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EVALUATION OF "QUALITY" ANADROMOUS
SMOLT PRODUCTION TECHNIQUES

Period Covered: 1 October 1976 to 30 September 1977

by

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EVALUATION OF "QUALITY" ANADROMOUS SMOLT PRODUCTION TECHNIQUES

ABSTRACT

Oregon Moist Pellet feed again yielded superior results in starting steelhead fry to feed and to the time the fish reach approximately 1,100-1,200/kg (500-550/lb). After this size was reached, the declining growth benefits are offset by the convenience and lower cost of dry diets.

Results have shown that steelhead trout destined for a dirt pond rearing regime should exceed 120/kg (55/lb) prior to being placed in the pond environment to achieve optimum growth and survival.

Age 0 spring chinook salmon smolt releases are feasible at Hayden Creek, but a 30% incubator and early stage mortality can be expected.

An estimated 226 adult salmon returned to the Hayden Creek system in 1977. Ladder bypass continued to be a serious problem at the station, particularly during spring flows.

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RECOMMENDATIONS

Steelhead trout fry should be started on Oregon Moist Pellets and converted to a dry feed formula upon reaching 1,100-1,200/kg (500-550/lb) to achieve maximum growth per cost at hatcheries set up to rear steelhead on a dry feed regimen.

Steelhead trout should be fed one size smaller feed than established rainbow trout feeding charts recommend.

Steelhead trout destined for a dirt pond rearing regime should not be transferred to the pond environment at a size less than 120/kg (55/lb).

Handling chinook salmon and steelhead trout during the smoltification stage should be minimized or avoided and techniques or methods be devised for measuring final pond output other than hand counting or weighing out smolts.

We recommend that research be initiated at Hayden Creek to explore the feasibility of rearing spring chinook salmon and steelhead trout simultaneously in the same pond.

OBJECTIVES

To investigate and explore various methods and techniques of rearing chinook salmon and steelhead trout to the smolt stage in dirt bottomed ponds.

To determine those rearing and handling procedures that maximize the quality and quantity of smolts and promote maximum smolt survival and adult contributions and returns.

TECHNIQUES USED

Steelhead

General Rearing

The source of steelhead eggs varies depending on annual experimental needs. In the period covered by this report we used eggs taken from adults which returned to the Skamania Trout Hatchery near Washougal, Washington and the Dworshak National Hatchery near Orofino, Idaho. The eggs taken from adults which returned to the Hayden Creek Research Station were hatched and released in the Hayden Creek drainage.

Incubation took place in Heath stack-type incubators loaded with 29.6 cm^3 (32 oz) of eggs per basket. The water supply consisted of varying proportions of Hayden Creek water at 0-15 C (32-59 F) and spring water at 12.7 C (55 F). We moved the resulting fry from the incubators to raceways when they reached the button-up stage of development.

Rearing continued in 61 x 1.2 x 1.2 m (200 x 4 x 4 ft) raceways supplied

with straight spring water. Hourly hand-feeding of either dry diet or Oregon Moist Pellets of appropriate size produced good growth in past years and was continued, as was prophylatic treatments of Purina 4X (2 ppm) and Formalin (1:6000).

We loaded the raceways with similar densities of fry, used identical water sources and flows, treated for disease in both raceways simultaneously, and sampled weekly using a standardized displacement method.

When the fish reached "ponding size" (150-175/kg), we moved them to either of two 0.2 hectare (0.6 acre) dirt ponds where rearing continued in a 3:1 spring water-Hayden Creek water mix at 10-14.4 C (50-58 F). Dry feed was dispensed automatically once an hour by Neilsen feeders on the perimeters of each pond. Monthly samples for length and weight allowed us to follow the growth rates of the various groups of fish.

In April, we released the fish from the south pond into Hayden Creek after excising the adipose fins and implanting coded wire tags. The fish in the north pond were released into Hayden Creek unmarked to allow evaluation of the effects of the handling of the south pond fish. Tag retention checks among fish held from the south pond release showed 98.5% of the tagged fish retained the coded wire tags after 9 days.

Monitoring the quality of the smolts consisted of comparing the data gathered during release sampling to established criteria, including (1) silvery coloration, (2) deciduous scales, (3) absence of parr marks, (4) minimum 160 mm (6.3 in) total length, (5) overall good health and (6) the tendency to migrate to the ocean. Criteria 1-5 were observed directly during release sampling. Seaward emigration was assessed by visually checking two short sections of Hayden Creek where the recently released fish tend to congregate, and by reports of department personnel who maintain irrigation screens on Hayden Creek and the Lemhi River. We can estimate roughly when the smolts begin downstream movement and also what portion of the group starts active migration.

Comparative Rearing - Oregon Moist Pellets vs. Dry Diet

We received 370,000 eyed summer steelhead eggs in mid-March 1976 from the Skamania Trout Hatchery. These extremely early eggs resulted from the selective spawning of early ripening adults. We incubated the eggs in a mix of spring and Hayden Creek waters, 6.7 C (44.1 F), until the fish buttoned-up.

We moved 338,000 fry averaging 4,550/kg (2,064/lb) from the incubators to the south raceway the first of May 1976, and held the fish in straight spring water, 12-13 C (54-55 F) throughout the raceway phase of rearing. Oregon Moist Pellets (OMP) starter mash was hand fed once an hour until the fish reached 1,150/kg (522/lb) on 10 June 1976. We then divided the fish, moving 160,000 to the north raceway to be fed Silver Cup dry diet, and retaining 165,000 in the south raceway for continued feeding of OMP. The north raceway fish were slow in accepting the dry feed but within a week were feeding well. Hourly hand feedings continued to maintain equivalent rearing conditions for the two groups of steelhead. Periodic prophylactic treatments of Purina 4X (2 ppm – 3 consecutive days) and Formalin (1:6000 - 1 day) prevented disease in both raceways. We experienced a loss of 5,000 fish on 9-10 August to anoxia when

the dissolved oxygen (D.O.) content of the spring water supply dropped to the range of 2-4 ppm as measured with a Hatch kit. The addition of Hayden Creek water (10 ppm) remedied the problem.

We terminated the differential feeding portion of the OMP/dry diet experiment in early August when we fed dry terramycin-laced feed to both raceways. On 29 August, we moved 112,000 fingerlings from the south raceway (OMP) to the north pond. These fish averaged 159/kg (72/lb) and 90 mm (3.5 in). We held the dry diet fish in the two raceways until 19 September, when we moved 123,000 fingerlings, averaging 115/kg (52/lb) to the south pond. We added 14,000 steelhead to the north pond to maintain equal density in the ponds.

