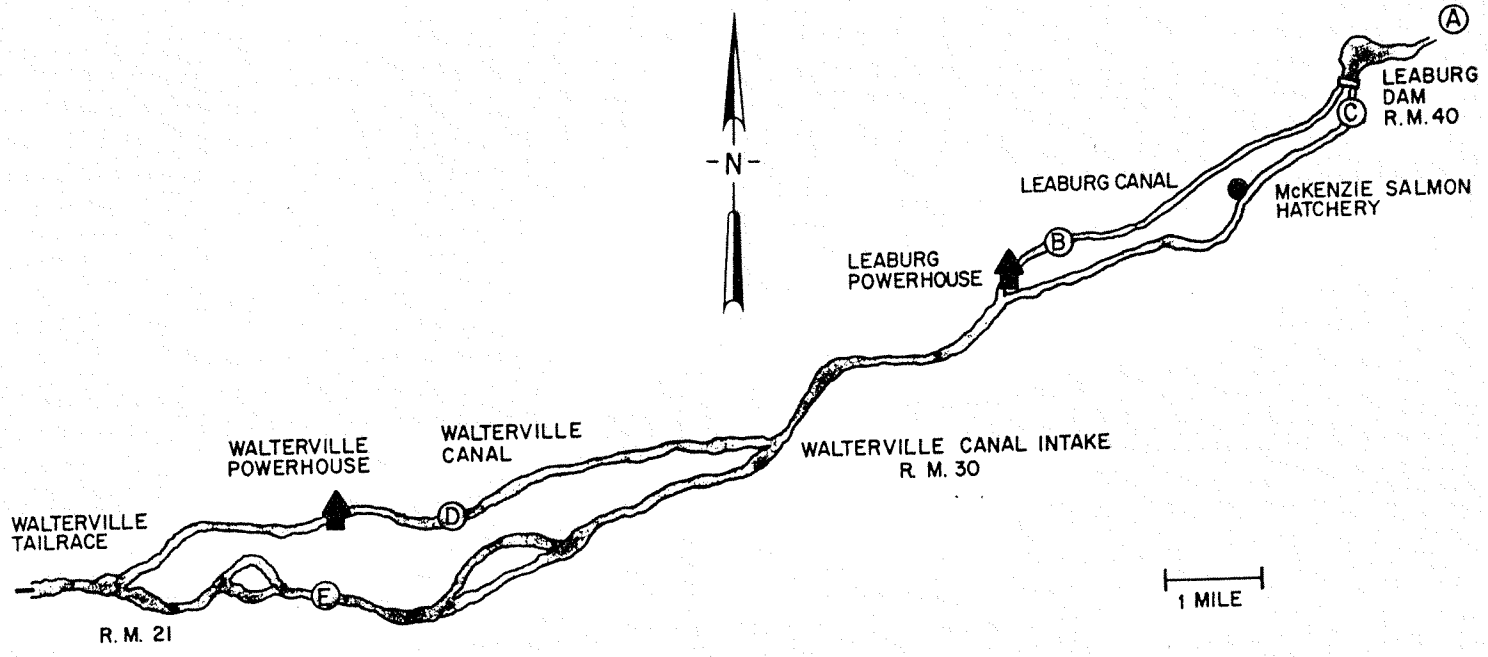


Fig. 1. Diagram of McKenzie River illustrating relative locations of EWEB's water diversion projects and fish release areas, 1982.

## MORTALITY TEST RESULTS AND DISCUSSION

Highest losses were sustained by the smolts released above Leaburg Dam (Table 15), although many of the fish released into Leaburg Canal were also killed. A significant mortality was sustained by the smolts released into Walterville Canal, but the similarity between recapture rates of the control (Group E) and Leaburg Hatchery (Group C) releases indicate that, at the flows tested, few migrants were apparently diverted out of the river into Walterville Canal.

## DOWNSTREAM MIGRATION

Wild chinook, either as fry or smolts, move out of the McKenzie River in all months of the year (Table 16). July, August and September are the low points in downstream movement.

# FALL SALMON STUDIES

## PURPOSE

The Willamette Salmon Studies include investigations of the success of introduced populations of two fall salmon species, coho and fall chinook. The purposes of the investigations with fall chinook are to collect life history information for the continuity of a data base, to measure the magnitude of natural and artificial production, and evaluate the cost/benefit of the pond rearing program. The purpose of the coho investigation is to determine the contribution and survival of two stocks of Columbia Basin coho reared to smolt size and released into the upper Willamette Basin. Details of past enhancement programs and specific research objectives are found in Hansen and Williams (1979). Study objectives referred to in this report are:

Table 15. Summary of results of mortality tests conducted at EWEB's power canals on the McKenzie River, 1982.

| | | % Loss By Group Compared To[a] | |
|---|---|---|---|
| | | Control Group E[a] | Leaburg Hat. Group C |
| Group A: | Thompsons Lane Release | | |
| | 30,816 Released / 1,395 Recaptured = 4.527% Recovery | 4.527 / 6.188 = 26.8% Loss | 4.527 / 6.478 = 30.1% Loss |
| Group B: | Leaburge Canal Release | | |
| | 31,341 Released / 1,458 Recaptured = 4.652% Recovery | 4.652 / 6.188 = 24.8% Loss | 4.527 / 6.478 = 28.2% Loss |
| Group C: | Leaburg Hatchery Release | | |
| | 30,008 Released / 1,944 Recaptured = 6.478% Recovery | 6.478 / 6.188 = 4.7% Gain[a] | - Used as control[a] |
| Group D: | Walterville Canal Release | | |
| | 30,877 Released / 1,733 Recaptured = 5.613% Recovery | 5.613 / 6.188 = 9.3% Loss | 5.613 / 6.478 = 13.4% Loss |
| Group E: | Hendricks Bridge Release | | |
| | 31,127 Released / 1,926 Recaptured = 6.188% Recovery | = Control | 6.188 / 6.478 = 4.5% Loss[a] |

[a]We found no significant differences in recapture rate between Group C and Group E smolts. Thus, it is possible to use either group for a basis for comparison of relative survival.

