FISHERY REPORT NUMBER 5

RESEARCH DIVISION
Oregon State Game Commission

Winter Steelhead Investigations
A SUMMARY OF INVESTIGATIONS OF THE USE OF HATCHERY-REARED STEELHEAD IN THE MANAGEMENT OF A SPORT FISHERY

by

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Fishery Report Number 5

January, 1967
PREFACE

The investigations were for the most part supported by the Salmon Research Account Funds of the Oregon State Game Commission. The Sandy River segment was supported from July, 1961 through June, 1966 by the United States Fish and Wildlife Service through the Columbia River Fishery Development Program.
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Steelhead investigations

Harry H. Wagner

Introduction

The importance of the winter steelhead trout as a sport fish continues to grow as Oregon's angling population increases. It is essentially the only salmonid that is available to sport fishermen during the winter months of December through March. It is found in varying abundance in all coastal streams and in many tributaries of the Willamette River, in addition to other lower Columbia River tributaries. Availability alone does not account for its popularity for the steelhead is known world-wide for its attributes as a game fish.

The freshwater habitat of the steelhead has undergone considerable alteration because of man's activities. Unfortunately, most of the changes have adversely affected the production of steelhead at various points in time and space in their life history.

The loss of potential eggs could occur from the complete stoppage or delay of all or part of the spawning run at dams with inadequate fish passage facilities, where debris chokes the stream, or as a result of temperature, pollution, or disease problems. When the adult fish reach the spawning gravel, flows might be unsuitable or marginal for successful egg deposition. If suitable at the time of spawning, siltation with its subsequent effect on gravel permeability and reduction in the content of dissolved oxygen in addition to gravel erosion could destroy or reduce the number and quality of the embryos which eventually emerge as fry.

In the wild, from one to four years will be required for the juvenile to reach migrant size. Survival will depend on adequate stream flows of water of the proper quality with respect to temperature, dissolved gases, and purity. The food and shelter requirements necessary for survival are closely associated with land use.
The downstream migration of the juvenile steelhead is difficult and dangerous. Dams and associated structures, water diversion installations, water pollution in its various forms as well as predators take their toll of the migrants in the stream and estuary before the young fish reach the sea.

Under the multiple use concept of watershed management, the amounts of stream flow, oxygen, etc., for aquatic life will be a compromise with domestic, industrial and agricultural needs. It is unlikely that in the future many streams will be reserved strictly for fish production and as a consequence each stream will have to be intensively managed if the fishery resources are to be maintained.

Numerous management practices are now in use or under investigation. Artificial propagation is one technique being used to supplement natural reproduction. Although steelhead trout and Pacific salmon have been artificially propagated since the latter part of the nineteenth century in hatcheries along the Pacific coast, information on the efficiency and justification for the practice has been absent or inconclusive.

In the winter of 1959-60 the Research Division of the Oregon State Game Commission initiated a study to assess the role of artificial propagation of winter steelhead as a means of supplementing natural reproduction. The study has continued along the guidelines established at the beginning of the investigation.

Objectives

The study was designed to provide the following information:

(1) The contribution of adult hatchery-reared steelhead to the winter sport fishery with respect to angling intensity, the number of fish stocked, the contribution of native stocks, and availability as affected by regulation, release location and racial differences.
(2) The survival of hatchery-reared steelhead in relation to the conditions under which the fish were reared and released. Early areas of inquiry dealt with the affect of size at release on survival. Recently, time of release has come under investigation. Marking experiments to determine the survival of wild downstream migrants in comparison to the hatchery product were initiated.

(3) The cost of placing an adult steelhead of hatchery origin in the creel and as a potential spawner. The administrator and fishery manager should be apprised of the cost as well as the effectiveness of hatchery stocking in order to compare them with other management techniques.

In addition to the above areas of investigation, much information has been gathered with respect to the life history pattern (freshwater and marine age and the number of repeated spawnings), size, growth, sex ratios, and temporal movement of wild and hatchery adults and juveniles during the course of the study and will be presented in later reports.

Methods

The methods remain essentially the same as those outlined in the 1963 report. The Alsea, Sandy and Wilson rivers have been retained as study streams and in this report are referred to as the "key-streams". They continue to receive heavy plantings of hatchery fish in accord with a predetermined design. All hatchery fish going into the study streams have been marked and sampled for size and condition at the time of release.

The original sampling programs for estimating catch and effort have been modified wherever necessary in order to improve the accuracy and precision of the estimates.
Definitions

In the present discussion, a "wild" fish refers to a steelhead of unknown origin which is the result of natural propagation. Over the years that steelhead have been reared in hatcheries, indigenous stocks have been used for the obtainment and widespread distribution of hatchery fish and, thus, in any particular Oregon coastal stream, the pre-aquicultural stock has probably undergone dilution of the genetic pool to an extent that no truly native winter fish exist. The above is of special importance to the key-streams because of the heavy plantings of hatchery fish that they have received in recent years.

The term "marked" or "hatchery" fish refers to steelhead which were artificially incubated and reared and subsequently marked prior to release into the stream.

Sampling program restrictions

The effort and catch estimates are for the period of December 1 through March 31. A small fishery occurs in November and is dependent on water flow in all three study streams. A few winter steelhead are taken on the Wilson and Sandy rivers in April.

The fishery on the Alsea River is sampled from the Sand Hole just above the head of tide upstream approximately 40 miles to the fishing deadline on the North Fork just above the confluence of Crooked Creek (Figure 1). The lower reaches of the larger tributaries are open to fishing but receive little angling pressure and are not regularly sampled. A fishery at the head of tide and in the upper estuary has developed in recent years. In periods of low river discharge the head-of-tide fishery has taken significant numbers of steelhead. Such areas have not been included in the sampling program. A pay access fishing area exists in the lower river and a complete record of catch is kept. A partial record is made of fish caught at the head of tide. The estimates
Figure 1. The Alsea River, estuary and major tributaries.
of catch, effort and fishing success presented for the Alsea River are for
only sections of river (main stem and the North Fork) covered by the controlled
sampling program. For purposes of computing the return of a particular marked
group to the sport fishery, the estimated river catch and the pay access area
total catch are summed.

The main stem of the Sandy River is sampled from Lewis and Clark Park,
in the lower river, to Marmot Dam a distance of some 40 miles (Figure 2).
Although the river is open to fishing above the dam as far as Brightwood Bridge,
there is little angler activity in the area and it is not included in the
regular sampling program. The lower section of the Bull Run River is sampled
at its confluence with the Sandy River at Dodge Park.

Only the main stem of the Wilson River is open to fishing. The entire
fishing area is sampled from Highway 101 Bridge to Lee's Camp, a distance of
approximately 25 road miles (Figure 3).

In this report following the procedures used in California (Hallock, et
al., 1961), each time a steelhead returned it was treated as a separate
individual. A fish could be counted one year in the spawning escapement and
again the following year in the sport catch or escapement. If each fish were
treated as a single individual, regardless of its number of spawning migrations,
the result would be to lower the total number of adult returns by approximately
5 percent.

Fish stocked

The numbers of hatchery fish released into the study streams are summarized
in Table 1 for the period 1958 to 1965. The numbers of fish stocked in the
Alsea has ranged from 34,000 to 157,000 fish per year. The fish have been
released at various times, sizes, locations and by different methods in accord
with experimental designs. Releases requiring large numbers of fish of a
Figure 2. The Sandy River and major tributaries.
Figure 3. The Wilson River system and major Tillamook Bay tributaries.
certain size at a previous selected time could not always be followed because of variation in the hatchery production of yearling steelhead.

### Table 1

A summary of hatchery-reared steelhead liberations into the key streams for the period 1958 through 1965

<table>
<thead>
<tr>
<th>Date of release</th>
<th>Number released</th>
<th>Pounds</th>
<th>Fish per pound</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alsea River</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apr. 1958</td>
<td>34,300</td>
<td>3,353</td>
<td>11.7</td>
</tr>
<tr>
<td>Apr. 1959</td>
<td>43,900</td>
<td>4,734</td>
<td>9.3</td>
</tr>
<tr>
<td>May-Apr. 1960</td>
<td>65,300</td>
<td>6,267</td>
<td>10.4</td>
</tr>
<tr>
<td>Feb.-Apr. 1961</td>
<td>101,800</td>
<td>11,614</td>
<td>8.7</td>
</tr>
<tr>
<td>Feb.-Apr. 1962</td>
<td>157,800</td>
<td>17,990</td>
<td>8.8</td>
</tr>
<tr>
<td>Feb.-Apr. 1963</td>
<td>149,700</td>
<td>17,980</td>
<td>12.8-5.7</td>
</tr>
<tr>
<td>Feb.-Apr. 1964</td>
<td>152,000</td>
<td>20,980</td>
<td>10.4-5.6</td>
</tr>
<tr>
<td>Feb.-Apr. 1965</td>
<td>96,200</td>
<td>11,916</td>
<td>12.8-6.9</td>
</tr>
</tbody>
</table>

| **Sandy River** |                 |        |                |
| Apr. 1958       | 57,600          | 1,993  | 29.0           |
| Mar. 1959       | 83,500          | 8,003  | 10.4           |
| Mar. 1960       | 76,900          | 12,965 | 5.9            |
| Mar.-June 1961 | 163,000         | 15,009 | 10.9           |
| Apr.-May 1962   | 176,800         | 15,950 | 11.1           |
| May 1963        | 214,200         | 19,420 | 11.0           |
| May 1964        | 200,300         | 22,429 | 8.9            |
| Apr.-June 1965 | 198,800         | 22,900 | 8.7            |

| **Wilson River** |                 |        |                |
| Mar. 1958       | 78,500          | 7,357  | 10.6           |
| Feb. 9-Apr. 3, 1959 | 101,900    | 12,110 | 8.4            |
| Mar.-June 1960 | 106,000         | 8,203  | 12.9           |
| Apr.-June 1961 | 106,900         | 11,304 | 9.4            |
| Mar.-Apr. 1962 | 105,700         | 12,399 | 8.5            |
| Apr.-May 1963 | 119,800         | 15,471 | 7.7            |
| Apr. 1964      | 112,100         | 14,200 | 7.9            |
| Apr. 1965      | 105,000         | 11,592 | 9.1            |

The numbers of yearling steelhead released in the Wilson have been held at approximately 100,000 each spring. The fish were stocked at times and sizes designed to give the best possible survival in accord with information available.
at the time, hatchery production, and liberation schedules. Thus, an attempt was made to measure the return to the fishery on the Wilson River of the best hatchery product available.

The Sandy River releases were conducted under a similar plan to that of the Wilson River since 1961, in that an attempt was made to increase the magnitude of the run through the release of large numbers of what were believed to be the best hatchery fish available.

All hatchery fish released into the Alsea originated from and were reared at the North Fork of the Alsea River. The Sandy River since 1961 has been stocked with fish reared only at Gnat Creek Hatchery originating from Sandy River, Alsea River, and Big Creek (lower Columbia River tributary) stocks. Prior to 1961 the Sandy River was stocked with fish from several different hatcheries and origins. Fish released into the Wilson River have come primarily from Cedar Creek Hatchery (Nestucca tributary) and the eggs originated from fish returning to the Alsea River, Cedar Creek and Wilson River.

Additional details of the release characteristics of specific release groups are given in Tables 10, 11, and 12.

Results and discussion

The sport fisheries

Alsea River

The estimated catch, effort and fishing success are summarized in Table 2 for the Alsea River for the seasons of 1960-61 through 1965-66 and shown graphically in Figure 4.