After moving the two groups of fish to the dirt ponds, we continued rearing them under equivalent conditions. Both ponds received Rangen dry diet hourly from 0700 to 1800 hr. A predominately spring water mix, 10-14.4 C (50-58 F), maintained optimum temperature and dissolved oxygen levels.

By the end of November the two groups of fish were equal in length and fish per kilogram although the south pond (dry diet) fish were ponded 3 weeks later than the north pond (OMP) fish. Past observations have shown that fish ponded at larger sizes show faster initial growth. As rearing progressed, both ponds of fish exhibited nearly equal growth rates and mortality. We administered treatments of terramycin-laced feed in March just prior to the scheduled releases in an effort to prevent any "breaking" of bacterial infections during the increased stress of handling.

South Pond Release - April 1977

We released 110,000 Skamania-stock steelhead from the south pond on 4-8 April 1977 into Hayden Creek. These fish were captured in the pond outlet trap, netted into a 757 1 (200 gal) fish tank and transported to the lower half of the north raceway. The fish were then moved into the coded wire tagging trailer as needed where they had tags implanted and their adipose fins excised. The fin clippers did not mark the smallest fish. These unmarked fish measured 135 mm (5.3 in) or less and made up 7.9% (8,641 fish) of the total release. All the remaining fish were Ad-clipped and coded wire tagged, then released via the spring bypass into Hayden Creek. We released 100,292 tagged fish.

We categorized the fish in this release as being very high quality smolts showing the external characteristics of smoltification, i.e., extreme silveriness, marked slimness and deciduous scales. But seaward emigration was less than expected. One probable cause of this was the unusually low warm water in Hayden Creek and the Lemhi River, brought about by the drought conditions of 1977. Large numbers of steelhead smolts were reported in Hayden Creek by anglers and irrigation screen tenders. Fish and Game personnel reported the fish in poor condition as observed during the transport of 13,000 smolts around a 8 km (5 mi) stretch of the Lemhi River that had been dewatered by an irrigation diversion. We feel the unusual water conditions during release and migration caused some of the fish to slow or stop seaward movement and also caused the fish to deteriorate physically more rapidly than usual.

We sampled for weight and total length several times throughout the release. The average size of 1,016 fish was 183.2 mm (7.2 in) and 18.3/kg (8.3/lb). These were the largest steelhead ever reared at this station, including

past 2-year reared releases.

We retained 400 tagged fish in 6.1 m (20 ft) Heath vats to check wire tag retention. After 9 days, six fish had lost their tags for a retention rate of 98.5%.

North Pond Release - April 1977

We released 112,400 Skamania-stock steelhead from the north pond directly into Hayden Creek on 9 April 1977. None of these smolts were marked. By comparing marked and unmarked adults when they return in 1979-80 we hope to determine if the handling of smolts required for tagging and/or weighing-out at release was detrimental.

The smolts averaged 176.5 mm (6.9 in) total length and 20.9/kg (9.5/lb) at release. Sampling showed that 12.0% of the north pond fish were less than 135 mm (5.3 in), compared to 7.9% of the south pond fish. We feel this higher percent of sub-smolts was related to ponding size, 160/kg (72.1/lb) for the north pond and 115/kg (52.3/lb) for the south pond. Average smolt size (greater than 135 mm) for both ponds were within 2 mm of each other. This supports past findings that the larger the fish at ponding, the better the growth.

We classified these north pond fish as very good quality smolts showing the expected physical characterisitcs. Emigration of some of the fish was adversely affected by the unusually low, warm waters of Hayden Creek and the Lemhi River at release time.

Comparative Rearing - Skamania VS. Dworshak Stocks

On 22 March 1977 I transported 263,000 Skamania-stock, eyed-eggs from the Vancouver Hatchery to the Hayden Creek Research Station. These eggs came from adults which returned to the Skamania Trout Hatchery near Washougal, Washington.

We incubated these eggs in straight Hayden Creek water at 4.3-6.1 C (40-43 F) to slow development until a nearly equal number of Dworshak-stock eggs could be obtained and hatched. The Skamania eggs completed hatching on 15 April 1977.

We took receipt of 259,000 eyed, Dworshak-stock eggs on 4 May 1977 and incubated them in straight spring water at 12.7 C (55 F) to speed development. Hatching was complete on 23 May 1977.

On 16 May 1977 we moved 257,000 Skamania-stock fry to the south raceway. We transferred 257,000 Dworshak-stock fry to the north raceway on 1 June 1977. Both raceways received straight spring water at 12.7 C. We hand fed Oregon Moist Pellets (OMP) hourly to both groups of fish through the starter mash size of feed. Dry diet of appropriate size replaced the OMP in late June.

We sampled both raceways weekly and recorded growth rates. Mortality was monitored by direct count of the dead fish removed from the tail screens.

We added Hayden Creek water to both raceways to increase dissolved oxygen and treated for Bacterial Gill Disease with Purina 4X (2 ppm - 3 days,

consecutively) and for Costia with Formalin (1:6000 - 1 hour flush).

We moved 126,000 Skamania-stock fingerlings from the north raceway to the north pond on 29 September 1977. The fish averaged 83.0 mm (3.3 in) and 163.8/kg (74.5/lb). On 24-25 October 1977, we moved 123,000 Dworshak fish to the south pond. Prior to ponding we graded out the smallest fish to compensate for a period of decreased growth. This lack of growth was probably caused by our feeding over-sized feed received from the contracted supplier. The Dworshak fingerlings averaged 84.8 mm (3.3 in) and 195.8/kg (89.0/lb) at ponding.

The 112,000 Skamania-stock fingerlings excess to our research needs were planted in the upper Lemhi River on 12 August and 29 September 1977. Nearly 80,000 Dworshak-stock fingerlings were planted in the upper East Fork of the Salmon River on 28 October 1977.

Both groups of fish are currently (November 1977) rearing in straight spring water at 12 C (54 F) and receive dry feed hourly from the Neilsen automatic feeders (0700-1800 hours). Differential marking and release is scheduled for April 1978.

Spring Chinook

General Rearing

The techniques employed in rearing spring chinook were similar to those used for steelhead. We obtained eggs from the adults which returned to the station and from a September shipment of eyed eggs from Rapid River Hatchery near Riggins, Idaho. Heath incubators, supplied with varying mixes of spring and Hayden Creek waters, provided incubation. We loaded the trays with 37 cm^3 (40 oz) of eggs and adjusted flows to 19 fpm (5 gpm).