Table 16. Catch of small salmonids at Leaburg Dam trap, 1980-82.

| | 1980 | | | | | | | 1981 | | | | | | | 1982 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Chinook | | | Steelhead | | Trout | | Chinook | | | Steelhead | | Trout | | Chinook | | | Steelhead | | Trout | |
| | Hatchery | Wild Fry | Wild Smolt | Hatchery | Wild | Ct | Rb | Hatchery | Wild Fry | Wild Smolt | Hatchery | Wild | Ct | Rb | Hatchery | Wild Fry | Wild Smolt | Hatchery | Wild | Ct | Rb |
| Jan. | | | | | | | | 0 | 4 | 11 | 0 | 0 | 2 | 14 | 0 | 4 | 10 | 0 | 0 | 1 | 7 |
| Feb. | | | | | | | | 0 | 33 | 10 | 0 | 0 | 0 | 4 | 0 | 331 | 5 | 0 | 0 | 2 | 5 |
| Mar. | | | | | | | | 1,599 | 751 | 13 | 0 | 0 | 4 | 17 | 1,784 | 227 | 2 | 0 | 0 | 4 | 5 |
| Apr. | | | | | | | | 45 | 157 | 9 | 561 | 79 | 4 | 35 | 2 | 4 | 0 | 0 | 8 | 6 | 48 |
| May | | | | | | | | 108 | 95 | 16 | 4,633 | 1,431 | 52 | 77 | 4 | 201 | 0 | 2,605 | 290 | 10 | 45 |
| June | | | | | | | | 0 | 32 | 5 | 21 | 1 | 0 | 3 | 1 | 33 | 0 | 164 | 47 | 3 | 44 |
| July | | | | | | | | 0 | 13 | 0 | 1 | 0 | 0 | 5 | 1 | 4 | 0 | 0 | 0 | 0 | 13 |
| Aug. | | | | | | | | 0 | 10 | 2 | 0 | 0 | 1 | 5 | 0 | 0 | 5 | 1 | 0 | 0 | 6 |
| Sept. | Sampling Began | | | | | | | 0 | 0 | 7 | 0 | 0 | 9 | 6 | | | | | | | |
| Oct. | 98 | 0 | 12 | 1 | 0 | 0 | 13 | 0 | 17 | 0 | 1 | 19 | 21 | 0 | | | | | | | |
| Nov. | 2,313 | 0 | 117 | 0 | 0 | 10 | 250 | 1,662 | 0 | 18 | 0 | 1 | 1 | 25 | | | | | | | |
| Dec. | 0 | 0 | 15 | 0 | 0 | 3 | 31 | 0 | 0 | 9 | 0 | 0 | 2 | 40 | | | | | | | |

1. Determine the magnitude of the natural and propagated portions of the Tule fall chinook run above Willamette Falls.

2. Determine the need and value of supplementing naturally-produced fall chinook with propagated fish.

3. Determine the contribution and survival of the Cowlitz and Toutle stocks of coho reared at Columbia River hatcheries and released into Scoggins Creek.

This document reports activities and results from 1979 to 1981 (October 1979 to September 1981).

1981 is the third year of a nine year evaluation study and is one part of a larger hatchery evaluation being conducted by the National Marine Fisheries Service.

## METHODS

### Objective 1

Some modifications have been made to the methods as originally explained in the project proposal. The evaluation uses a mark-recapture technique to determine the proportion of propagated fish in the run. If the total run is greater than the estimated number of propagated fish, the additional fish are considered to be from natural production. Each production lot (brood year) of propagated fish has only a small proportion marked (about 5%), but this proportion varies from year to year. Fall chinook mature and return to freshwater at four different ages (primarily age 3 and age 4). Therefore, any run year may contain fish from four brood years, each with different marked protions. Some method must be used to determine the age structure to

assign the correct marked proportion for expansion. Originally carcass surveys on the spawning grounds were going to be done to obtain scales for aging. We've now installed a trap at Willamette Falls on one of three legs of the fishway. Consequently, a sample of the 1981 run was randomly subsampled for descriptive and demographic characteristics and all Ad+CWT marked fish collected were sacrificed for decoding.

Samples were expanded based on marked to unmarked fish counts to estimate the total number of each marked group in the entire 1981 run. These are based on each marked groups' proportional representation in the entire sample, and the marked proportion of each group at release.

Previous to 1981 the fish counts at the fishway recorded observations on ad-marked fall chinook passing the viewing chamber. These observations were not designed to give as accurate a measure of marked fish passage as the present sampling technique. However, the data can be used to generally determine the run composition for the age-3 adults in 1979 and 80. Since no Ad+CWT fish were captured at the fishway, strays are not identified during these two years.