During the period, effort increased from approximately 4,100 angler days in 1960-61 to 26,700 in 1965-66. The tremendous increase in angling pressure on the Alsea and Wilson rivers during the study period is not typical of increases experienced in other coastal streams because the Alsea and Wilson
have received much publicity as a result of stocking programs and the large numbers of fish which have subsequently become available to the angler.

Table 2

Estimates of effort, catch, and fishing success for wild and marked steelhead on the Alsea River, 1960-61 to 1965-66, inclusive

<table>
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<tbody>
<tr>
<td>Fishing intensity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angler days¹/²</td>
<td>4,168</td>
<td>8,156</td>
<td>10,394</td>
<td>18,413</td>
<td>22,957</td>
<td>26,717</td>
</tr>
<tr>
<td>Catch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild fish</td>
<td>323</td>
<td>770</td>
<td>816</td>
<td>1,608</td>
<td>1,009</td>
<td>828</td>
</tr>
<tr>
<td>Marked fish</td>
<td>291</td>
<td>1,265</td>
<td>2,044</td>
<td>4,954</td>
<td>3,586</td>
<td>6,117</td>
</tr>
<tr>
<td>Total fish</td>
<td>614</td>
<td>2,035</td>
<td>2,860</td>
<td>6,562</td>
<td>4,595</td>
<td>6,945</td>
</tr>
<tr>
<td>Fishing success</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild fish per hour</td>
<td>0.019</td>
<td>0.020</td>
<td>0.018</td>
<td>0.019</td>
<td>0.012</td>
<td>0.007</td>
</tr>
<tr>
<td>Marked fish per hour</td>
<td>0.019</td>
<td>0.035</td>
<td>0.046</td>
<td>0.058</td>
<td>0.039</td>
<td>0.047</td>
</tr>
<tr>
<td>Total fish per hour</td>
<td>0.038</td>
<td>0.055</td>
<td>0.063</td>
<td>0.077</td>
<td>0.051</td>
<td>0.053</td>
</tr>
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</table>

¹/² The angler day is approximately 4.5 hours in duration as determined by the contacts made with anglers who had completed fishing at the time of the interview on the stream.

The numbers of wild fish entering the catch have ranged from 323 to 1,608. The catch of wild fish increased as fishing pressure became greater through the 1963-64 season, but subsequently declined in 1964-65 and 1965-66 despite increasing effort. Whether the decline is the result of a change in population size or is a result of decreased availability as a result of flooding that existed in 1964-65 and increased turbidity (from road construction) in 1965-66 is not known.
Figure 4. The estimated catch, effort and fishing success for the winter steelhead fishery on the Alsea River from 1960-61 to 1965-66 inclusive.
The catch of hatchery fish increased rapidly through the period with the exception of 1964-65. The greater numbers of hatchery fish caught are related in part to increased effort and to greater numbers of fish in the river. The population increase is the result of larger numbers of fish being stocked and consistently higher survivals experienced in recent years.

Changes in total catch are influenced to the greatest extent by the abundance of marked fish in the river.

Fishing success for wild steelhead remained strikingly constant (0.018 to 0.020) from 1960-61 through 1963-64 despite increasing angling effort but has declined in the last two migratory seasons. For hatchery fish, success increased rapidly from 0.19 in 1960-61 to 0.058 fish per hour in 1963-64. Fishing success declined in 1964-65 to 0.039 fish per hour but rose to 0.047 fish per hour in 1965-66.

Fishing success for total steelhead (wild plus hatchery) has ranged from 0.038 fish per hour in 1960-61 to a high of 0.077 fish per hour in 1963-64.

The contribution of hatchery-reared steelhead to the sport fishery (estimated plus the pay access area record) in comparison to wild fish is shown graphically in Figure 5. The contribution of hatchery-reared steelhead as a percentage has ranged from 37 (1959-60) to 86 (1965-66) and in numbers from approximately 300 (1960-61) to 6,100 (1965-66). In comparison to the numbers of fish of hatchery origin caught, the numbers of wild fish have remained relatively constant during the study period.

An estimated 34,000 hatchery-reared steelhead have returned from releases made from 1958 through 1964 in the Alsea River (Table 10). Of the
Figure 5. The contribution of hatchery-reared steelhead to the sport fishery in comparison to wild fish on the Alsea, Wilson, and Sandy rivers.

\(^1\) Included for the Alsea River is the observed catch at the pay access area.
total returns 2,100 fish or 6 percent were classified as jacks. The origin (sport fishery or escapement) of the returns in Table 10 shows that the catch of jacks was proportional to their abundance and there was apparently no selection on the part of the angler, assuming that jacks and adult fish are equally difficult to catch. Of the 2,100 jacks estimated to have returned, 61 percent (1,273 out of 2,094) were taken in the sport fishery which compares favorably to 55 percent for adult fish (17,724 out of 31,970).

Wilson River

Estimates of catch, effort and fishing success for the winter steelhead fishery on the Wilson River are summarized in Table 3 and shown graphically in Figure 6. The fishery on the Wilson is similar in many respects to that observed on the Alsea River. Angling intensity increased approximately three fold during the study period from 10,400 angler days in 1960-61 to 30,300 in 1965-66. The greatest increase in effort occurred in the 1965-66 season when approximately 8,000 angler days of use were recorded over the previous season. The 1965-66 increase could be a result of the attraction of the new bag limit of three-fish on the Wilson or was a result of a normal influx of anglers which did not appear in 1964-65 because of the flood conditions which existed for much of the season. Angling effort remained constant at approximately 22,000 angler days for the 1963-64 and 1964-65 seasons.

\footnote{Jack is a term used for a male fish which has reached maturity after one summer in the ocean and has returned to the stream to spawn at a size usually less than 20 inches.}
Table 3
Estimates of effort, catch, and fishing success for wild and marked steelhead on the Wilson River, 1959-60 to 1965-66, inclusive

<table>
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<tr>
<td>Fishing intensity</td>
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</tr>
<tr>
<td>Angler days</td>
<td>12,440</td>
<td>10,399</td>
<td>14,632</td>
<td>16,494</td>
<td>22,348</td>
<td>22,605</td>
<td>30,284</td>
</tr>
<tr>
<td>Catch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild fish</td>
<td>1,402</td>
<td>997</td>
<td>1,351</td>
<td>1,844</td>
<td>2,165</td>
<td>2,867</td>
<td>1,792</td>
</tr>
<tr>
<td>Marked fish</td>
<td>1,763</td>
<td>1,027</td>
<td>607</td>
<td>1,974</td>
<td>3,518</td>
<td>5,618</td>
<td>6,193</td>
</tr>
<tr>
<td>Total fish</td>
<td>3,165</td>
<td>2,024</td>
<td>1,958</td>
<td>3,818</td>
<td>5,683</td>
<td>8,485</td>
<td>7,985</td>
</tr>
<tr>
<td>Fishing success</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild fish per hour</td>
<td>0.026</td>
<td>0.022</td>
<td>0.023</td>
<td>0.027</td>
<td>0.022</td>
<td>0.018</td>
<td>0.015</td>
</tr>
<tr>
<td>Marked fish per hour</td>
<td>0.030</td>
<td>0.023</td>
<td>0.009</td>
<td>0.025</td>
<td>0.036</td>
<td>0.042</td>
<td>0.049</td>
</tr>
<tr>
<td>Total fish per hour</td>
<td>0.055</td>
<td>0.045</td>
<td>0.031</td>
<td>0.052</td>
<td>0.054</td>
<td>0.061</td>
<td>0.065</td>
</tr>
</tbody>
</table>

1/ The angler day is approximately 4.5 hours in duration as determined by the contacts made with anglers who had completed fishing at the time of the interview on the stream.

The number of wild fish in the sport catch has ranged from approximately 1,000 in 1960-61 to 2,860 in 1964-65. The catch of wild fish increased each season since the low in 1960-61 until 1965-66 when approximately 1,800 fish were estimated to have been caught. In spite of the 1964-65 floods, the estimated number of wild and hatchery-reared steelhead harvested was greater than in previous seasons.

The least number of hatchery fish caught in any season on the Wilson River occurred in 1961-62 and probably reflects a low population level resulting from the stocking of small fish (12.9 fish per pound) in 1960. Since the 1961-62 season, the catch of hatchery fish has continually increased to a high of
Figure 6. The estimated catch, effort, and fishing success for the winter steelhead fishery on the Wilson River from 1959-60 to the 1965-66 season, inclusive.
approximately 6,200 fish in 1965-66 in the face of the constant stocking rate of approximately 100,000 yearlings per year. The increased catch in part must be related to the increased angling pressure and also to the increased availability of the hatchery product in terms of numbers. Changes in the total catch are primarily a reflection of the catch of hatchery fish.

From 1959-60 through 1963-64, fishing success for wild steelhead remained relatively constant (0.022 to 0.027 fish per hour) but declined to 0.015 fish per hour by 1965-66. Fishing success for hatchery steelhead has ranged from 0.023 to 0.049 with the exception of 1961-62 when marked fish were caught at the rate of 0.009 fish per hour.

Changes in total fish per hour (0.031 to 0.065) are largely a reflection of changes in fishing success for the hatchery product because of the constancy of the catch per unit of effort for wild fish and the differences in the magnitude of the catch of wild and hatchery fish.

The contribution of hatchery fish has ranged from 31 percent (600 fish) in 1960-61 to 78 percent (6,200 fish) in 1965-66. Although the contribution of wild fish in percentage has been reduced, the numbers have remained relatively stable (Figure 5).

Sandy River

The estimates of catch, effort and fishing success are presented in Table 4 and Figure 7 for the migratory seasons 1959-60 through 1965-66. The fishery on the Sandy River differs in several respects from those reported previously for the Alsea and Wilson rivers.

During the study period, fishing effort declined from a high of 32,000 angler days in 1959-60 to approximately 18,100 in 1965-66. The cause of the continued decline in angler use is not known.
Table 4

Estimates of effort, catch and fishing success for wild and marked steelhead on the Sandy River
1959-60 to 1965-66, inclusive

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing intensity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angler days(^1)</td>
<td>30,079</td>
<td>32,391</td>
<td>20,354</td>
<td>25,074</td>
<td>23,420</td>
<td>19,516</td>
<td>18,074</td>
</tr>
<tr>
<td>Catch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild fish</td>
<td>1,824</td>
<td>1,312</td>
<td>1,056</td>
<td>1,107</td>
<td>2,064</td>
<td>2,694</td>
<td>2,155</td>
</tr>
<tr>
<td>Marked fish</td>
<td>247</td>
<td>182</td>
<td>15</td>
<td>195</td>
<td>1,756</td>
<td>2,204</td>
<td>2,582</td>
</tr>
<tr>
<td>Total fish</td>
<td>2,071</td>
<td>1,494</td>
<td>1,071</td>
<td>1,302</td>
<td>3,820</td>
<td>4,898</td>
<td>4,737</td>
</tr>
<tr>
<td>Fishing success</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild fish per hour</td>
<td>0.019</td>
<td>0.014</td>
<td>0.021</td>
<td>0.016</td>
<td>0.019</td>
<td>0.029</td>
<td>0.029</td>
</tr>
<tr>
<td>Marked fish per hour</td>
<td>0.002</td>
<td>0.002</td>
<td>0.001</td>
<td>0.003</td>
<td>0.016</td>
<td>0.024</td>
<td>0.035</td>
</tr>
<tr>
<td>Total fish per hour</td>
<td>0.021</td>
<td>0.016</td>
<td>0.021</td>
<td>0.019</td>
<td>0.034</td>
<td>0.054</td>
<td>0.064</td>
</tr>
</tbody>
</table>

\(^1\) The angler day is approximately 4.0 hours in duration as determined by the contacts made with anglers who had completed fishing at the time of the interview on the stream.