In October we increased the proportion of spring water to speed development of half of the Rapid River eggs and continued using predominately Hayden Creek water for the remaining Rapid River eggs and all of the Hayden Creek eggs. By late November the accelerated fry were buttoned-up and moved to the north raceway for rearing until their release in April, 1977 as Age 0 smolts. Just prior to release, 9,600 of these smolts were adipose clipped and coded wire tagged. The Rapid River/Hayden Creek fry buttoned-up in mid-January and were then moved to the south raceway for rearing until they reached ponding size 350/kg (159/lb) in May.

We moved these fish to the south pond and held them in predominately spring water 10.5-13.0 C (51-55 F). Neilsen automatic feeders dispensed dry feed hourly from 0600 to 2000 hr. Monthly samples were taken to monitor growth. On 19-23 September we Ad-clipped and coded wire tagged 86,000 Age 0 smolts and released them into Hayden Creek, the remaining fish were released 8 October. Prior to the 8 October release, we moved 18,000 fish to the north raceway for rearing until April 1978, when they will be marked and released as Age I smolts.

We hope to gain information about comparative rearing/release schedules by comparing the percent of adult returns from these three groups (Age 0 - spring release, Age 0 - fall release, and Age I - spring release).

Age 0 - Spring Release

We received 261,000 eyed, spring chinook eggs from the Rapid River Hatchery on 24 September 1976. Incubation started in straight Hayden Creek water 9-11 C (48-52 F) until 14 October when we converted about one-half of the eggs to predominately spring water 12 C (54 F) in order to speed development.

On 27 November 1976 we moved 120,000 Rapid River fry from the incubators to the north raceway where they were held in straight spring water and hand fed Oregon Moist Pellets (OMP) hourly. We treated with Purina 4X (2 ppm) to control Bacterial Gill Disease. We fed OMP starter mash for the first few days after the fish were moved to the raceway, then mixed increasing proportions of OMP 1/32 in pellets into the feed rations as suggested by Parrish (1976).

Rearing continued under these conditions until 29-30 March 1977 when coded wire tags were implanted and the adipose fin excised from 9,600 Age 0 smolts before being returned to the raceway. We released a total of 99,000 spring chinook smolts directly into Hayden Creek on 22 April 1977. They averaged 86.0 mm (3.4 in) fork length and 150/kg (68/lb). Nearly all of these fish left the hatchery area within hours indicating excellent initial emigration. Some of the fish were reported stranded in the lower Lemhi River when a 8 km (5 mi) section was dewatered on 27 April. A tag retention check on 400 fish held after tagging showed that 98% or 9,400 of tagged/clipped fish carried the tags at release.

Age 0 - Fall Release

The 102,000 eggs taken from the adults which returned to the Hayden Creek trap in 1976 were combined with some 120,000 eggs received from Rapid River Hatchery. Button-up was synchronized by mixing spring and Hayden Creek waters.

On 20 January 1977, we moved 222,000 of the Hayden Creek/Rapid River fry to the south raceway for rearing in straight spring water. We fed OMP hourly until we converted to dry diet on 24 March 1977 when the fish averaged 450/kg (204.5/lb).

Rearing continued under these conditions until 22 May 1977, when we moved 189,000 fingerling averaging 86.8 mm (3.4 in) and 147.6/kg (67.1/lb) to the south pond We held these fish in straight spring water at 12.7 C (55 F) and fed dry diet hourly.

We coded wire tagged, adipose clipped, and released 86,000 Hayden Creek/Rapid River-stock spring chinook smolts on 19-23 September 1977. Random samples showed these fish to average 148.6 mm (5.9 in) and 31/kg (14.1/lb). We captured the fish by baiting them over a 2 x 2 m (6 x 6 ft) unbrella net (Fig. 1). We stockpiled the captured fish in a floating live net until they were needed in the tagging trailer (Fig. 2).

Handling mortality and a low-level systemic bacterial infection decreased the overall quality of the released fish. The fish not affected by either of