Additional information has been gathered to add to the data base previously established. These data include sex ratios, age composition, age-specific lengths, redd counts and spawning distribution.

Objective 2

As part of the cost/benefit analysis annual production statistics are recorded of the pond rearing program. This report will summarize the first three brood years of production at the pond facility.

Fall chinook were not released in the upper river area for two years to determine the effect on run size by elimination of the propagated portion (Hansen 1978). Returns in 1979-81 reflect the resulting run size changes.

Objective 3

No changes have been made since the proposal was documented.

RESULTS

Objective 1

Releases of marked fish from Stayton Pond have varied from 4.3 to 6.3% of the population during the first three years of the evaluation (Table 17).

The first year of marked adult returnees (age-3) from the evaluation groups returned in 1981. Observation of 9,812 migrating chinook revealed that 447 or 4.56% were marked. Since the total run was 17,928 chinook, 817 of these were then marked fish. One spring chinook was found in our trap sample and it is considered to be only a stray and not representative of the entire production, resulting in 816 marked fall chinook in the run. Several experimental groups of marked fall chinook and strays from out of system (see Appendix Table 1 for details), were present in the run. The estimated number of fish from each propagated group is given in Table 18.

Table 17. Summary of fall chinook releases from Stayton Pond into the Willamette River, 1978-80 broods.

| Brood year | Release period | Size | RELEASES Unmarked | Adipose marked with CWT | Adipose marked without CWT | Total | Proportion adipose marked |
|---|---|---|---|---|---|---|---|
| 1978 | 5/7-29/79 | 6.8 gr | 4,394,794 | 287,097 | 9,794 | 4,691,685 | 6.3% |
| 1979 | 4/28-6/21/80 | 5.2 gr | 6,062,813 | 282,039 | 3,843 | 6,348,695 | 4.5% |
| 1980 | 4/28-6/15/81 | 6.1 gr | 5,649,743 | 245,499 | 7,489 | 5,902,731 | 4.3% |

Table 18. Estimated numbers of propagated fish in the run of fall chinook passing Willamette Falls, 1981.

| Origin | No. Captured | Estimated No. in Run |
|---|---|---|
| Willamette River Evaluation releases | 83 | 8,870 |
| Willamette River Experimental groups | 39 | 258 |
| Strays from other rivers | 4 | 577 |
| Total propogated fish | 126 | 9,705 |

Table 19 shows the magnitude of the natural and propagated portions of the 1981 run. Table 20 shows the same categories but based on age-3 adults for the run years 1979 and 1980.

Table 19. Estimated composition of the 1981 fall chinook salmon run passing Willamette Falls.

| Origin | Number | Proportion of entire run | Proportion of Willamette released fish |
|---|---|---|---|
| All fall chinook | 17,928 | 100% | -- |
| Strays | 577 | 3.2% | |
| Willamette River releases | 17,351 | 96.8% | 100% |
| Willamette River propagated | 9,128 | 50.9% | 52.6% |
| Willamette River natural | 8,223 | 45.9% | 47.4% |

Table 20. Estimated composition of fall chinook run passing Willamette Falls, 1979 and 1980.

| Run year and origin | Number[a] | Proportion |
|---|---|---|
| 1979 | | |
| Propagated | 3,651 | 51% |
| Natural | 3,515 | 49% |
| 1980 | | |
| Propagated | 171 | 5% |
| Natural | 3,464 | 95% |

[a]All fish are age-3 adults only.

Demographic characteristics of the fall chinook spawning populations of 1979-81 are given in Tables 21-23.

Table 21. Age composition (percent) of fall chinook from the Willamette Basin determined from scales recovered from spent carcasses, 1979-81.

| Year and area | Sample size | Age 2 | 3 | 4 | 5 | Yearling[a] |
|---|---|---|---|---|---|---|
| 1979 | | | | | | |
| Clackamas R. | 75 | 0 | 83 | 15 | 1 | 1 |
| Above falls | 172 | 1 | 72 | 24 | 3 | 0 |
| Total | 247 | 1 | 75 | 22 | 2 | <1 |
| 1980 | | | | | | |
| Clackamas R. | 33 | 0 | 27 | 70 | 0 | 3 |
| Above falls | 252 | 5 | 44 | 49 | 1 | 1 |
| Total | 285 | 4 | 43 | 52 | <1 | 1 |
| 1981 | | | | | | |
| Clackamas R. | 19 | 0 | 68 | 32 | 0 | 0 |
| Above falls | 779 | 8 | 83 | 9 | <1 | 0 |
| Total | 798 | 8 | 82 | 10 | <1 | 0 |

[a]Refers to age at downstream smolt migration years past brood year (Gilbert-Rich designation of $X_2$). These are usually considered to be spring chinook.

Table 22. Sex composition of the fall chinook spawning population in the Willamette River Basin, 1979-81.

| Run Year | Percent by sex Male | Female | Ratio |
|---|---|---|---|
| 1979 | 65 | 35 | 1.9:1 |
| 1980 | 49 | 51 | 1:1 |
| 1981 | 63 | 37 | 1.7:1 |

Table 23. Age-specific lengths of Ad+CWT marked fall chinook captured at Willamette Falls, 1981.

| Stock | Age | No. fish sampled | Length (cm) Average | 95% C.I. | Range |
|---|---|---|---|---|---|
| Tule | 2 | 7 | 59.1 | ± 3.4 | 52-66 |
| Tule | 3 | 75 | 79.5 | ± 2.3 | 61-95 |
| Tule | 4 | 20 | 92.0 | ± 2.6 | 75-102 |
| Cowlitz | 4 | 17 | 74.6 | ± 3.4 | 57-86 |

The magnitude and distribution of fall chinook spawning activity in 1979-81 is detailed in Appendix Tables 2-4.