The catch of wild steelhead declined from approximately 1,800 fish in the 1959-60 season to 1,000 in 1961-62 but since then the catch increased to approximately 2,700 fish in the 1964-65 migratory season. Prior to 1963-64 the catch of hatchery-reared steelhead was so small that it was difficult to measure with any degree of accuracy or precision. The estimated catch of marked fish from 1959-60 through the 1962-63 season ranged from roughly less than 100 to 250 fish. In 1963-64, 1964-65, and 1965-66 approximately 1,700, 2,200 and 2,500 steelhead of hatchery origin respectively, were estimated to have been harvested.
Figure 7. The estimated catch, effort, and fishing success for the winter steelhead fishery on the Sandy River from 1959-60 to the 1965-66 season, inclusive.
The low return of hatchery-reared steelhead during the early 1960's can be attributed to the quality of the fish stocked. Prior to 1961, many fish were released at times and sizes which have been shown in recent years to be the least favorable for survival. In addition, the condition of the fish stocked in some years was questionable. The increased catch of marked steelhead in 1963-64 through 1965-66 is a result of the larger numbers and improved quality of hatchery fish stocked in the spring of 1962, 1963, and 1964 from Gnat Creek Hatchery.

The total catch of adult fish has largely been a reflection of wild steelhead in the creel with the exception of the last two migratory seasons when marked fish made a significant contribution.

Fishing success for wild steelhead has ranged from 0.014 (1960-61) to 0.029 (1965-66) fish per hour, which compares favorably to that calculated for the Alsea River.

Hatchery fish were caught at a rate of approximately 0.002 fish per hour prior to the 1963-64 season. A significant increase in fishing success has been noted in the last three migratory seasons where fish per hour figures increased to 0.016 (1963-64), 0.024 (1964-65), and 0.035 (1965-66).

The catch of wild and hatchery steelhead combined for the Sandy River is considerably below that of the other two streams during the 1959-60 to 1962-63 period but in subsequent seasons the total fish per hour for the Sandy River was similar to that recorded on the Alsea and Wilson rivers.

The contribution of hatchery fish to the sport fishery is shown graphically in Figure 4. The percentage has ranged from less than one (<100 fish) to 55 (2,500 fish) in 1965-66.

Hatchery fish in recent years have made a significant contribution to the sport fisheries on all three study streams. The numbers of wild steelhead being
caught have remained relatively constant in comparison to the increased harvest of hatchery-reared steelhead.

Regulation effects on catch and effort

In January of 1965, the bag limit on the Wilson River was increased from two to three fish per day and the weekly possession limit from four to six fish. The season bag limit of 20 steelhead was maintained. Since the regulation was not in effect over the entire 1964-65 season, the present discussion with respect to the three-fish bag limit will be confined to the 1965-66 season.

Table 5 shows the distribution of observed catch with respect to the number of anglers catching no fish, one fish, two fish, and three fish for a period covering five migratory seasons on the Wilson River.

The three-fish bag has not had a significant effect on the distribution of catch. The percentage of anglers catching from 0 to 2 fish has remained relatively the same over the period with some decrease in the number of successful anglers interviewed in 1965-66. Out of 4,560 anglers interviewed, 104 were in possession of two fish and fishing for a third. These anglers theoretically would have been removed from the angling population under the old regulation. Of the 460 anglers that had completed fishing, 18 or 3.9 percent had caught three fish. The total catch of the 460 anglers was 163 steelhead of which 18 or 11 percent were the "third fish". If the success of these 460 anglers can be considered representative of the angling population, the "third fish" increased the total catch by 11 percent or 878 steelhead. However, the appearance of three fish in an anglers bag could have occurred without any increase in catch as a result of an angler acknowledging ownership of the "third fish", whereas prior to the three-fish bag limit the fish would have been claimed by a less-successful member of the angling party.
Table 5

The distribution of observed catch and hours per angler among "complete" and "incomplete" anglers interviewed on the Wilson River over five migratory seasons

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of anglers catching no fish (percent)</th>
<th>Number of anglers catching one fish (percent)</th>
<th>Number of anglers catching two fish (percent)</th>
<th>Number of anglers catching three fish (percent)</th>
<th>Number of anglers catching five fish (percent)</th>
<th>Hours per angler week days</th>
<th>Hours per angler weekend days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-62</td>
<td>5,081(93.3)</td>
<td>363(6.7)</td>
<td></td>
<td></td>
<td></td>
<td>2.41</td>
<td>2.47</td>
</tr>
<tr>
<td>1962-63</td>
<td>3,319(89.8)</td>
<td>379(10.2)</td>
<td></td>
<td></td>
<td></td>
<td>2.70</td>
<td>3.04</td>
</tr>
<tr>
<td>1963-64</td>
<td>4,028(87.7)</td>
<td>564(12.3)</td>
<td></td>
<td></td>
<td></td>
<td>2.47</td>
<td>2.88</td>
</tr>
<tr>
<td>1964-65</td>
<td>2,250(83.9)</td>
<td>431(16.0)</td>
<td>2(0.1)</td>
<td></td>
<td></td>
<td>2.60</td>
<td>2.75</td>
</tr>
<tr>
<td>1965-66</td>
<td>4,020(88.1)</td>
<td>436(9.6)</td>
<td>104(2.3)</td>
<td></td>
<td></td>
<td>2.52</td>
<td>2.79</td>
</tr>
</tbody>
</table>

For the "incomplete" group:

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of anglers catching no fish (percent)</th>
<th>Number of anglers catching one fish (percent)</th>
<th>Number of anglers catching two fish (percent)</th>
<th>Number of anglers catching three fish (percent)</th>
<th>Number of anglers catching five fish (percent)</th>
<th>Hours per angler week days</th>
<th>Hours per angler weekend days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-62</td>
<td>184(76.7)</td>
<td>27(11.2)</td>
<td>29(12.1)</td>
<td></td>
<td></td>
<td>4.85</td>
<td>4.37</td>
</tr>
<tr>
<td>1962-63</td>
<td>352(73.3)</td>
<td>88(18.3)</td>
<td>40(8.3)</td>
<td></td>
<td></td>
<td>4.47</td>
<td>4.57</td>
</tr>
<tr>
<td>1963-64</td>
<td>356(69.4)</td>
<td>108(21.0)</td>
<td>49(9.6)</td>
<td></td>
<td></td>
<td>5.13</td>
<td>4.98</td>
</tr>
<tr>
<td>1964-65</td>
<td>299(79.7)</td>
<td>69(16.8)</td>
<td>9(2.4)</td>
<td>4(1.1)</td>
<td></td>
<td>5.33</td>
<td>5.01</td>
</tr>
<tr>
<td>1965-66</td>
<td>357(77.6)</td>
<td>61(13.3)</td>
<td>24(5.2)</td>
<td>18(3.9)</td>
<td></td>
<td>4.62</td>
<td>4.91</td>
</tr>
</tbody>
</table>

For the "complete" group:

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of anglers catching no fish (percent)</th>
<th>Number of anglers catching one fish (percent)</th>
<th>Number of anglers catching two fish (percent)</th>
<th>Number of anglers catching three fish (percent)</th>
<th>Number of anglers catching five fish (percent)</th>
<th>Hours per angler week days</th>
<th>Hours per angler weekend days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-62</td>
<td>5,265(92.6)</td>
<td>390(6.9)</td>
<td>29(0.5)</td>
<td></td>
<td></td>
<td>4.19(7.4)</td>
<td></td>
</tr>
<tr>
<td>1962-63</td>
<td>3,671(87.9)</td>
<td>467(11.2)</td>
<td>40(0.9)</td>
<td></td>
<td></td>
<td>5.07(12.1)</td>
<td></td>
</tr>
<tr>
<td>1963-64</td>
<td>4,380(85.9)</td>
<td>672(13.2)</td>
<td>49(0.9)</td>
<td></td>
<td></td>
<td>7.21(14.1)</td>
<td></td>
</tr>
<tr>
<td>1964-65</td>
<td>2,549(82.4)</td>
<td>494(16.0)</td>
<td>47(1.5)</td>
<td>4(0.1)</td>
<td></td>
<td>5.45(17.5)</td>
<td></td>
</tr>
<tr>
<td>1965-66</td>
<td>4,377(87.2)</td>
<td>497(9.9)</td>
<td>128(2.5)</td>
<td>18(0.4)</td>
<td></td>
<td>6.42(12.8)</td>
<td></td>
</tr>
</tbody>
</table>
Of the 460 anglers completing fishing, 103 or 22 percent were successful (one or more fish in possession), that is, 22 percent of the anglers caught 100 percent of the fish.

The hours fished in 1965-66 by "completed" and "incompleted" anglers did not differ substantially over those of previous years, again indicating that the number of anglers catching more than two fish is so small that the additional time spent fishing for the third fish does not influence the hours-per-angler statistic.

Although the number of anglers involved in the category of "incomplete" (having two fish and a potential for a third) or "complete" with three fish, is so small that the effort per angler or catch per angler statistic has not changed, (Table 5 and 2 respectively), the catch of the "third fish" appears to have increased the total catch by approximately 11 percent. In addition, the catch might have been increased indirectly as well as from the increased effort in the form of angler days of use. The three-fish bag limit appears to be of benefit to only the better fishermen which represent a small proportion of the total angling population.

Escapement

Facilities are available on the Alsea and Sandy rivers for trapping most of the marked and wild (Sandy only) steelhead which escape the sport fishery. No such facilities are available on the Wilson River.

Alsea River

Essentially all of the hatchery-reared steelhead released prior to 1964 were stocked in the North Fork of the Alsea River. The adults which escaped the fishery and returned to the North Fork were trapped at a fish ladder at
the hatchery water-diversion dam, Figure 8. Trapping on other tributaries has indicated that little straying occurs. Results of tagging studies at the ladder, and stream surveys in the North Fork, have indicated that hatchery fish spawn below the trapping facility in increasing numbers in winter when low flows occur. In the 1964-65 flood, considerable numbers of potential spawners were displaced downstream and were not enumerated. Thus, the escapement figures are minimal for any given year but the amount of negative bias is variable.

The observed escapement is summarized in Table 6. The numbers of hatchery fish escaping has increased considerably despite the greater angling effort and catch. The greater escapement is a result of the larger numbers of hatchery fish returning to the river as a result of increased stocking rates and survival. The number of wild fish returning to the North Fork in recent seasons is similar to the nine-year average (1953-62).