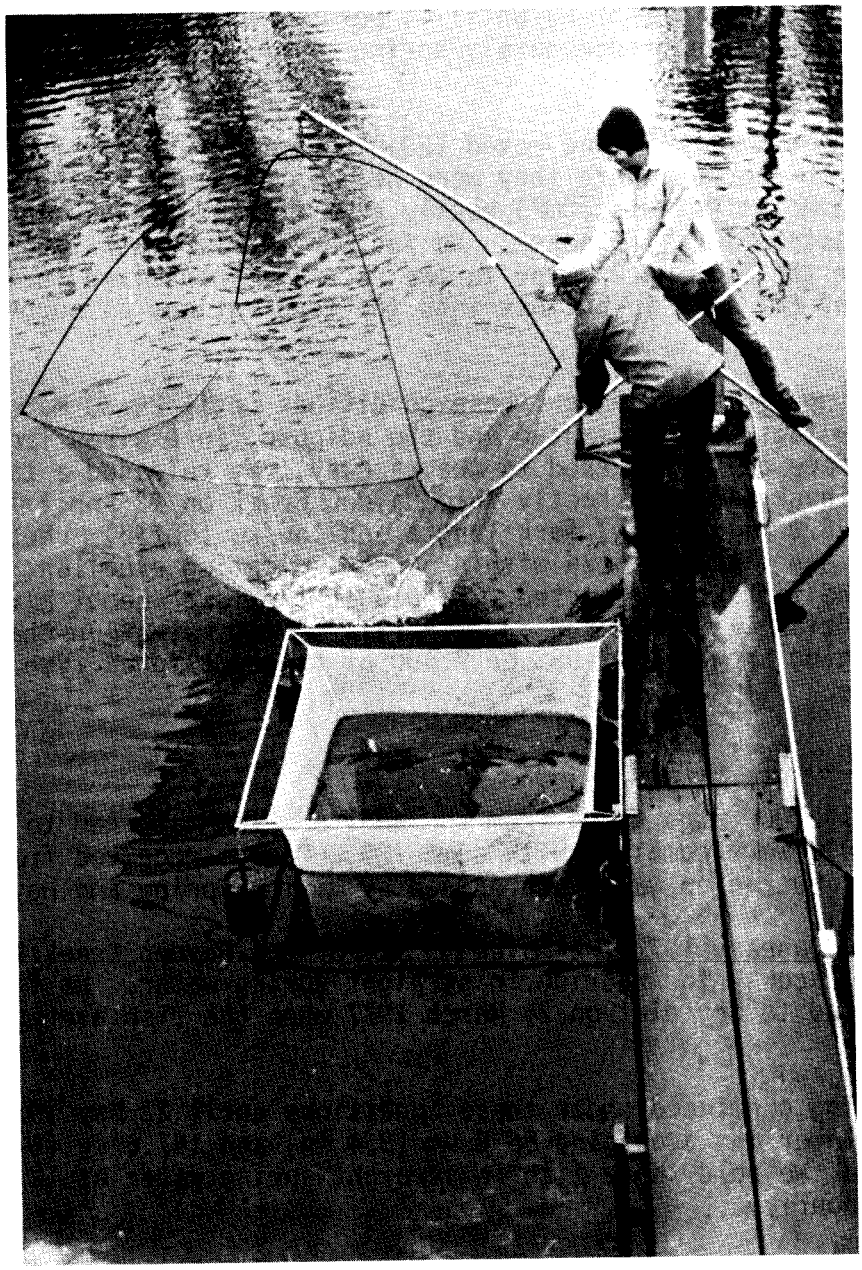

Figure 1. Chinook salmon smolts were captured from the ponds by baiting them over a 2x2 m (6x6 ft) umbrella net and stockpiled for marking in a floating live net.

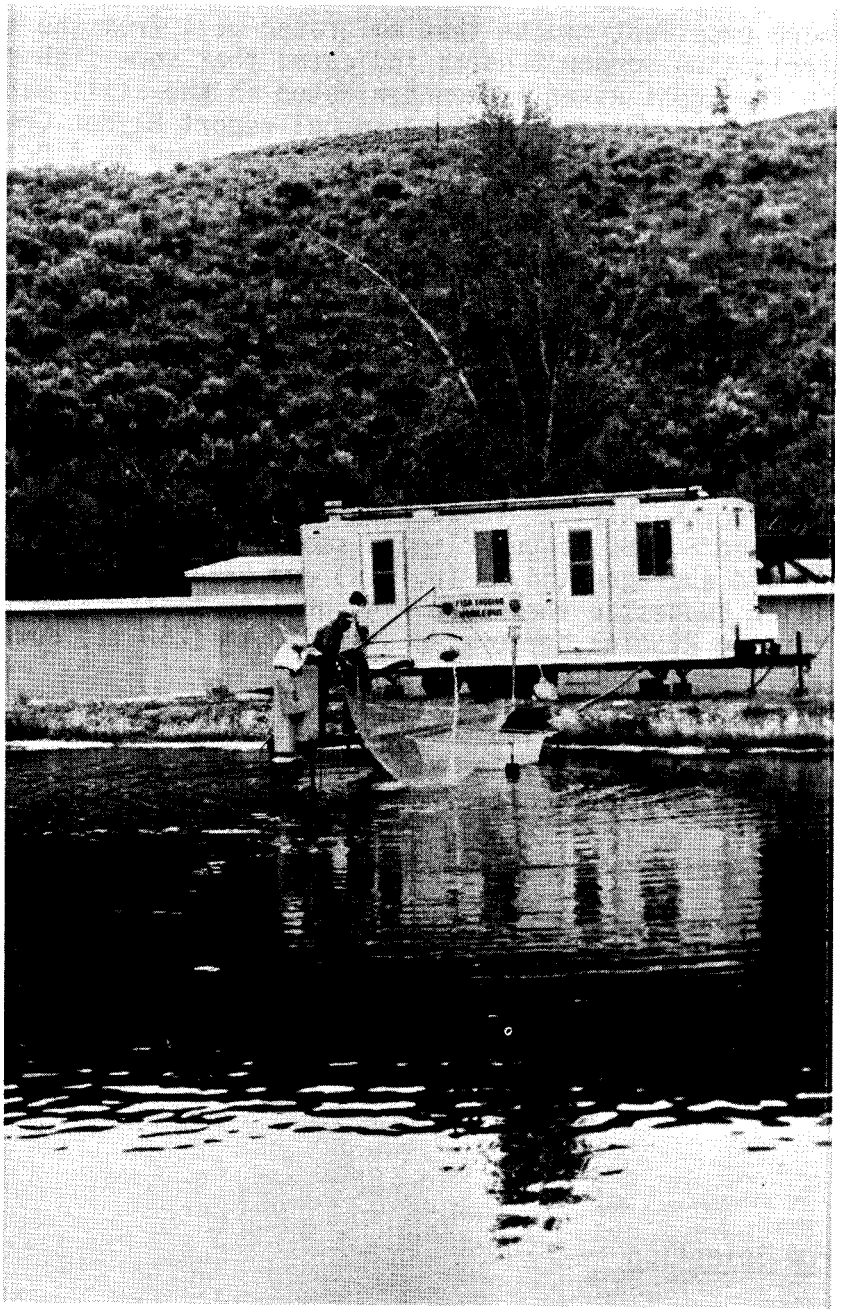

Figure 2. Some 86,000 chinook were collected and sent through the Mobile Tagging Unit where an adipose clip-coded wire tag was applied.

the problems were excellent smolts that emigrated well from the hatchery area. Reports from irrigation screen tenders indicated that some fish stopped migration once in the Lemhi River and concentrated in the still water near irrigation diversion and headgates. NMFS personnel report Hayden Creek fish captured some 400 km (250 mi) downriver at the Riggins barge trap on 4 October 1977, indicating that some of the smolts moved well (Ron Strain, personal communication). In late November, Hayden Creek smolts were captured in the Lower Granite Dam collection facilities near Lewiston, Idaho.

Tag retention checks of 626 fish held from this release showed that 99.5% retained the tags after 4 weeks.

Age 0 - Fall Release (Unmarked)

We released 75,500 Hayden Creek/Rapid River-stock smolts directly into Hayden Creek on 8 October 1977. These fish remained in the south pond after we removed and released 86,000 tagged/clipped smolts in September. They were released unmarked and averaged 154 mm (6.1 in) and 22.4/kg (10.2/lb). Their physical condition suggested they were high quality smolts as did reports of their capture at the Riggins barge trap some 400 km (250 mi) downriver on 16-24 October.

Age I - Spring (1978) Release

We moved 18,400 chinook smolts from the south pond to the north raceway on 6-7 October 1977. We plan to hold these fish in predominately Hayden Creek water until April 1978 when we will coded wire tag and release them into Hayden Creek.

A treatment of Oregon Moist Pellets, laced with Erythromycin, was administered to prevent Bacterial Kidney Disease (KD) which caused 50% mortality in a similar group in 1975-76.