Objective 2

Results of the fish culture operations at the pond complex are summarized in Table 24.

Table 24. Summary information of fall chinook pond culture program in the Willamette Valley, 1978-80 broods.

| Production Category | Brood Year 78 | 79 | 80 |
|---|---|---|---|
| | ----------1,000's---------- | | |
| No. fish started in pond | 8,962 | 9,188 | 7,309 |
| lbs. fish started | 8.5 | 8.4 | 6.8 |
| [a]No. of fish released | 4,692 | 6,349 | 5,903 |
| lbs. fish released | 70.5 | 73.0 | 79.0 |
| Estimated No. not released | 274 | 817 | 327 |
| Net gain in lbs (released) | 62.0 | 64.6 | 72.2 |
| | ----------actual---------- | | |
| Food conversion (fish released) | 1:1.83 | 1:1.55 | 1:1.39 |
| (all fish in pond) | 1:1.72 | 1:1.35 | 1:1.31 |
| Costs Total | $51,000 | $65,477 | $60,076 |
| per lb released | $ 0.82 | $ 1.01 | $ 0.83 |
| Percent released | | | |
| [b] inclusive | 52.4 | 69.1 | 80.8 |
| [c] from rearing pond | 94.5 | 88.6 | 94.8 |

[a]Rearing pond cannot be completely drained, therefore not all fish are released.
[b]No fish started at fry stage - no. smolts released.
[c]No. fish put into rearing pond as fingerling - no. smolts released.

The run size fluctuations for the 1979 and 80 run years trended downward, with increases recorded in 1981 (Table 25).

Table 25. Escapement of fall chinook adults and jacks over Willamette Falls, 1972-81.

| Year | Adults | Jacks | Total |
|---|---|---|---|
| 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 | 465 | 17,902 |
| 1979 | 9,905 | 436 | 10,341 |
| 1980 | 7,760 | 625 | 8,385 |
| 1981 | 16,834 | 1,088 | 17,928 |
| 10-Year average 1972-1981 | 20,722 | 568 | 21,290 |

Objective 3

Recovery data of marked coho (Table 26) is complete except for the final expansion of the Columbia River gill net fishery. Comparison of survivals can be made with the available data (Table 27).

Table 26. Numbers of marked coho recoveries from stock comparison tests conducted at Scoggins Creek, tributary of upper Willamette River.

| Brood year and stock | Total | Ocean | | Freshwater | |
|---|---|---|---|---|---|
| | | Commercial | Sport | Fisheries | Escapement |
| 1975 | | | | | |
| Toutle | 943 | 533 | 230 | 10 [a] | 170 |
| Cowlitz | 187 | 63 | 98 | (11)[a] | 15 |
| 1976 | | | | | |
| Toutle | 545 | 394 | 83 | (18)[a] | 50 |
| Cowlitz | 1,219 | 606 | 367 | (61)[a] | 185 |
| 1977 | | | | | |
| Toutle | 679 | 329 | 175 | (30)[a] | 145 |
| Cowlitz | 685 | 164 | 296 | (87)[a] | 138 |

[a]Columbia River gill net fishery includes preliminary expansions only.

Table 27. Summary of survivals of two stocks of Columbia River coho smolts released into Scoggins Creek, tributary upper Willamette River.

| Stock | No. Released | No. Recovered[a] | Survival |
|---|---|---|---|
| Cowlitz | 238,993 | 2,091 | 0.88% |
| Toutle | 240,706 | 2,167 | 0.90% |

[a]Columbia River gill net fishery includes preliminary expansions only.

## DISCUSSION

Changes in the structure of the objectives for the next year will result in the study based on these job objectives:

Objective 1 -- Determine the magnitude of the natural and propagated portions of the Tule fall chinook run above Willamette Falls.

Objective 2 -- Determine the benefits from naturally produced Tule stock to ocean and river fisheries.

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

Objective 4 -- Compile data relative to the past introduction of coho salmon in the Willamette River system and submit report analyzing data to determine the coho production potential of the system.

## REFERENCES


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Hansen, H.L. and R.H. Williams. 1978. Stock Assessment and Enhancement of Fall Salmon Species in the Willamette River System. Annual Progress Report. Columbia River Development Program, ODFW, Research Section. 46p.

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Oregon Department of Fish and Wildlife. 1980. Willamette Basin Fish Management Plan. Portland, Oregon. 19p.

Smith, E.M. and J.C. Zakel. 1981. Willamette River Spring Chinook Evaluation. Progress Report, Oregon Department of Fish and Wildlife, Corvallis. 32p.