The estimated percentage of returning hatchery fish escaping the sport fishery on the Alsea River from 1960-61 through 1965-66 is shown in Table 7. Although the number of hatchery fish returning during the period has increased, the percentage of the total run reaching the North Fork has declined, probably as a result of increased angling effort. In interpreting the data, it should be kept in mind that the catch and effort measurements are at a minimum but the magnitude in each case is now known. The available data do indicate that in recent years a greater proportion of the hatchery run was harvested. The harvest of wild stock has probably increased as well but not to the same degree because of the difference in timing and destination of the upstream migration within the river system.
Figure 8. Fish ladder and trap on the North Fork of the Alsea River.
Table 6

Observed escapement of steelhead to the North Fork of the Alsea River for the period 1953-1966

<table>
<thead>
<tr>
<th>Migratory season</th>
<th>Wild fish (percent)</th>
<th>Hatchery fish (percent)</th>
<th>Total steelhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>1953-62</td>
<td>361 (39)</td>
<td>557 (61)</td>
<td>918</td>
</tr>
<tr>
<td>1962-63</td>
<td>92 (4)</td>
<td>2,021 (96)</td>
<td>2,113</td>
</tr>
<tr>
<td>1963-64</td>
<td>175 (6)</td>
<td>2,718 (94)</td>
<td>2,893</td>
</tr>
<tr>
<td>1964-65</td>
<td>408 (12)</td>
<td>2,960 (88)</td>
<td>3,368</td>
</tr>
<tr>
<td>1965-66</td>
<td>456 (9)</td>
<td>4,676 (91)</td>
<td>5,132</td>
</tr>
</tbody>
</table>

1/Winter steelhead only
2/Nine-year average

Table 7

Percentage of returning hatchery fish escaping the sport fishery on the Alsea River, 1960-61 through 1965-66

<table>
<thead>
<tr>
<th>Migratory season</th>
<th>Escapement (percent)</th>
<th>Catch/ (percent)</th>
<th>Total return</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-61</td>
<td>638 (68)</td>
<td>304 (32)</td>
<td>942</td>
</tr>
<tr>
<td>1961-62</td>
<td>2,010 (60)</td>
<td>1,354 (40)</td>
<td>3,364</td>
</tr>
<tr>
<td>1962-63</td>
<td>2,021 (48)</td>
<td>2,225 (52)</td>
<td>4,246</td>
</tr>
<tr>
<td>1963-64</td>
<td>2,718 (34)</td>
<td>5,386 (66)</td>
<td>8,104</td>
</tr>
<tr>
<td>1964-65</td>
<td>2,960 (43)</td>
<td>3,873 (57)</td>
<td>6,833</td>
</tr>
<tr>
<td>1965-66</td>
<td>4,017 (44)</td>
<td>5,022 (56)</td>
<td>9,039</td>
</tr>
</tbody>
</table>

1/Includes observed catch at pay access area.
2/In the 1964-65 flood, considerable numbers of potential spawners were displaced downstream and not enumerated. Thus, the percentage of the run escaping the sport fishery is higher than indicated.
3/Returns from the lower river releases excluded.
Because of the Alsea Hatchery operation, the production of wild fish in the North Fork and the subsequent adult return cannot be considered representative of the population dynamics of wild stock elsewhere in the Alsea system.

**Sandy River**

Prior to 1964, essentially all hatchery fish were released above Marmot Dam. Adult fish which pass above the dam have been designated as the spawning escapement. Tributaries and the main stem below the dam are believed to support only limited spawning so that unmarked adult fish enumerated at the dam are used as a measure of the escapement of wild steelhead. Marmot Dam and fish ladder are shown in Figure 9.

The numbers of hatchery fish passing over Marmot Dam increased from 1962-63 through 1965-66 primarily as a result of the larger numbers of fish stocked two years earlier (Table 8). The escapement of wild fish has remained relatively constant in the last four migratory seasons and is similar to the nine-year average (1953-62) of 2,400 fish.

<table>
<thead>
<tr>
<th>Migratory season</th>
<th>Wild fish (percent)</th>
<th>Hatchery fish (percent)</th>
<th>Total steelhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>1953-62</td>
<td>2,378 (94)</td>
<td>164 (6)</td>
<td>2,542</td>
</tr>
<tr>
<td>1962-63</td>
<td>2,425 (73)</td>
<td>901 (27)</td>
<td>3,326</td>
</tr>
<tr>
<td>1963-64</td>
<td>2,252 (58)</td>
<td>1,641 (42)</td>
<td>3,893</td>
</tr>
<tr>
<td>1964-65</td>
<td>3,456 (62)</td>
<td>2,074 (38)</td>
<td>5,530</td>
</tr>
<tr>
<td>1965-66</td>
<td>2,239 (63)</td>
<td>1,329 (37)</td>
<td>3,568</td>
</tr>
</tbody>
</table>

1/ Fish passing above Marmot Dam from 1958-59 through 1964-65 have been enumerated by means of an electronic counter. The numbers of hatchery fish were calculated from the ratio of marked to unmarked fish as determined by periodic trapping.

2/ Nine-year average

2/ First year for return of adult steelhead originating from Gnat Creek Hatchery.
The effect of stocking hatchery-reared steelhead on wild populations

The effects of stocking large numbers of yearling hatchery-reared, winter steelhead on wild stocks has long been a question of concern and speculation but largely ignored in hatchery evaluation programs. In general, an investigation of the matter would be hampered by the lack of historical records concerning the abundance of the wild population prior to and after the introduction of hatchery fish. An assumption would have to be made that population changes brought about by other environmental factors could be distinguished. There is little information presently available as to whether or not hatchery stockings are harmful or beneficial to wild steelhead populations, much less how, when, and where wild fish are influenced by such introductions.

Although the present study was not specifically designed to answer this question, data have become available concerning the catch and fishing success for wild steelhead, thus providing some insight as to how well the wild population has maintained itself in the presence of greater numbers of hatchery-reared steelhead and under increased angling effort.

Alsea River

From 1960-61 through the 1963-64 migratory season, the catch of wild fish increased in proportion to effort with the result that fishing success remained relatively constant (Table 2). During the period, it is not possible to say definitely whether the wild fish populations were increasing, decreasing or remaining static. If the efficiency of the fishing method remained constant during the period, the levels of exploitation were not sufficient to show any population decline or natural cycle of abundance, if it existed.

There appears to be a correlation between catch and population size with
respect to hatchery fish on the Alsea. If the same degree of correlation exists between catch and population for wild stocks, then an increase in abundance might be assumed. Whether the increase is related in some manner to the presence of hatchery fish in the stream or is just a population fluctuation from natural causes is a matter of speculation. Since there is little straying of adult hatchery fish into other tributaries on the Alsea River the recruitment of progeny resulting from the natural spawning of hatchery fish is believed to be small and any changes in abundance of the wild population the results of some other factor(s).

If the wild population was not constantly increasing during the period of 1960-61 through 1963-64, runs in previous years were probably under-harvested.

In the 1964-65 migratory season the number of wild fish caught in the sport fishery declined despite the increase in effort. The fishery in that migratory season was severely affected by flood conditions and whether the population level was down from previous years or unavailable to the angler because of the adverse water conditions is not known.

In 1965-66, the catch of 828 unmarked fish resulting from 26,700 angler days of effort was down to the level of the 1962-63 harvest which occurred with 10,400 angler days of use. In contrast, the catch of hatchery fish reached an all-time high in 1965-66. It appears at present that there was a decline in the abundance of the wild population in the 1965-66 migratory season.

The greatest catch of wild fish occurred in the 1963-64 migratory season. The adults which made up that return migrated seaward, for the most part, in 1962. The largest number of hatchery fish ever released on the Alsea River (157,000 yearling steelhead) occurred that same spring. It is not known what the long term effects of continued stocking of such large numbers of hatchery fish would be on the wild population.
In recent years, some of the releases of hatchery fish have been made in the lower Alsea River. When the adults return, straying into all the tributaries will occur. The spawning of adult hatchery fish in the tributaries where primarily only wild fish spawned previously could be theorized as potentially beneficial or harmful to the future abundance of wild populations.

Wilson River

The fishery on the Wilson River is similar to that of the Alsea and much of the discussion presented previously applies to the wild population in the Wilson River. The numbers of wild fish caught have paralleled changes in angling effort until the 1965-66 migratory season when the number of wild steelhead harvested declined to about 1,800 fish. Approximately 30,000 angler days of effort were expended in 1965-66 as compared to 16,500 in 1962-63 which resulted in a similar harvest. At the same time that the number of wild fish in the catch declined in 1965-66, a record catch of hatchery fish occurred. A decline in the abundance of winter steelhead in the 1965-66 migratory season is indicated. There are not sufficient data to assign the decline to the presence of hatchery fish. It is possible that an abundance of hatchery steelhead caused a replacement of wild fish in the creel.

Hatchery steelhead have been stocked at the rate of approximately 100,000 fish each spring since 1959. If the rate of stocking were to have an adverse effect on the wild population it should soon become apparent unless the wild population levels were so high that the early rate of exploitations could not detect the decline until recently.

In contrast to the Alsea, returning adult hatchery fish which escape the fishery on the Wilson have the opportunity to add to the population of juveniles resulting from natural reproduction.
In summary, if hatchery fish have had some adverse effect on the wild population on the Alsea and Wilson rivers with respect to abundance, it is not readily apparent from the data available.

**Sandy River**

The influence of hatchery-reared steelhead on the wild population appears to be negligible from evidence within the present data. The run of wild steelhead, while variable, has shown a trend of increasing abundance (Table 9). The average escapement of hatchery fish which were potential spawners was approximately 160 fish for the 1953-62 period (Table 8). It is doubtful that their progeny have played a major role in increasing the size of the wild populations.

**Table 9**

The estimated population of wild steelhead returning to Sandy River over twelve migratory seasons

<table>
<thead>
<tr>
<th>Migratory season</th>
<th>Estimated catch of wild steelhead (percent)</th>
<th>Estimated escapement of wild steelhead (percent)</th>
<th>Estimated population</th>
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<tbody>
<tr>
<td>1954-55</td>
<td>958 (38)</td>
<td>1,581 (62)</td>
<td>2,539</td>
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<tr>
<td>1955-56</td>
<td>1,157 (34)</td>
<td>2,240 (65)</td>
<td>3,397</td>
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<tr>
<td>1956-57</td>
<td>741 (27)</td>
<td>1,975 (73)</td>
<td>3,403</td>
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<tr>
<td>1957-58</td>
<td>1,581 (35)</td>
<td>2,917 (65)</td>
<td>4,498</td>
</tr>
<tr>
<td>1958-59</td>
<td>1,213 (35)</td>
<td>2,290 (65)</td>
<td>3,503</td>
</tr>
<tr>
<td>1959-60</td>
<td>1,824 (54)</td>
<td>1,578 (46)</td>
<td>3,402</td>
</tr>
<tr>
<td>1960-61</td>
<td>1,312 (32)</td>
<td>2,749 (68)</td>
<td>4,061</td>
</tr>
<tr>
<td>1961-62</td>
<td>1,056 (21)</td>
<td>3,871 (79)</td>
<td>4,927</td>
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<tr>
<td>1962-63</td>
<td>1,107 (31)</td>
<td>2,425 (69)</td>
<td>3,532</td>
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<tr>
<td>1963-64</td>
<td>2,064 (48)</td>
<td>2,252 (52)</td>
<td>4,316</td>
</tr>
<tr>
<td>1964-65</td>
<td>2,694 (44)</td>
<td>3,456 (56)</td>
<td>6,150</td>
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<tr>
<td>1965-66</td>
<td>2,155 (49)</td>
<td>2,239 (51)</td>
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</table>

The heavy stocking of hatchery fish beginning in 1961 does not appear to have influenced the wild downstream migrants since the subsequent adult returns of wild fish for the last four seasons (1962-66) are equal to or greater than the previous eight-year average of 3,600 fish (1954-62). Whether the adult returns of
wild fish would have been more or less without the stocking of hatchery fish is a matter of speculation.