FINDINGS

Steelhead

Egg Source Selection

We elected to use Skamania-stock summer steelhead for our 1976-77 rearing program for three reasons: (1) this egg supply was available when in-state egg sources were low caused by small adult returns, (2) the extremely early spawning characteristics brought about by the selective breeding of early-ripening adults allowed a 4-6 week longer rearing period than the earliest eggs obtainable in Idaho, and (3) to investigate the feasibility of subsidizing our indigenous stocks if that alternative ever requires decision.

Starting Diet - Oregon Moist Pellets Compared to Dry Diet

Past research work comparing fish "started" on Oregon Moist Pellets (OMP) and switched to dry feed with fish fed OMP throughout raceway rearing, yielded

information that allows more efficient use of time and financial resources (Anderson 1977). We observed all rearing parameters but paid most attention to growth and survival. We noticed little difference among the two groups of fish at the time we ended differential feeding (Fig. 3). The small variance in growth was probably due to the dry diet fish having to change diet and endure moving to another raceway while the OMP fish had no stress from either operation.

We observed little difference in size disperions, disease, number of "pinheads" or condition. The only parameter showing significant difference was cost per pound of fish gained which was about 15.5¢ for the dry diet fish and 32(t for the OMP fish. This indicates only the difference of purchase price. Dry feed is easier to feed and store since it need not be kept frozen.

From the information gathered in 1974, 1975 and 1976 at Hayden Creek, and in 1976 experiments at Niagara Springs Steelhead Hatchery (Reingold 1977), we conclude that OMP is a superior feed in starting steelhead to feed and to the time the fish reach approximately 1,100-1,200/kg (500-550/lb). After this size is reached, the declining growth benefits are offset by the convenience and lower cost of dry diets, and the feed should be changed for the remainder of the rearing cycle.

Feeding Frequency and Feed Size

We experienced difficulty in getting steelhead to eat the recommended amount of feed. To remedy this problem we fed hourly during both raceway and pond rearing. This necessitates decreasing the amount fed at each feeding. It requires that more time be spent feeding fish but provides more opportunity for the fish to receive the needed feed.

We found that steelhead prefer smaller feed than the rainbow catchables for which the feeding charts were designed. If we feed one size smaller feed than the chart calls for for we observe better growth.

Ponding Size

The size of the fish when moved from the raceways to the ponds appears important in obtaining the best initial growth. Considering the two groups of steelhead released in April 1977, we noted that the south pond fish ponded 19 September, at 115/kg grew at a faster rate than the north pond fish ponded 29 August at 160/kg. This increased growth rate continued until the two groups of fish were equal in size at the end of November.

We feel also, that ponding size affects the number of sub-smolts at release. The south pond release contained 7.9% sub-smolts (fish less than 135 mm, 5.3 in) while the north pond release included 12.0% sub-smolts.

Ponding the fish at not less than 120/kg (55/lb) should help them adapt to pond rearing by allowing increased ability to obtain the feed dispensed by the automatic feeders.

Handling Mortality

The handling required for marking steelhead smolts precipitates increased

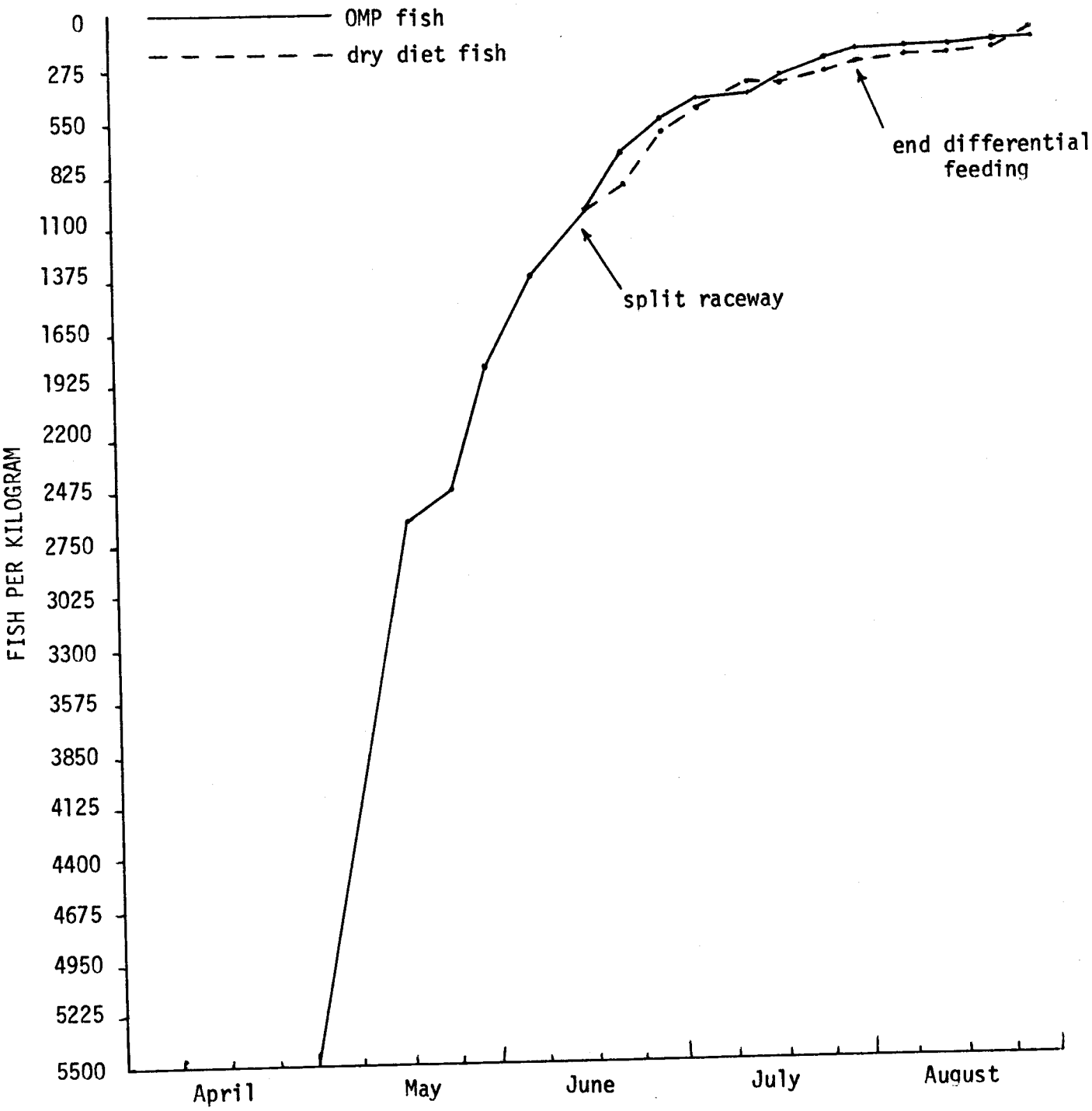

Figure 3. Weekly size samples show little difference between fish "started" on Oregon Moist Pellets (OMP) and converted to dry feed and fish fed OMP throughout the raceway rearing period.

mortality. We estimated some 1,500 fish died from the time they entered the coded wire tagging trailer to the time they entered Hayden Creek. We also estimated that 2,000 fish died during capture in the outlet trap and transfer to the raceway.