# APPENDIX

Appendix Table 1. Numbers of stray fall chinook captured at Willamette Falls, 1981.

| Tag Code | Origin | No. Captured | Estimated total in run[a] |
|---|---|---|---|
| 03-40/02 | Big Creek | 1 | 6 |
| 03-48/01 | Spring Creek | 1 | 6 |
| 07-17/04 | Big Creek | 2 | 13 |

[a] Expansion factor = 6.48

Appendix Table 2. Spawning surveys of fall chinook salmon in the Willamette River system, October 2-4, 1979.

| River | River section: Reference points | River km | Redds | Km surveyed | Redds/km |
|---|---|---|---|---|---|
| Willamette River | Newberg to Wheatland Ferry | 80.5-115.7 | 51 | 35.2 | 1.4 |
| | Wheatland Ferry to Salem | 115.7-135.2 | 92 | 19.5 | 4.7 |
| | Salem to Independence | 135.2-154.6 | 6 | 19.4 | 0.3 |
| | Independece to Albany | 154.6-192.0 | 40 | 37.4 | 1.1 |
| | Albany to Marys R. | 192.0-212.6 | 4 | 20.6 | 0.2 |
| | Marys R. to American Can Co. (Concrete water intake structure) | 212.6-237.2 | 24 | 24.6 | 1.0 |
| | American Can Co. water intake to Harrisburg | 237.2-259.4 | 68 | 22.2 | 3.1 |
| | Harrisburg to McKenzie R. | 259.4-281.3 | 124 | 21.9 | 5.7 |
| | McKenzie R. to Jct. Coast & Middle Forks | 281.3-300.9 | 5 | 19.6 | 0.3 |
| | Total | | 414 | 220.4 | 1.9 |
| Middle Fork Willamette R. | Mouth to Fall Cr. | 8.0- 18.2 | 19 | 18.2 | 1.0 |
| | Fall Cr. to Dexter Dam | 18.2- 27.0 | 21 | 8.8 | 2.4 |
| | Total | | 40 | 27.0 | 1.5 |
| Coast Fork Willamette R. | Mouth to Row R. | 0.0- 33.3 | 0 | 33.3 | 0 |
| | Row R. to Cottage Grove Res. | 33.3- 47.8 | 1 | 14.5 | 0.1 |
| | Total | | 1 | 47.8 | 0.1 |
| Row R. | Mouth to Dorena Dam | 0.0- 12.2 | 0 | 12.2 | 0 |
| | Total | | 0 | 12.2 | 0 |
| Mill Cr.[a] | Mouth to Jct. of Stayton Ditch | 0.0- 35.4 | 305 | 35.4 | 8.6 |
| | Total | | 305 | 35.4 | 8.6 |

[a] *Includes 87 redds in 4.8 km of Shelton Ditch.*

Appendix Table 2. (continued)

| River | River section: Reference points | River km | Redds | Km surveyed | Redds/km |
|---|---|---|---|---|---|
| McKenzie R. | Mouth to Interstate 5 Br. | 0.0- 7.1 | 16 | 7.1 | 2.3 |
| | Interstate Br. to Mohawk R. | 7.1- 17.2 | 53 | 10.1 | 5.2 |
| | Mohawk R. to Hendricks Br. | 17.2- 33.8 | 80 | 16.6 | 4.8 |
| | Total | | 149 | 33.8 | 4.4 |
| Calapooia R. | Mouth to Corvallis Hwy. Br. | 0.0- 13.2 | -- | -- | -- |
| | Corvallis to 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 | 199 | 5.1 | 39.0 |
| | OERR Br. to Interstate 5 Br. | 5.1- 10.3 | 204 | 5.2 | 39.2 |
| | Interstate 5 Br. to Jefferson Br. | 10.3- 15.4 | 142 | 5.1 | 27.8 |
| | Jefferson Br. to Jct. of N. & S. Santiam R. | 15.4- 18.8 | 137 | 3.4 | 40.3 |
| | Total | | 682 | 18.8 | 36.3 |
| North Santiam R. | Mouth to First Hwy. Br. | 0.0- 4.7 | 35 | 4.7 | 7.4 |
| | Hwy. Br. to SPRR Br. | 4.7- 17.9 | 55 | 13.2 | 4.2 |
| | SPRR Br. to Stayton Br. | 17.9- 26.9 | 15 | 9.0 | 1.7 |
| | Stayton Br. to L.N. Fork | 26.9- 43.0 | 9 | 17.0 | 0.5 |
| | Total | | 114 | 43.0 | 2.7 |
| South Santiam R. | Mouth to Crabtree Hwy. Br. | 0.0- 12.2 | 406 | 12.2 | 33.3 |
| | Crabtree Hwy. Br. to Lebanon Br. | 12.2- 29.4 | 343 | 17.2 | 19.9 |
| | Lebanon Br. to Lebanon Dam | 29.4- 33.5 | 6 | 4.1 | 1.5 |
| | Lebanon Dam to Foster Dam | ~~33.5- 60.7~~ | 37 | 27.2 | 1.4 |
| | Total | | 792 | 60.7 | 13.0 |
| Thomas Cr. | Mouth to County Road Br. | 0.0- 3.5 | 0 | 3.5 | 0 |
| | County Rd. Br. to Covered Br. above Scio | 3.5- 19.3 | 0 | 15.8 | 0 |
| | Total | | 0 | 19.3 | 0 |