Summary of marking experiments

The total return of specific release groups of hatchery-reared steelhead on the Alsea River is based on a summation of the estimated sport catch and observed escapement. On the Sandy River, the sport catch and escapement are estimated. The survival of specific release groups on the Wilson River is based only on returns to the sport fishery.

As indicated previously, the Alsea has been utilized primarily as an experimental stream with respect to the study of various factors possibly influencing survival, while the Sandy and Wilson rivers have been stocked on the basis of a program to ascertain the contribution of the hatchery product to the sport fishery and to increase fishing success.

The following presentation will be confined to experiments conducted on the Alsea River but will include information from the Sandy and/or Wilson rivers where applicable to the discussion.

Survival

The returns of specific groups of yearling steelhead released into the Alsea and Wilson rivers from 1958 through 1964 are summarized in Tables 10 and 11, respectively. The adult returns from fish released from 1961 through 1964 are summarized in Table 12 for the Sandy River.

Survivals have ranged from 0.4 percent up to 9.6 percent for 17 groups of fish released over a 7-year period (1958-1964) on the Alsea River. Approximately 400,000 fish have been released with an average survival of 5.0 percent. The return to the sport fishery has been 2.6 percent.
Table 10. Numbers of adult steelhead returning to the Alsea River from hatchery-reared groups liberated during 1958-64.

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<tbody>
<tr>
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<td>164</td>
<td>172</td>
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<td>189</td>
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<td>216</td>
<td>227</td>
<td>248</td>
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</table>

| TOTAL RETURN      | 120     | 198     | 44      | 49      | 237     | 315     | 155     | 146     |
| PERCENT TOTAL RETURN | 48      | 7.5     | 4.8     | 4.5     | 13      | 1.8     | 13      | 14.3    |
| PERCENT RETURN TO FISHERY | 0.3     | 3.5     | 0.1     | 0.1     | 0.4     | 0.2     | 0.4     | 0.4     |
Table 11. Numbers of adult steelhead returning to the sport fishery on the Wilson River from hatchery-reared groups liberated during 1958-64.

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Table 12. Numbers of adult steelhead returning to the Sandy River from hatchery-reared groups liberated during 1961-64.

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<tr>
<td>NUMBER RELEASED</td>
<td>47 100</td>
<td>43 600</td>
<td>127 000</td>
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<tr>
<td>NUMBER PER LB.</td>
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MIGRATORY SEASON 1962-63

| SPORT CATCH | 53          | 44          | 615        | 1001       | 21       |
| ESCAPEMENT | 234         | 251         | 654        | 673        | 0        |
| COMMERCIAL CATCH | 112        | 40          | 39         | 33         | 21       |
| OTHER | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED |
| TOTAL | 339         | 427         | 1310       | 1707       | 0        |

1963-64

| SPORT CATCH | 22          | 88          | 615        | 1001       | 21       |
| ESCAPEMENT | 115         | 148         | 654        | 673        | 0        |
| COMMERCIAL CATCH | 12        | 15          | 39         | 33         | 21       |
| OTHER | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED |
| TOTAL | 133         | 251         | 1310       | 1707       | 0        |

1964-65

| SPORT CATCH | 35          | 35          | 242        | 375        | 309      | 1102     |
| ESCAPEMENT | 0           | 0           | 277        | 158        | 422      | 174      |
| COMMERCIAL CATCH | 0        | 0           | 0          | 0          | 28       | 44       |
| OTHER | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED |
| TOTAL | 35          | 35          | 242        | 375        | 309      | 1102     |

1965-66

| SPORT CATCH | 26          | 0           | 129        | 204        | 646      | 775      | 671      | 103      |
| ESCAPEMENT | 34          | 18          | 154        | 132        | 507      | 342      | 51       | 27       |
| COMMERCIAL CATCH | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED |
| OTHER | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED | NOT MEASURED |
| TOTAL | 60          | 18          | 283        | 338        | 1175     | 1119     | 730      | 134      |

TOTAL RETURN 587 733 1899 2238 1253 2414 1.4 2.8 1.9 0.3

PERCENT 1.2 1.7 1.5 4.5 1.2 2.3 1.4 2.8 1.9 0.3
Twelve separate releases of hatchery-reared steelhead have been made over a 7-year period (1958-64) on the Wilson River. A total of 499,000 fish were released of which 18,476 or 2.5 percent were estimated to have been taken in the sport fishery as adults. Survivals to the sport fishery have ranged from 0.5 to 6.6 percent.

On the Sandy River, for six groups of fish released over a 3-year period, survivals have ranged between 1.0 and 4.5 percent. In general, returns to the Sandy have been below those measured on the Alsea or Wilson.

It has not been possible to control all the variables that might influence the survival of hatchery-reared steelhead. The stream, estuary, and ocean environments are changing seasonally as well as from year to year. The excising of various fins with respect to location and numbers for purposes of identification probably influences the survival potential of a given group. Disease and parasites can generally be controlled but the effect of the pathological condition or treatment on viability is not known.

Criteria for measuring the general health or viability of the fish at the time of release have not been developed. Diets have changed as new knowledge of the nutritional requirements was established, resulting in the production of a healthier fish during the course of the study. Viability as related to genetic endowment, particularly with respect to growth rate, is not understood. Thus, there are many uncontrolled factors which influence the survival of the hatchery product and add to the variability of the return. The above-mentioned factors must be considered in the final interpretation of results.

The influence of fish size at release on survival

Of the many possible factors which apparently affect the adult return of hatchery-reared steelhead, size at release is one of the most important, although it cannot be completely separated from closely associated factors such
as the parr-smolt transformation and time of release.

Sufficient evidence is available from marking experiments conducted in California, Oregon, and Washington to show that increased marine survival can be expected with increased size at release (Wagner et al., 1963; Hallock et al., 1961; and Larson and Ward, 1954). Information is available indicating that marine survival rates for wild steelhead populations are related to size at time of seaward migration. The picture is complicated for wild smolts by the influence of factors of unknown importance. For instance, larger smolts tend to move downstream first (Shapovalov and Taft, 1954). Over a two or three-month migration period, environmental conditions could and probably do change and early migrants (the larger fish) might find freshwater, estuary, or ocean less hostile than could later migrants. As the migration progresses, a buildup of predatory animals could occur. Information is available (see following section on the influence of size at release on life history pattern and size of returning adults) for hatchery fish showing that with increasing size at release, less time is spent in the ocean.

Survival of hatchery-reared steelhead in relation to size has been variable as a result of the existence of a number of uncontrollable factors. Nevertheless the trend towards increased survival when fish are released at a larger size is apparent.

In any given release year on the Alsea River from 1958 through 1960, and on the Wilson from 1959 through 1960, the larger fish have shown the greatest return (Tables 10 and 11 respectively). The fastest-growing individuals of any lot of hatchery yearlings, whether they reached a size of 5 or 12 per pound in any one year, have had the greatest survival of the size groups released at that time. The possible relationship between growth rate and viability in the present case is not known.
Data from the Alsea and Sandy rivers in Oregon, Chambers Creek and Samish River in Washington and the Sacramento River in California are presented in Figure 10. Despite the diversity of the geographic locations, times of release, life history patterns, and many other variables, the data from each river are in agreement with respect to the relationship of size at release and survival. Not until a size of 9-10 fish per pound is reached do consistent survivals above 1-2 percent occur.

Size alone should not be the only criterion for governing time of release. Size as such is primarily a means to an end, that is, an insurance that a high percentage of the fish will smolt and migrate seaward when the proper priming and releasing factors are present.

In general, fish size appears to play a dual role in juvenile steelhead. First, size is important from the standpoint of the parr-smolt transformation and secondly, it appears to be of importance once migration is under way and the fish enters the marine environment.

Influence of fish size at release on time spent in the marine environment

Of considerable importance is the influence of size at release on the life history, in particular, on the amount of time spent in the marine environment prior to the first spawning migration. Time spent in the ocean influences the number and size of the adult fish returning.

The number of adult hatchery-reared steelhead returning to spawn for the first time after spending one, two, or three summers in the ocean is summarized in Tables 13 and 14 by specific release groups, for the Alsea and Wilson rivers.

In general, there appears to be a tendency for fish released at a larger size to spend less time in the ocean, that is, a higher percentage return after one summer (age/1) in the ocean. For groups released at a smaller mean size, larger returns of fish in the age/3 category occurred.
Figure 10. Relationship between size at release and adult return for hatchery-reared steelhead in California, Oregon and Washington.
Table 13. The survival and life history pattern for specific release groups of hatchery-reared steelhead spawning for the first time on the Alsea River1/.

<table>
<thead>
<tr>
<th>Release Date</th>
<th>Size (fish per pound)</th>
<th>Per-cent age/1 (number)</th>
<th>Per-cent age/2 (number)</th>
<th>Per-cent age/3 (number)</th>
<th>Total number of fish (number)</th>
<th>Total estimated mated percent return age/2 and age/3 fish</th>
<th>Esti- Number of estimated repeat spawners</th>
<th>Total6/</th>
<th>Estimated percent return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr. 1958</td>
<td>13</td>
<td>4.2(5)</td>
<td>78.3(94)</td>
<td>17.5(21)</td>
<td>120</td>
<td>0.8</td>
<td>115</td>
<td>0.7</td>
<td>0</td>
</tr>
<tr>
<td>Apr. 1959</td>
<td>7.7</td>
<td>7.8(107)</td>
<td>81.7(1,120)</td>
<td>10.5(114)</td>
<td>1,371</td>
<td>8.8</td>
<td>1,285</td>
<td>8.3</td>
<td>109</td>
</tr>
<tr>
<td>Apr. 1959</td>
<td>25.6</td>
<td>8.7(4)</td>
<td>82.6(38)</td>
<td>8.7(4)</td>
<td>46</td>
<td>0.4</td>
<td>42</td>
<td>0.4</td>
<td>3</td>
</tr>
<tr>
<td>Apr. 1959</td>
<td>9.0</td>
<td>5.8(13)</td>
<td>88.0(159)</td>
<td>6.2(14)</td>
<td>266</td>
<td>0.9</td>
<td>213</td>
<td>0.9</td>
<td>11</td>
</tr>
<tr>
<td>Apr. 1959</td>
<td>5.5</td>
<td>18.9(78)</td>
<td>78.0(322)</td>
<td>3.1(13)</td>
<td>413</td>
<td>4.7</td>
<td>335</td>
<td>3.8</td>
<td>12</td>
</tr>
<tr>
<td>Apr. 1960</td>
<td>20.0</td>
<td>0.0(0)</td>
<td>78.1(107)</td>
<td>21.9(30)</td>
<td>137</td>
<td>1.1</td>
<td>137</td>
<td>1.1</td>
<td>18</td>
</tr>
<tr>
<td>Apr. 1960</td>
<td>9.4</td>
<td>3.1(93)</td>
<td>85.6(2,549)</td>
<td>11.3(338)</td>
<td>2,980</td>
<td>5.6</td>
<td>2,934</td>
<td>5.5</td>
<td>210</td>
</tr>
<tr>
<td>Feb. 1961</td>
<td>10.0</td>
<td>11.6(148)</td>
<td>86.0(1,095)</td>
<td>2.4(30)</td>
<td>1,273</td>
<td>2.5</td>
<td>1,205</td>
<td>2.4</td>
<td>136</td>
</tr>
<tr>
<td>Apr. 1961</td>
<td>7.8</td>
<td>8.1(189)</td>
<td>88.4(2,080)</td>
<td>3.5(83)</td>
<td>2,352</td>
<td>4.6</td>
<td>2,339</td>
<td>4.6</td>
<td>261</td>
</tr>
<tr>
<td>Feb. 1962</td>
<td>8.4</td>
<td>2.0(53)</td>
<td>96.0(2,559)</td>
<td>2.0(55)</td>
<td>2,667</td>
<td>4.7</td>
<td>2,615</td>
<td>4.6</td>
<td>57</td>
</tr>
<tr>
<td>Mar. 1962</td>
<td>8.9</td>
<td>2.0(42)</td>
<td>94.8(2,059)</td>
<td>3.2(71)</td>
<td>2,172</td>
<td>4.2</td>
<td>2,130</td>
<td>4.1</td>
<td>54</td>
</tr>
<tr>
<td>Apr. 1962</td>
<td>9.1</td>
<td>1.2(36)</td>
<td>94.6(2,887)</td>
<td>4.2(129)</td>
<td>3,052</td>
<td>6.2</td>
<td>3,018</td>
<td>6.1</td>
<td>100</td>
</tr>
</tbody>
</table>

Means and totals 5.5-25.6 4.6(762) 89.9(15,109) 5.5(932) 16,808 4.2 16,368 4.1 971(5.4)6/ 17,780 4.6/.