The causes of handling mortality are varied but we feel the main contributor was very dirty water to which the fish were exposed when the accumulated detritus on the pond bottom was disturbed during the pond draining process. Many fish left the pond only when forced out by dirty, shallow water near the end of the draining process. We could move only 20,000-30,000 fish to the raceway each day so some of the smolts were exposed to extremely turbid water several times. Another contributor to handling mortality was netting and moving the fish which resulted in injury. We feel that the effects of both of these factors on the fish were amplified because of their strongly smolted condition.

Consideration should be given to applying coded wire tags earlier in the rearing phase, perhaps upon transfer from raceway to rearing pond, to avoid or minimize handling during the smolt stage.

Genetic Stock Comparison -- Dworshak and Skamania Stocks

The incubation phase of this comparative rearing investigation indicated slightly better survival for the Dworshak eggs (99.2%) than for the Skamania eggs (97.7%) from the time of loading into the incubators until button-up. However, incubation water came from different sources and could account for this difference in survival.

In comparing raceway rearing we concerned ourselves mainly with growth and survival. Weekly samples showed similar growth rates up to the time we ponded the Skamania fish (Fig. 4). At this time, the recently ponded Skamania fish grew well, while the Dworshak fish experienced a 3-week period of slowed growth. We partly attribute this lack of growth to our feeding oversize feed, but we feel these different genetic stocks reacted differently to the raceway rearing regime also.

The major difference between stocks was mortality. Observed mortality for the first 3 months of raceway rearing was higher for the Skamania fish (4.3%) than the Dworshak fish (2.2%), but during this period we noted the "disappearance" of a large number of Dworshak fish. We eventually confirmed a 36,000 fish debit that could not be accounted for by observed mortality or escape. We have seen this inventory loss occur in past years with Dworshak-stock fish but it occurred during pond rearing. This has not been noticed with Skamania-stock steelhead. Overall survival during the raceway phase of rearing was 92.9% for the Skamania-stock fish and 80.8% for the Dworshak group.

Dworshak fish appear more affected by changes in rearing conditions than Skamania fish. The Dworshak fish were slower in starting to feed when moved from the incubators. Some of these fish refused the larger size feed when routine feed size changes occurred. When bacterial gill disease caused both groups to decrease feeding, a portion of the Dworshak fish failed to resume normal feeding activity after the disease was controlled. All of these rearing characteristics decreased the overall quality of the Dworshak group by increasing the number of pinheads.

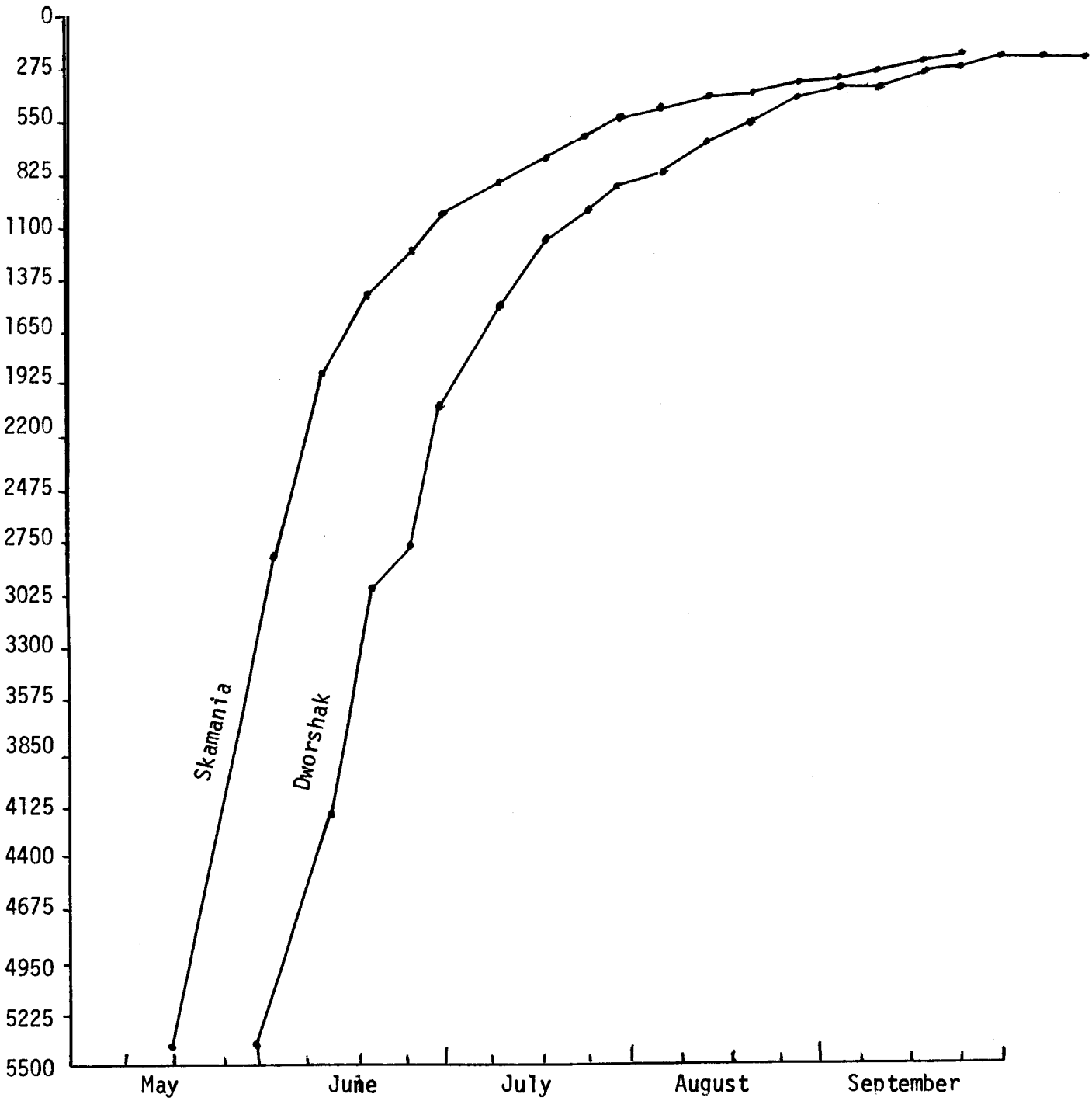

Figure 4. Weekly samples showed similar growth rates for Skamania and Dworshak stock of steelhead during raceway rearing.