Appendix Table 2. (continued)

| River | River section: Reference points | River km | Redds | Km surveyed | Redds/km |
|---|---|---|---|---|---|
| Crabtree Cr. | Mouth to SPRR Br. | 0.0- 6.0 | 0 | 6.0 | 0 |
| | SPRR Br. to Transmission Lines | 6.0- 15.9 | 0 | 9.9 | 0 |
| | Total | | 0 | 15.9 | 0 |
| Molalla R. | Mouth to Hwy. 99E Br. | 0.0- 5.8 | 29 | 5.8 | 5.0 |
| | Hwy. 99E Br. to Goods Br. | 5.8- 9/7 | 33 | 3.9 | 8.5 |
| | Goods Br. to SPRR Br. | 9.7- 16.3 | 41 | 6.6 | 6.2 |
| | SPRR Br. to Hwy. 213 Br. | 16.3- 23.2 | 7 | 6.9 | 1.0 |
| | Hwy. 213 Br. to Feyer Pk. | 23.2- 29.9 | 0 | 6.7 | 0 |
| | Feyer Pk. to Robbins Rd. | 29.9- 33.3 | 2 | 3.4 | 0.6 |
| | Robbins Rd. to N.F. Molalla | 33.3- 42.6 | 7 | 9.3 | 0.8 |
| | Total | | 119 | 42.6 | 2.8 |
| | Total Above Willamette Falls | | 2,616 | 543.1 | 4.8 |
| Clackamas R. | Mouth to 82nd Ave. Bridge | 0.0- 2.0 | 5 | 2.0 | 2.5 |
| | 82nd Ave. Br. to Carver Bridge | 2.0- 13.2 | 93 | 11.2 | 13.9 |
| | Carver Br. to Barton Bridge | 13.2- 22.2 | 55 | 9.0 | 6.1 |
| | Barton Br. to Eagle Creek | 22.2- 27.8 | 15 | 5.6 | 2.7 |
| | Eagle Cr. to River Mill | 27.8- 38.0 | 28 | 10.2 | 2.7 |
| | Total Clackamas R. | | 196 | 38.0 | 5.2 |
| | TOTAL WILLAMETTE SYSTEM | | 2,812 | 619.0 | 4.5 |

Appendix Table 3. Spawning surveys of fall chinook salmon in the Willamette River system, Sept. 15-Oct. 15, 1980.

| River | River section: Reference points | River km | Redds | Km surveyed | Redds/km |
|---|---|---|---|---|---|
| Willamette River | Newberg to Wheatland Ferry | 80.5-115.7 | 170 | 35.2 | 4.8 |
| | Wheatland Ferry to Salem | 115.7-135.2 | 218 | 19.5 | 11.2 |
| | Salem to Independence | 135.2-154.6 | 11 | 19.4 | 0.6 |
| | Independence to Albany | 154.6-192.0 | 43 | 37.4 | 1.1 |
| | Albany to Marys R. | 192.0-212.6 | 2 | 20.6 | 0.1 |
| | Marys R. to American Can Co. (Concrete water intake structure) | 212.6-237.2 | 10 | 24.6 | 0.4 |
| | American Can Co. water intake to Harrisburg | 237.2-259.4 | 10 | 22.2 | 0.5 |
| | Harrisburg to McKenzie R. | 259.4-281.3 | 10 | 21.9 | 0.5 |
| | McKenzie R. to Jct. Coast & Middle Forks | 281.3-300.9 | 1 | 19.6 | 0.1 |
| | Total | | 475 | 220.4 | 2.2 |
| Middle Fork Willamette R. | Mouth to Fall Cr. | 8.0- 18.2 | 0 | 18.2 | 0 |
| | Fall Cr. to Dexter Dam | 18.2- 27.0 | 11 | 8.8 | 1.3 |
| | Total | | 11 | 27.0 | 0.4 |
| Coast Fork Willamette R. | Mouth to Row R. | 0.0- 33.3 | 3 | 33.3 | 0.1 |
| | Row R. to Cottage Grove Res. | 33.3- 47.8 | 1 | 14.5 | 0.1 |
| | Total | | 4 | 47.8 | 0.1 |
| Row R. | Mouth to Dorena Dam | 0.0- 12.2 | 0 | 12.2 | 0 |
| | Total | | 0 | 12.2 | 0 |
| Mill Cr.[a] | Mouth to Jct. of Stayton Ditch | 0.0- 35.4 | 214 | 35.4 | 6.0 |
| | Total | | 214 | 35.4 | 6.0 |

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

Appendix Table 3. (continued)