1/ Assignment to life history pattern is based on scale analysis (674 scale samples) and chronological time of return.

2/ Age refers to summers spent in the ocean (/1=one summer in the ocean) freshwater age is usually 1/. Few hatchery fish (an estimated 50 out of 16,808 fish) showed a second freshwater annulus.

3/ Age/1 fish are predominantly precocial males, commonly referred to as "Jacks".

4/ Summation of first time spawners and repeat spawners.

5/ Percent repeat spawners of total estimated return.

6/ From 1958 through 1962, 400,336 fish were released.
Table 14. The survival and life history pattern for specific release groups of hatchery-reared steelhead spawning for the first time on the Wilson River.

<table>
<thead>
<tr>
<th>Release date</th>
<th>Size (fish per pound)</th>
<th>Per-Percent2/2/ Percent2/2/</th>
<th>Per-Percent2/2/ Total</th>
<th>Total Percent</th>
<th>Total Percent</th>
<th>Estimated</th>
<th>Estimated</th>
<th>Number</th>
<th>Total Number</th>
<th>Estimated</th>
<th>Estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(fish age/1 number)</td>
<td>(fish age/2 number)</td>
<td>number of fish</td>
<td>percent return</td>
<td>number/2 and</td>
<td>percent return</td>
<td>return</td>
<td>of return</td>
<td>percent return</td>
<td>percent return</td>
</tr>
<tr>
<td>Mar. 1958</td>
<td>10.6</td>
<td>0.6(10)</td>
<td>94.1(1,520)</td>
<td>1,615</td>
<td>2.1</td>
<td>1,605</td>
<td>2.0</td>
<td>37</td>
<td>1,652</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Feb.-Mar. 1959</td>
<td>9.0</td>
<td>6.1(44)</td>
<td>93.2(681)</td>
<td>725</td>
<td>0.8</td>
<td>681</td>
<td>&lt;0.8</td>
<td>71</td>
<td>796</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Feb.-Mar. 1959</td>
<td>5.6</td>
<td>9.3(18)</td>
<td>88.6(171)</td>
<td>193</td>
<td>1.6</td>
<td>175</td>
<td>1.4</td>
<td>4</td>
<td>197</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Mar.-June 1960</td>
<td>15.7</td>
<td>0.0(0)</td>
<td>55.6(25)</td>
<td>45</td>
<td>0.5</td>
<td>45</td>
<td>0.5</td>
<td>0</td>
<td>45</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Mar.-June 1960</td>
<td>12.7</td>
<td>0.0(0)</td>
<td>62.1(532)</td>
<td>857</td>
<td>0.9</td>
<td>857</td>
<td>0.9</td>
<td>138</td>
<td>995</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Apr. 1961</td>
<td>9.3</td>
<td>4.5(30)</td>
<td>82.9(553)</td>
<td>667</td>
<td>1.5</td>
<td>637</td>
<td>1.4</td>
<td>53</td>
<td>720</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Apr. 1961</td>
<td>9.5</td>
<td>1.9(18)</td>
<td>89.3(829)</td>
<td>929</td>
<td>1.5</td>
<td>911</td>
<td>1.4</td>
<td>55</td>
<td>984</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Mar.-Apr. 1962</td>
<td>8.5</td>
<td>3.6(118)</td>
<td>91.1(2,973)</td>
<td>3,265</td>
<td>3.1</td>
<td>3,147</td>
<td>3.0</td>
<td>58</td>
<td>3,323</td>
<td>3.1</td>
<td></td>
</tr>
</tbody>
</table>

Means and totals 5.6-15.7 2.9(238) 87.7(7,284) 9.4(779) 8,296 1.7 8,058 1.6 416(4.8) 8,712 1.75/ 1/Assignment to life history pattern is based on scale analysis (348 scale samples) and chronological time of return.
2/ Age refers to summers spent in the ocean (/1=one summer in the ocean) freshwater age is usually 1/. Few hatchery fish (an estimated 5 out of 8,296 fish) showed a second freshwater annulus.
3/ Age/1 fish are predominantly precocial males, commonly referred to as "jacks".
4/ Summation of first time spawners and repeat spawners.
5/ Percent repeat spawners of total estimated return.
6/ From 1958 through 1962, 499,000 fish were released.
7/ Percent return to sport fishery only.
On the Alsea River for the 1958-62 releases, 4.6 percent of the fish return at age/1, 89.9 percent at age/2 and 5.5 percent at age/3. Of the total return of hatchery-reared adults, approximately 5.4 percent had spawned previously.

The Wilson River has been similar to the Alsea River with respect to the time spent in the marine environment by hatchery fish. Approximately 2.9 percent of them returned to spawn for the first time at age/1, 87.7 percent at age/2, and 9.4 percent at age/3. Of the total of hatchery-reared steelhead returning to the Wilson River, 4.8 percent had spawned previously.

Hatchery fish appear to spend less time in the ocean than do wild fish originating from the Alsea River. Chapman (1958) reported that 5.4 percent were age/1, 66.4 percent age/2, 25.6 percent age/3, and 2.6 percent age/4.

The precocial steelhead (jacks) returning have ranged from zero to 18.9 percent of the total estimated returns of hatchery-reared fish for individual release groups on the Alsea River.

The return to the river after only one summer in the ocean appears to be related primarily to size at time of release. The occurrence of precocity in wild and hatchery-reared steelhead is similar. As reported previously, 5.4 percent of the wild fish spawning for the first time in the Alsea River were classified as age/1. Hatchery-reared steelhead returning to the Alsea River for their first spawning have been made up of 4.6 percent age/1 fish.

Generally, the larger the mean size of the hatchery fish at release the higher the incidence of precocity (Tables 13 and 14). Precocial female steelhead are rarely observed. The mechanism by which accelerated growth of the pre-smolt in a freshwater (and perhaps saline) environment results in early sexual maturation is not understood.
Chapman (1958) also reported an 11.1 percent "repeat spawners" in a sample of 1,195 returning adults in the winters of 1951-55. Fishing intensity has increased in recent years and the difference in percentage of repeat spawners could be a function of fishing mortality.

Hatchery fish have generally been smaller than those that are wild as a result of being younger upon return. The tendency for hatchery fish to return earlier in comparison to wild stocks might be a result of hatchery migrants being larger than wild smolts or to physiological differences arising from the freshwater rearing period or genetic changes.

A more detailed discussion of the life history pattern and size of hatchery-reared steelhead as related to size at time of release and in comparison to wild fish will be presented in a future report.

The effect of time of release on survival

The success of the hatchery program in supplementing the natural production of winter steelhead smolts depends in part on the elimination or reduction of factors which might adversely affect the wild stock or reduce the number of viable hatchery smolts reaching the sea. Ideally, the stream is to serve only as a highway to the sea and not as a post-liberation rearing area for the hatchery product. In keeping with this end, it is essential that the hatchery fish migrate seaward shortly after release and not remain in the stream where competition and predation might result in reduced survival of native and introduced populations.

Two facts have been established for the parr-smolt transformation in steelhead trout. The phenomenon is markedly size dependent and the transformation and resulting downstream migration are seasonal in occurrence. The timing of the release of the hatchery product is the primary concern of the present discussion.
February and March releases versus April releases

It has been noted that as early as February the larger fish in the hatchery take on a silvery appearance, tend to school, and frequently mill about the outlet of the raceways. It was felt that considerable saving in the rearing cost might be realized if the larger fish could be released as early as February and that their survival might be enhanced over those held and released in April.

Consequently, in February of 1961, approximately 51,000 of the fastest-growing yearling steelhead at a size of 10 fish per pound were released into the Alsea River. In April, it was planned to release a group of fish of a comparable size (slower-growing and some faster-growing fish from a later egg take) but they reached a size of 7.8 fish per pound at release.

A 2.8 percent return was estimated for the February release (10 fish per pound) and a 5.1 percent for the April release (7.8 fish per pound), see Table 10. Whether the difference between the survival of the two groups was a result of time and/or size is not known. The data indicate that the survival potential of the group released in February might have been substantially greater if held to April.

In the spring of 1962, three releases of yearling steelhead of similar size were made into the Alsea River. In February, approximately 57,000 fish at a size of 8.4 fish per pound were released and then in March 52,000 fish at 8.9 fish per pound were liberated. The last release was made in April, when 50,000 fish at 9.1 fish per pound were placed in the stream. The February group was essentially made up of fish with a fast growth rate, while those in March and April contained individuals with slower growth rates but also contained a high proportion of fish which grew rapidly and originated from later egg takes.

The February and March groups gave comparable returns, 4.8 and 4.3 percent,
respectively. The April release was considerably higher with an estimated 6.4 percent return. Because of the many uncontrolled variables, additional releases are required before a definite conclusion can be drawn with respect to the effect of time of release within a spring period on survival. It appears at present, that the best use of the hatchery product will be obtained by holding the fish to the normal period of seaward migration before releasing.

Voluntary releases versus April forced releases

On the Alsea River, the downstream migration period for wild smolts occurs from April through May with only a few fish observed prior to or after that interval. Peak movements have varied from mid-April to mid-May. It is apparent from the data that not all the wild fish undergo the parr-smolt transformation at the same time or at least not all are as receptive to stimuli which initiate the downstream migration.

It was thought that in a group of hatchery-reared steelhead which are released en masse on a pre-selected date, some of them might have been held too long and would have reverted back to a non-migratory form, or other individuals might be released too soon. The end result would be that some fish would take up residency in the stream for varying periods of time.

In 1963, 1964, and 1965, hatchery-reared steelhead at the Alsea Trout Hatchery were allowed to leave the rearing raceway voluntarily. The adult returns have been compared to the survival obtained from fish forced from the rearing area in mid-April. The forced liberation dates were based on knowledge of the migratory pattern of the wild fish, results of previous marking experiments, fish size, general appearance of the animal, changes in coefficient of condition, and stream flow existing at the time.