Adult Returns

Twenty-four adult summer steelhead returned to the Hayden Creek trap from 20 April 1977 to 30 April 1977. We classified 6 as 1-ocean returnees with total length between 610 and 635 mm (24-25 in), and 18 as 2-ocean returnees with total length 686-889 mm (27-35 in)(Table 1). Deformed dorsal fins appeared on 12 adults indicating hatchery origin. No other marks were observed.

We calculated a release-to-return percentage of .03% for the November 1973 and April 1974 releases. This includes 1-ocean returnees in 1976 and 2-ocean returnees in 1977 (Table 1). We combined these groups because the Tetracycline mark intended for differentiation proved unreliable. Some adult steelhead may have bypassed the ladder-trap entrance and spawned naturally in Hayden Creek as we have suspected in past years.

Egg Take

We spawned 12 female steelhead from the 1977 returns for a total egg take of 59,000 eggs. The average number of eggs per female was about 4,900. The eye-up percentage was 79.5%. We planted the resultant fry above a gravelly meadow on Bear Valley Creek, a tributary to Hayden Creek.

Chinook Salmon

Age 0 Spring Release

We used straight spring water (12 C) to speed development of the spring chinook fry scheduled for release in April 1977. Predominately Hayden Creek water supplied incubation for the fry scheduled for fall release. We noted increased mortality and incidence of deformity among the accelerated fry. The higher mortality carried through the early part of raceway rearing. After the first month of rearing we classified 10-15% of this group of fish as pinheads (fish which failed to start feeding). We feel this unusually high incidence of pinheads was related to our incubating the sac-fry in straight spring water. The problem may have been caused by any of several factors including (1) the high levels of ionic zinc and copper, (2) the higher temperatures than those at which chinook fry naturally develop, or (3) the endemic presence of bacterial gill disease in the spring source.

Our overall feeling toward an Age 0 spring release is that we should expect high mortality and deformity (10-15%) in the incubators and a large percentage of pinheads (10-15%), but the surviving 70% can be reared to smolts size (80 mm F.L.) for release in April.

Handling Mortality

Handling mortality, both immediate and delayed, appears to be a serious problem when marking strongly smolted fish. Approximately 500 fish, from the 19-23 September release, died before reaching Hayden Creek. The cause of death was netting injury or anoxia. Delayed mortality was difficult to assess but it appeared considerable. A low-level bacterial infection increased to a lethal level during the stress of capturing and marking. In a group of 400 smolts

Table 1. Summary of steelhead smolt releases and adult returns to Hayden Creek Research Station since initiation of the program in 1966.

Brood year	Year released	Number juveniles released	Number marked	Mark used	River race	Number adults returned as : One-ocean fish	Two-ocean fish
1966	1967 (May)	180,000	22,800	LV	Clearwater	48 (1969)	46 (1970)
1967	1968 (May)	340,000	12,000	LV			
			11,700	LV AD	Snake	8 (1970)	10 (1971)
1968	1969 (May)	87,500	26,700	LV			
				L Brand	Clearwater	5 (1971)	6 (1972)
1969	1970 (May)	187,400	55,000	LV	Clearwater, Lemhi		
					1969 return	11 (1972)	15 (1973)
1970	1971'(May)	72,000	38,000	LV	Lemhi Weir,		
					1970 return	5 (1973)	17 (1974)
1970	1972 (March)	87,500	50,000	LV	Lemhi Weir,		
					1970 return	3 (1974)	2 (1975)
1971	1973 (April)	31,700	13,800	LV	Lemhi Weir		
					1971 return	2 (1975)	23 (1976)
1972	1973 (Nov.)	47,000	0		Lemhi Weir)		
					1972 return)	21 (1976)	18 (1977)
1973	1974 (April)	80,000	0		Clearwater)		
1973	1975 (April)	229,000	0		Clearwater		
					Hayden Creek	6 (1977)	_ (1978)
1975	1976 (April)	125,000	0	--	Washougal	(1978)	_ (1979)
1976	1977 (April)	100,000	100,000	CWT & AD	Washougal	(1979)	_, (1980)
1976	1977 (April)	99,000	0	--	Washougal	(1979)	_ (1980)

held in vats after tagging, about 30 fish (7.5%) died showing the symptoms of systemic bacterial infection (yellow fluid in gut, hemorrhagic fin bases, and lesions on ventral and lateral surfaces). Fungus infection, especially of the caudal area, also caused delayed mortality among this group of fish held for tag retention and post-releasing mortality investigation. About 25 fish died showing marked fungus growth fungusing followed scale sloughage (Fig. 5). which is prevalent among strongly smolted fish, or started at the wound left where the adipose fin was removed. Fungus continued to kill fish during migration as evidenced by the Hayden Creek fish captured at the Riggins barge trap being infected (Ron Strain, NMFS, personal communication).

We noted increased mortality among the chinook smolts we moved from the south pond to the north raceway. Mortality was high for the first two days after transfer then decreased to normal level. We seldom experience losses when handling fish not in a smolted condition.

Remedies for reducing handling mortality should include the avoidance of handling of smolted fish. When handling is required it should be preceded by a medicated feed treatment to prevent bacterial outbreaks. A fungicidal bath following marking should help decrease the problem.

Adult Returns

A total of 54 adult spring chinook salmon returned to the Hayden Creek trap from 31 May to 22 August 1977. We classified 5 adults as 1-ocean (432-508 mm), 45 as 2-ocean (610-813 mm) and 4 as 3-ocean returnees (864-940 mm) (Table 2). Females numbered 14 and males 40. We innoculated all the adults with Erythromycin phosphate administered by subcutaneous injection near the origin of the dorsal fin at the dosage level of .1 cc/pound of fish.

In mid-April 1977 we installed a temporary weir in Hayden Creek to divert returning adults into the hatchery. We expected low flows in the stream due to the very dry winter but on 1 June, Hayden Creek raised and washed out the weir. We concluded that a temporary structure will probably never be practical for use in Hayden Creek.