| River | River section: Reference points | River km | Redds | Km surveyed | Redds/km |
|---|---|---|---|---|---|
| McKenzie R. | Mouth to Interstate 5 Br. | 0.0- 7.1 | 13 | 7.1 | 1.8 |
| | Interstate Br. to Mohawk R. | 7.1- 17.2 | 48 | 10.1 | 4.8 |
| | Mohawk R. to Hendricks Br. | 17.2- 33.8 | 51 | 16.6 | 3.1 |
| | Total | | 112 | 33.8 | 3.3 |
| Calapooia R. | Mouth to Corvallis Hwy. Br. | 0.0- 13.2 | -- | -- | -- |
| | Corvallis to 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 | 353 | 5.1 | 69.2 |
| | OERR Br. to Interstate 5 Br. | 5.1- 10.3 | 285 | 5.2 | 54.8 |
| | Interstate 5 Br. to Jefferson Br. | 10.3- 15.4 | 209 | 5.1 | 41.0 |
| | Jefferson Br. to Jct. of N. & S. Santiam R. | 15.4- 18.8 | 87 | 3.4 | 25.6 |
| | Total | | 934 | 18.8 | 49.7 |
| North Santiam R. | Mouth to First Hwy. Br. | 0.0- 4.7 | 3 | 4.7 | 0.6 |
| | Hwy. Br. to SPRR Br. | 4.7- 17.9 | 29 | 13.2 | 2.2 |
| | SPRR Br. to Stayton Br. | 17.9- 26.9 | 12 | 9.0 | 1.3 |
| | Stayton Br. to L.N. Fork | 26.9- 43.0 | 13 | 17.0 | 0.8 |
| | Total | | 57 | 43.0 | 1.3 |
| South Santiam R. | Mouth to Crabtree Hwy. Br. | 0.0- 12.2 | 206 | 12.2 | 16.9 |
| | Crabtree Hwy. Br. to Lebanon Br. | 12.2- 29.4 | 136 | 17.2 | 7.9 |
| | Lebanon Br. to Lebanon Dam | 29.4- 33.5 | 21 | 4.1 | 5.1 |
| | Lebanon Dam to Foster Dam | 33.5- 60.7 | 91 | 27.2 | 3.3 |
| | Total | | 454 | 60.7 | 7.5 |
| Thomas Cr. | Mouth to County Road Br. | 0.0- 3.5 | 0 | 3.5 | 0 |
| | County Rd. Br. to Covered Br. above Scio | 3.5- 19.3 | 0 | 15.8 | 0 |
| | Total | | 0 | 19.3 | 0 |

Appendix Table 3. (continued)

| River | River section: Reference points | River km | Redds | Km surveyed | Redds/km |
|---|---|---|---|---|---|
| Crabtree Cr. | Mouth to SPRR Br. | 0.0- 6.0 | 0 | 6.0 | 0 |
| | SPRR Br. to Transmission Lines | 6.0- 15.9 | 0 | 9.9 | 0 |
| | Total | | 0 | 15.9 | 0 |
| Molalla R. | Mouth to Hwy. 99E Br. | 0.0- 5.8 | 87 | 5.8 | 15.0 |
| | Hwy. 99E Br. to Goods Br. | 5.8- 9/7 | 44 | 3.9 | 11.3 |
| | Goods Br. to SPRR Br. | 9.7- 16.3 | 47 | 6.6 | 7.1 |
| | SPRR Br. to Hwy. 213 Br. | 16.3- 23.2 | 1 | 6.9 | 0.1 |
| | Hwy. 213 Br. to Freyer Pk. | 23.2- 29.9 | 5 | 6.7 | 0.7 |
| | Freyer Pk. to Robbins Rd. | 29.9- 33.3 | 0 | 3.4 | 0 |
| | Robbins Rd. to N.F. Molalla | 33.3- 42.6 | 0 | 9.3 | 0 |
| | Total | | 184 | 42.6 | 2.0 |
| | Total Above Willamette Falls | | 2,445 | 576.9 | 4.2 |
| Clackamas R. | Mouth to 82nd Ave. Bridge | 0.0- 2.0 | 6 | 2.0 | 3.0 |
| | 82nd Ave. Br. to Carver Bridge | 2.0- 13.2 | 136 | 11.2 | 12.1 |
| | Carver Br. to Barton Bridge | 13.2- 22.2 | 54 | 9.0 | 6.0 |
| | Barton Br. to Eagle Creek | 22.2- 27.8 | 24 | 5.6 | 4.3 |
| | Eagle Cr. to River Mill | 27.8- 38.0 | 4 | 10.2 | 6.1 |
| | Total Clackamas R. | | 224 | 38.0 | 5.9 |
| | TOTAL WILLAMETTE SYSTEM | | 2,669 | 619.7 | 4.3 |

Appendix Table 4. Spawning surveys of fall chinook salmon in the Willamette River system, Sept. 15-Oct. 15, 1981.

| River | River section: Reference points | River km | Redds | Km surveyed | Redds/km |
|---|---|---|---|---|---|
| Willamette River | Newberg to Wheatland Ferry | 80.5-115.7 | 18 | 35.2 | 0.5 |
| | Wheatland Ferry to Salem | 115.7-135.2 | 40 | 19.5 | 2.1 |
| | Salem to Independence | 135.2-154.6 | 15 | 19.4 | 0.8 |
| | Independence to Albany | 154.6-192.0 | 49 | 37.4 | 1.3 |
| | Albany to Marys R. | 192.0-212.6 | 7 | 20.6 | 0.3 |
| | Marys R. to American Can Co. (Concrete water intake structure) | 212.6-237.2 | 102 | 24.6 | 4.1 |
| | American Can Co. water intake to Harrisburg | 237.2-259.4 | 101 | 22.2 | 4.5 |
| | Harrisburg to McKenzie R. | 259.4-281.3 | 260 | 21.9 | 11.9 |
| | McKenzie R. to Jct. Coast & Middle Forks | 281.3-300.9 | 30 | 19.6 | 1.5 |
| | Total | | 622 | 220.4 | 2.8 |
| Middle Fork Willamette R. | Mouth to Fall Cr. | 8.0- 18.2 | 1 | 18.2 | 0.1 |
| | Fall Cr. to Dexter Dam | 18.2- 27.0 | 12 | 8.8 | 1.4 |
| | Total | | 13 | 27.0 | 0.5 |
| Coast Fork Willamette R. | Mouth to Row R. | 0.0- 33.3 | 10 | 33.3 | 0.3 |
| | Row R. to Cottage Grove Res. | 33.3- 47.8 | 7 | 14.5 | 0.5 |
| | Total | | 17 | 47.8 | 0.4 |
| Row R. | Mouth to Dorena Dam | 0.0- 12.2 | 1 | 12.2 | 0.1 |
| | Total | | 1 | 12.2 | 0.1 |
| Mill Cr.[a] | Mouth to Jct. of Stayton Ditch | 0.0- 35.4 | 408 | 35.4 | 11.5 |
| | Total | | 408 | 35.4 | 11.5 |