In early February, the screens were removed from the outlet of the raceway
and an opening 9 inches by 12 inches in dimension was provided in the stop logs approximately 12 inches below the water surface. The orifice provided escape from the raceway to the stream via the water discharge system of the hatchery. We can only assume that the movement of fish out of the raceway was directed as a result of a change in the migration disposition of the animal resulting from the parr-smolt transformation and was not influenced by the position and/or geometry of the submerged orifice. At approximately 30-day intervals, the number of fish remaining in the raceway was determined from the total pounds and the fish per pound. In mid-May, the fish which had not migrated were forced out into the stream.

The movement and growth data for fish in the voluntary and forced release groups in 1963, 1964, and 1965 is summarized in Table 15. The 50 percent point in the movement of fish out of the raceway varied from mid-April to the first week in May. In 1963, the movement of hatchery fish occurred earlier and was more extensive than in 1964 and 1965. The migration pattern of 1963 is believed to be partially the result of the larger number of freshets occurring that spring which perhaps provided a continuous flow of releasing stimuli. In general, the movement pattern of hatchery fish from the raceway appeared similar to the movement of wild fish in the stream, see Figure 11. The data used in plotting the downstream movement of wild fish with respect to time was obtained from a paper by Wagner et al., (1963).

The estimated total returns of fish released in 1963 and 1964 are shown in Table 10. The 1963 returns are complete and those of 1964 are essentially complete with the exception of the return of the four-year-old fish (3+). An estimated 3.9 percent return (2,700 fish) was obtained from the voluntary release group in 1963 and 4.4 percent (3,100 fish) from the April forced liberation. The estimated returns from the 1964 returns were 8.1 percent (3,200 fish) from
Figure 11. The percentage of hatchery fish remaining in the raceway and wild fish in the stream each month from February through May.
Table 15

The movement and growth of fish in the voluntary and forced release groups in 1963, 1964 and 1965

<table>
<thead>
<tr>
<th>Year</th>
<th>Method</th>
<th>Mean fork length (cm)</th>
<th>Mean weight (gm)</th>
<th>Mean coefficient of condition</th>
<th>Fish per pound</th>
<th>Number of fish remaining in pond</th>
<th>Percent of total</th>
<th>Mean discharge, N.F. Alsea (CFS)</th>
<th>Water temperature, mean low and high (F°)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Voluntary</td>
<td>Feb. 10</td>
<td>15.3</td>
<td>37.3</td>
<td>1.021</td>
<td>12.8</td>
<td>70,000</td>
<td>100</td>
<td>615</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mar. 22</td>
<td></td>
<td></td>
<td></td>
<td>8.9</td>
<td>64,200</td>
<td>92</td>
<td>441</td>
</tr>
<tr>
<td>1963</td>
<td>Apr. 24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.4</td>
<td>6,950</td>
<td>10</td>
<td>566</td>
</tr>
<tr>
<td></td>
<td>May 16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.7</td>
<td>2,300</td>
<td>3</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td>Forced</td>
<td>Apr. 17</td>
<td>17.4</td>
<td>51.7</td>
<td>0.941</td>
<td>8.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voluntary</td>
<td>Feb. 10</td>
<td>16.2</td>
<td>42.6</td>
<td>0.998</td>
<td>10.4</td>
<td>40,000</td>
<td>100</td>
<td>302</td>
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<td>Mar. 1</td>
<td>16.9</td>
<td>49.8</td>
<td>1.004</td>
<td>9.2</td>
<td>39,200</td>
<td>98</td>
<td>472</td>
</tr>
<tr>
<td>1964</td>
<td>Apr. 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18.6</td>
<td>61.2</td>
<td>0.942</td>
<td>34,000</td>
</tr>
<tr>
<td></td>
<td>May 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20.0</td>
<td>76.1</td>
<td>0.937</td>
<td>11,000</td>
</tr>
<tr>
<td></td>
<td>Forced</td>
<td>Apr. 14</td>
<td>18.3</td>
<td>57.7</td>
<td>0.921</td>
<td>7.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voluntary</td>
<td>Feb. 6</td>
<td>15.4</td>
<td>35.8</td>
<td>0.953</td>
<td>12.8</td>
<td>40,000</td>
<td>100</td>
<td>410</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mar. 8</td>
<td></td>
<td></td>
<td></td>
<td>10.4</td>
<td>36,800</td>
<td>91</td>
<td>184</td>
</tr>
<tr>
<td>1965</td>
<td>Apr. 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18.3</td>
<td>56.8</td>
<td>0.918</td>
<td>36,600</td>
</tr>
<tr>
<td></td>
<td>May 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19.4</td>
<td>65.6</td>
<td>0.889</td>
<td>15,000</td>
</tr>
<tr>
<td></td>
<td>Forced</td>
<td>Apr. 15</td>
<td>18.3</td>
<td>57.7</td>
<td>0.928</td>
<td>8.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1/ Released on date indicated.
the voluntary group and 9.6 percent (4,800 fish) from the forced group. The returns from the 1965 release groups are not yet complete. When the 10 to 15 percent error associated with these estimates is taken into consideration the difference between returns of the two methods of release cannot be considered significant.

Under the conditions that the liberations were made, the voluntary release method has not enhanced the survival of the hatchery product when compared to the usual method of release where the fish are forced out of the pond on a preselected date. One reason for the similarity in survival of the two groups (forced versus voluntary) can be related to the movement pattern of the fish out of the raceway. Most of the voluntary movement occurred between mid-April and mid-May with the possible exception of an earlier movement for the 1963 voluntary release group. Consequently, the release of hatchery fish in mid-April probably matched the migratory activity period of most of the smolts in the forced liberation group. Fish which were held in the raceway the first part of April, which would have migrated if released, apparently retained the migration urge or if they had reverted to a non-migratory form, their numbers were so few as not to alter the returns substantially.

The data from the above marking experiments indicate a necessity for release of fish during the period of migratory activity for maximum survival. It also appears that mid-April is the most favorable time for the forced liberation of hatchery-reared steelhead on the Alsea River.

Influence of release location on contribution of hatchery-reared steelhead

Adult steelhead trout returning on their spawning migration are known to home rather precisely to the site of release in freshwater. Steelhead are routinely reared at a hatchery in one watershed and then transported and
released in another watershed during the migration period. Yet, as adults they return to the release stream and not to the watershed where they were reared. It appears that the homing cue(s) are implanted rather quickly prior to and/or during the downstream migration. The actual time and/or distance traveled to insure a high degree of homing for a given release group is not known.

Hatchery fish placed in the key streams have been released in the upper sections of the watershed. Consequently, the adult fish upon their return migrate upstream and are exposed to the sport fishery over its entire length before reaching the sanctuary of the spawning grounds. Under suitable water conditions, the returning fish move upstream at such a rapid rate that they are vulnerable to the fishery for only a short period of time.

It was thought that fish stocked in the lower or middle sections of the rivers would, perhaps, delay their upstream migration upon return after reaching the release site and consequently be exposed to the sport fishery for a longer period of time. The time and size of the fish liberated were similar for all release locations on a given river.

In 1964, releases of hatchery-reared steelhead were made in the lower and middle sections of the Sandy and Wilson rivers and in the lower section on the Alsea River. The releases of some fish in the upper section on all three rivers were continued. Release sites in the lower and middle sections were selected on the basis of fishing pressure.

On the Alsea River, returns of 5.8 percent to the fishery for the upper-river release, and 3.4 percent for the lower river (Table 10), were estimated. The distribution of catch by river section for the two release groups is summarized in Table 16. Although fish of the lower-river release were taken in slightly greater numbers in the lower river, the overall contribution to the sport fishery was lower because of the existence of an intensive fishery in the
upper section (North Fork). Part of the upper-river plant was harvested upon return in the lower river and some, to a lesser degree, in the Middle river. Then it was subjected to an intensive fishery in the upper river. The lower-river plant appears to have held in the lower area for only a short while and then strayed into the other tributaries. Smaller numbers of fish were thus available for the upper-river fishery in comparison to the upper-river plant. Fewer adults originating from the lower-river plant (676 fish) were trapped on the North Fork in comparison to the upper-river plant (1,909 fish), see Table 10. The survival and the degree of straying to other river systems is not known for the lower-river plant.

Table 16
The observed and estimated catch of adult fish returning from the 1964 release groups by geographic location on the Alsea River in 1965-66

<table>
<thead>
<tr>
<th>Release group</th>
<th>Location of recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper River</td>
</tr>
<tr>
<td>Upper River</td>
<td>91/ (1,747)/</td>
</tr>
<tr>
<td>Lower River</td>
<td>31 (595)</td>
</tr>
<tr>
<td>Angler-days of use</td>
<td>9,849</td>
</tr>
</tbody>
</table>

1/ Observed
2/ Estimated

On the Wilson River, a 3.1 percent return to the sport fishery was estimated for the upper-river release group, a 5.6 percent return for the middle-river plant and a 6.6 percent return for the group released in the lower river (Table 11). The distribution of catch by river sections for the three release groups is summarized in Table 17. An examination of the distribution of catch by section of the river shows that the marked group observed in the greatest number was the group released in a particular area, but the number of marked fish observed for all three groups declined as the fish migrated upstream. Fishing pressure was
comparable in the lower and middle sections (11,500 angler days) but consider-
ably less in the upper section (7,100 angler days).

Table 17

The observed and estimated catch of adult fish returning from the 1964
release groups (by geographic location) on the Wilson River
in 1965-66

<table>
<thead>
<tr>
<th>Release group</th>
<th>Location of recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper River</td>
</tr>
<tr>
<td>Upper River</td>
<td>251/ (330)2/</td>
</tr>
<tr>
<td>Middle River</td>
<td>10 (132)</td>
</tr>
<tr>
<td>Lower River</td>
<td>4 (52)</td>
</tr>
<tr>
<td>Angler days of use</td>
<td>7,095</td>
</tr>
</tbody>
</table>

1/ Observed
2/ Estimated

The low comparative return of the upper-river plant is perhaps related to
one or more of the following causes:

(1) reduced fishing intensity in the upper section;

(2) the upper-river plant was made at a mean distance of approximately

5 miles above the upper fishing boundary and consequently the returning

adult fish probably passed through all three sections of the river at
nearly the same rate and;

(3) lower survival in comparison to other release groups.

Creel checks on the Trask River indicated a high incidence of straying of
adult steelhead from the 1964 release of steelhead in the Wilson River. Of the
136 fish observed, 15 or 11 percent originated from the Wilson. Seven fish each
were observed from the lower and upper-river releases and one fish from the
middle-river liberation.

The estimates of catch on the Sandy for the marked groups originating from
three release locations indicated that the upper-river plant gave slightly higher
returns to the fishery than did the middle-river release with 775 (50 observed) and 646 (51 observed) caught, respectively (Table 12). It is assumed that sampling in a given portion of the river was proportional to effort. Only 103 (7 observed) fish originating from the lower-river release were estimated in the sport catch. The reduced contribution of the lower-river group could be a result of the lack of angling activity in the area of release or a function of numbers. An examination of escapement data shows that if the middle and lower-river fish were as abundant as the upper-river plant in the 40 miles of stream below Marmot Dam, they apparently did not migrate upstream for purposes of spawning (Table 12).

In general, manipulation of the release location appears to be an effective means of increasing the contribution of hatchery-reared steelhead to the sport fishery on certain streams. It should be correlated with the known distribution of fishing effort.

The contribution of hatchery-reared steelhead to the sport fishery with respect to origin of the stock.