Spawning ground surveys were conducted on Hayden Creek and its major tributary, Bear Valley Creek, to estimate the number of adults that bypassed the trap and spawned naturally in these streams. We counted 14 redds below the hatchery and 29 redds upstream from the hatchery. Since adult males returned to the hatchery at a ratio of nearly 3:1, we assumed 3 males and 1 female per redd. We calculated that 172 adults failed to enter the trap, the largest number ever recorded. Reports from anglers and local irrigators also suggested that more salmon than usual appear in Hayden Creek.

Counting 4-year old returnees, jacks, 3-ocean adults and the adults that bypassed the station, we calculated a smolt to adult return percentage of .055 for the 1974 release. This was one-half of the .113% calculated for the 1973 release. In view of the general feeling that passage conditions were poor for the 1973 release and good for the 1974 release, we can offer no suitable explanation why the return percentage was so low.

Table 2. Summary of spring chinook smolt releases and adult returns to Hayden Creek Research Station since initiation of the program in 1969.

Brood year	Year released	Number juvenile released	Number marked	Mark used	River race	Number adults returned as: One-ocean fish	Two-ocean fish	Three-ocean fish
1969	1970 (Oct.)	83,200	25,200	AD	Lemhi Weir	0 (1972)	20 (1973)	3 (1974)
1970	1971 (Oct.)	201,000	52,000	/D, AD, LV	Rapid River	10 (1973)	7 (1974)	4 (1975)
1971	1972 (Oct.)	312,000	73,000	RV, L Max	Rapid River	38 (1974)	120 (1975)	10 (1976)
1972	1973 (Oct.)	151,000	0	--	Rapid River	27 (1975)	89 (1976)	4 (1977)
1973	1974 (Sept.)	350,000	0	--	Rapid River	9 (1976)	45 (1977)	_ (1978)
1974	1975 (Oct.)	276,000	0	--	Rapid River	5 (1977)	_ (1978)	_ (1979)
1974	1976(April)	6,000	0	R Max	Rapid River	0 (1977)	_ (1978)	_ (1979)
1975	1976 (Sept.)	255,000	0	--	Hayden Creek - Rapid River Mix	— (1978)	_ (1979)	_ (1980)
1976	1977 (April)	99,000	9,600	AD-CWT	Rapid River	_ (1978)	_ (1979)	+ (1980)
1976	1977(Sept.)	86,000	86,000	AD-CWT	Hayden Creek - Rapid River Mix	— (1979)	(1980)	_ (1981)
1976	1977 (Oct.)	75,500	0	--	Hayden Creek - Rapid River Mix	— (1979)	(1980)	_ (1981)

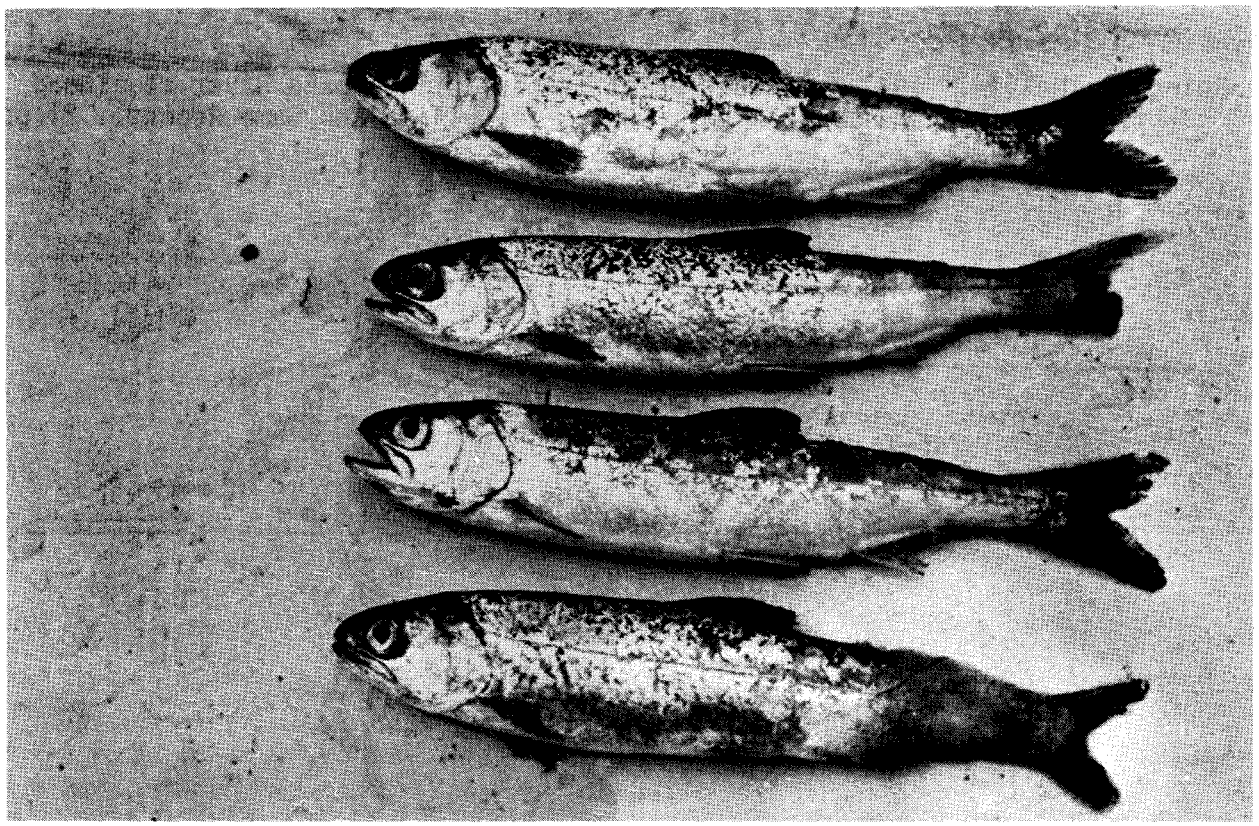

Figure 5. Fungus invasion followed scale sloughage induced by the handling of strongly smolted fish.

Egg Take

We spawned 11 female chinook from 15 July to 1 September 1977 for a total egg take of 37,500. The number of eggs per female average 3,410. The eye-up percentage was 90.1%. Pre-spawning mortality totalled 3 females, 1 to Bacterial Kidney Disease and 2 to fungus. The resultant fry are scheduled for planting in Bear Valley Creek at swim-up.

LITERATURE CITED

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