[a] *Includes 278 redds in 4.8 km of Shelton Ditch.*

Appendix Table 4. (continued)

| River | River section: Reference points | River km | Redds | Km surveyed | Redds/km |
|---|---|---|---|---|---|
| McKenzie R. | Mouth to Interstate 5 Br. | 0.0- 7.1 | 4 | 7.1 | 0.6 |
| | Interstate Br. to Mohawk R. | 7.1- 17.2 | 106 | 10.1 | 10.5 |
| | Mohawk R. to Hendricks Br. | 17.2- 33.8 | 10 | 16.6 | 0.6 |
| | Total | | 120 | 33.8 | 3.6 |
| Calapooia R. | Mouth to Corvallis Hwy. Br. | 0.0- 13.2 | -- | -- | -- |
| | Corvallis to 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 | 112 | 5.1 | 22.0 |
| | OERR Br. to Interstate 5 Br. | 5.1- 10.3 | 162 | 5.2 | 31.2 |
| | Interstate 5 Br. to Jefferson Br. | 10.3- 15.4 | 150 | 5.1 | 29.4 |
| | Jefferson Br. to Jct. of N. & S. Santiam R. | 15.4- 18.8 | 198 | 3.4 | 58.2 |
| | Total | | 532 | 18.8 | 23.3 |
| North Santiam R. | Mouth to First Hwy. Br. | 0.0- 4.7 | 27 | 4.7 | 5.7 |
| | Hwy. Br. to SPRR Br. | 4.7- 17.9 | 57 | 13.2 | 4.3 |
| | SPRR Br. to Stayton Br. | 17.9- 26.9 | 18 | 9.0 | 2.0 |
| | Stayton Br. to L.N. Fork | 26.9- 43.0 | 15 | 17.0 | 0.9 |
| | Total | | 117 | 43.0 | 1.5 |
| South Santiam R. | Mouth to Crabtree Hwy. Br. | 0.0- 12.2 | 246 | 12.2 | 20.2 |
| | Crabtree Hwy. Br. to Lebanon Br. | 12.2- 29.4 | 125 | 17.2 | 7.3 |
| | Lebanon Br. to Lebanon Dam | 29.4- 33.5 | 27 | 4.1 | 6.6 |
| | Lebanon Dam to Foster Dam | 33.5- 60.7 | 59 | 27.2 | 2.2 |
| | Total | | 457 | 60.7 | 7.5 |
| Thomas Cr. | Mouth to County Road Br. | 0.0- 3.5 | 2 | 3.5 | 0.6 |
| | County Rd. Br. to Covered Br. above Scio | 3.5- 19.3 | 0 | 15.8 | 0 |
| | Total | | 2 | 19.3 | 0.1 |

Appendix Table 4. (continued)

| River | River section: Reference points | River km | Redds | Km surveyed | Redds/km |
|---|---|---|---|---|---|
| Crabtree Cr. | Mouth to SPRR Br. | 0.0- 1.0 | 2 | 1.0 | 2.0 |
| Molalla R. | Mouth to Hwy. 99E Br. | 0.0- 5.8 | 34 | 5.8 | 5.9 |
| | Hwy. 99E Br. to Goods Br. | 5.8- 9.7 | 50 | 3.9 | 12.8 |
| | Goods Br. to SPRR Br. | 9.7- 16.3 | 40 | 6.6 | 6.1 |
| | SPRR Br. to Hwy. 213 Br. | 16.3- 23.2 | 52 | 6.9 | 7.5 |
| | Hwy. 213 Br. to Feyer Pk. | 23.2- 29.9 | 2 | 6.7 | 0.3 |
| | Feyer Pk. to Robbins Rd. | 29.9- 33.3 | 1 | 3.4 | 0.3 |
| | Robbins Rd. to N.F. Molalla | 33.3- 42.6 | 6 | 9.3 | 0.6 |
| | Total | | 185 | 42.6 | 4.3 |
| | Total Above Willamette Falls | | 2,47 | 562.0 | 4.4 |
| Clackamas R. | Mouth to 82nd Ave. Bridge | 0.0- 2.0 | 18 | 2.0 | 9.0 |
| | 82nd Ave. Br. to Carver Bridge | 2.0- 13.2 | 91 | 11.2 | 8.1 |
| | Carver Br. to Barton Bridge | 13.2- 22.2 | 50 | 9.0 | 5.6 |
| | Barton Br. to Eagle Creek | 22.2- 27.8 | 35 | 5.6 | 6.3 |
| | Eagle Cr. to River Mill | 27.8- 38.0 | 35 | 10.2 | 3.4 |
| | Total Clackamas R. | | 229 | 38.0 | 6.0 |
| | TOTAL WILLAMETTE SYSTEM | | 2,703 | 600.0 | 4.4 |