Hatchery fish stocked in the Sandy River in 1961-64 have originated from two egg sources, Sandy River and Big Creek². The wild run normally peaks in December and January on Big Creek while peak movements of steelhead over Marmot Dam (on the Sandy River) in the past have occurred in March and April. The pattern of fishing effort in the sport fishery on the Sandy River is similar to that of the coastal streams with maximal effort occurring in December, January, and February.

It has been found that adult hatchery fish of Big Creek origin stocked in the Sandy River have tended to enter the fishery and arrive at the trap earlier

² Big Creek stock also included fish of Alsea origin in 1964.
than fish of Sandy River origin. The time of return to the Sandy River for hatchery fish of Sandy stock has been similar to that of the parent fish. It appears feasible that the early fishery can be enhanced by the stocking of larger numbers of fish of early-return parentage. Neither the chances for successful natural reproduction of an early run nor the long term effect of such a stocking program on the native population are known.

The proportionally greater contribution of Big Creek stock to the sport fishery with respect to the escapement contribution in comparison to Sandy River stock can be seen in Table 12, and probably is a function of run timing.

Big Creek stock has consistently shown an over all higher adult return than has Sandy River stock. The reason probably lies in the size of fish released since Big Creek stocks have consistently been larger. Eggs from Big Creek fish are obtained earlier than from the Sandy River stock because of the difference of timing of the runs, resulting in a longer rearing period for the juvenile fish.

At present, artificial propagation and stocking are aimed at increasing the magnitude of the early run on the Sandy River.

Costs of returning adult hatchery-reared steelhead trout to the river and creel

An important aspect of the evaluation of artificial propagation as a management technique is the cost of adult fish returning to the river as potential spawners and the cost of a fish in the creel.

The known cost per pound for rearing yearling steelhead at Alsea, Cedar Creek and Gnat Creek hatcheries includes operating and maintenance expenses, feed, and facility and equipment costs. Capital investment in lands, buildings, and equipment is shown in Table 18 for the three hatcheries. Depreciation is figured for ponds and buildings on a 50-year basis and equipment from 5 to 20 years.
Table 18

Steelhead production costs in the form of capital investments in land, buildings, and equipment for the Alsea, Cedar Creek and Gnat Creek hatcheries

<table>
<thead>
<tr>
<th>Item</th>
<th>Alsea</th>
<th>Cedar Creek</th>
<th>Gnat Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>$ 59,807</td>
<td>$ 98,407</td>
<td>$296,514</td>
</tr>
<tr>
<td>Buildings</td>
<td>86,756</td>
<td>37,674</td>
<td>204,188</td>
</tr>
<tr>
<td>Office equipment</td>
<td>177</td>
<td>86</td>
<td>917</td>
</tr>
<tr>
<td>Construction &amp; maintenance</td>
<td>3,637</td>
<td>6,162</td>
<td>3,485</td>
</tr>
<tr>
<td>Farm &amp; hatchery equipment</td>
<td>2,119</td>
<td>9,000</td>
<td>21,321</td>
</tr>
<tr>
<td>Dorm &amp; household equipment</td>
<td>493</td>
<td>356</td>
<td>545</td>
</tr>
<tr>
<td>Field equipment</td>
<td>13,528</td>
<td>16,525</td>
<td>4,988</td>
</tr>
<tr>
<td>Total</td>
<td>$172,587</td>
<td>$168,210</td>
<td>$531,958</td>
</tr>
</tbody>
</table>

1/ Figures provided by Portland office accounting records

Table 19 shows the overall production in pounds of fish produced annually, total fiscal year costs, and cost per pound of fish produced. Not included in the production costs are the salaries for liberation truck drivers and the cost of feed delivery to the hatchery with the approximate cost for these two items being $0.023 and $0.015 per pound of fish, respectively.

The costs of the adult fish returning to the river and creel are presented in Table 20 for specific release groups for the Alsea, Sandy and Wilson rivers from 1958-64. Cost per adult fish is determined from the total pounds released, the rearing cost per pound, and the number of adults estimated to have returned to the river or creel.

As the size of the fish released increases, the cost for a given number of fish increases but the cost per returning adult is less because of the greater marine survival of the larger juveniles (≥9 fish per pound) in comparison to smaller fish (<9 fish per pound).

Rearing costs have been variable at the Alsea Hatchery during the 1958-64
Table 19
Cost assignment for producing a pound of yearling steelhead trout

<table>
<thead>
<tr>
<th>Year</th>
<th>Pounds of steelhead produced annually</th>
<th>Total fiscal year costs (operating costs and feed maintenance)</th>
<th>Adjusted fiscal year costs</th>
<th>Cost per pound of fish produced</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pounds</td>
<td>percent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alsea Hatchery production costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1958</td>
<td>29,549</td>
<td>10.5</td>
<td>$13,512</td>
<td>$33,861</td>
</tr>
<tr>
<td>1959</td>
<td>48,557</td>
<td>32.9</td>
<td>$15,705</td>
<td>$39,864</td>
</tr>
<tr>
<td>1960</td>
<td>39,279</td>
<td>20.1</td>
<td>$14,710</td>
<td>$40,907</td>
</tr>
<tr>
<td>1961</td>
<td>60,268</td>
<td>33.0</td>
<td>$13,435</td>
<td>$34,042</td>
</tr>
<tr>
<td>1962</td>
<td>54,057</td>
<td>38.5</td>
<td>$13,621</td>
<td>$36,437</td>
</tr>
<tr>
<td>1963</td>
<td>52,307</td>
<td>43.7</td>
<td>$19,346</td>
<td>$66,827</td>
</tr>
<tr>
<td>1964</td>
<td>55,302</td>
<td>66.5</td>
<td>$17,512</td>
<td>$43,573</td>
</tr>
<tr>
<td>Totals &amp; means</td>
<td>339,319</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cedar Creek Hatchery production costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1958</td>
<td>38,276</td>
<td>19.3</td>
<td>$18,196</td>
<td>$36,653</td>
</tr>
<tr>
<td>1959</td>
<td>42,479</td>
<td>5.2</td>
<td>$22,300</td>
<td>$47,872</td>
</tr>
<tr>
<td>1960</td>
<td>39,742</td>
<td>19.8</td>
<td>$15,177</td>
<td>$47,326</td>
</tr>
<tr>
<td>1961</td>
<td>44,487</td>
<td>21.6</td>
<td>$11,725</td>
<td>$31,573</td>
</tr>
<tr>
<td>1962</td>
<td>66,865</td>
<td>20.9</td>
<td>$12,350</td>
<td>$37,490</td>
</tr>
<tr>
<td>1963</td>
<td>76,330</td>
<td>22.2</td>
<td>$17,835</td>
<td>$46,478</td>
</tr>
<tr>
<td>1964</td>
<td>64,950</td>
<td>40.7</td>
<td>$13,579</td>
<td>$36,277</td>
</tr>
<tr>
<td>Totals &amp; means</td>
<td>373,129</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gnat Creek Hatchery production costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1961</td>
<td>22,237</td>
<td>72.0</td>
<td>$6,539</td>
<td>$36,131</td>
</tr>
<tr>
<td>1962</td>
<td>24,499</td>
<td>100.0</td>
<td>$6,741</td>
<td>$44,632</td>
</tr>
<tr>
<td>1963</td>
<td>33,972</td>
<td>89.1</td>
<td>$9,481</td>
<td>$56,362</td>
</tr>
<tr>
<td>1964</td>
<td>47,718</td>
<td>94.3</td>
<td>$14,220</td>
<td>$49,944</td>
</tr>
<tr>
<td>Totals &amp; means</td>
<td>80,708</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

period and have ranged from $0.66 to $1.32 per pound to produce yearling steelhead (average $0.91). At Cedar Creek Hatchery, rearing costs have declined from $1.12 to $0.67 per pound and have averaged $0.82. Because of the newness of the facility, rearing costs at Gnat Creek are higher. From 1961 through 1963 production cost declined from $2.06 to $1.49 per pound (average $1.80).
Table 20

Cost of returning adult steelhead trout for the Alsea, Sandy and Wilson rivers
for specific release groups

<table>
<thead>
<tr>
<th>River</th>
<th>Year of release</th>
<th>Size (fish per pound)</th>
<th>Number of fish released</th>
<th>Pounds of fish released</th>
<th>Cost per pound</th>
<th>Total cost of adults returning</th>
<th>Cost estimated No. of adults</th>
<th>Cost estimated No. of fish in creel</th>
<th>Cost per fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alsea</td>
<td>1958</td>
<td>7.7</td>
<td>15,500</td>
<td>2,019</td>
<td>$1.32</td>
<td>$2,665</td>
<td>1,480</td>
<td>$1.80</td>
<td>550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13.0</td>
<td>16,000</td>
<td>1,231</td>
<td>1.32</td>
<td>1,625</td>
<td>120</td>
<td>13.50</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>1959</td>
<td>5.5</td>
<td>8,800</td>
<td>1,597</td>
<td>0.88</td>
<td>1,405</td>
<td>425</td>
<td>3.30</td>
<td>151</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.0</td>
<td>24,000</td>
<td>2,699</td>
<td>0.88</td>
<td>2,375</td>
<td>237</td>
<td>10.00</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.6</td>
<td>11,100</td>
<td>438</td>
<td>0.88</td>
<td>385</td>
<td>49</td>
<td>7.90</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>1960</td>
<td>9.4</td>
<td>53,200</td>
<td>5,665</td>
<td>1.08</td>
<td>6,118</td>
<td>3,190</td>
<td>1.90</td>
<td>1,273</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20.0</td>
<td>12,100</td>
<td>602</td>
<td>1.08</td>
<td>650</td>
<td>155</td>
<td>4.20</td>
<td>126</td>
</tr>
<tr>
<td>Alsea</td>
<td>1961</td>
<td>7.8</td>
<td>51,100</td>
<td>6,539</td>
<td>0.66</td>
<td>4,250</td>
<td>2,613</td>
<td>1.60</td>
<td>1,208</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.0</td>
<td>50,750</td>
<td>5,075</td>
<td>0.66</td>
<td>3,350</td>
<td>1,409</td>
<td>2.40</td>
<td>708</td>
</tr>
<tr>
<td></td>
<td>1962</td>
<td>8.4</td>
<td>56,800</td>
<td>6,757</td>
<td>0.76</td>
<td>5,135</td>
<td>2,724</td>
<td>1.90</td>
<td>1,748</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.9</td>
<td>51,600</td>
<td>5,793</td>
<td>0.76</td>
<td>4,403</td>
<td>2,226</td>
<td>2.00</td>
<td>1,490</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.1</td>
<td>49,500</td>
<td>5,440</td>
<td>0.76</td>
<td>4,134</td>
<td>3,152</td>
<td>1.30</td>
<td>2,024</td>
</tr>
<tr>
<td></td>
<td>1963</td>
<td>8.4</td>
<td>70,000</td>
<td>8,235</td>
<td>1.02</td>
<td>8,400</td>
<td>3,088</td>
<td>2.47</td>
<td>1,782</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.7</td>
<td>50,000</td>
<td>6,193</td>
<td>0.90</td>
<td>5,844</td>
<td>4,804</td>
<td>1.20</td>
<td>2,895</td>
</tr>
<tr>
<td>Total &amp; means</td>
<td>520,400</td>
<td>58,583</td>
<td>$0.91</td>
<td>53,310</td>
<td>25,672</td>
<td>$2.07</td>
<td>14,105</td>
<td>$3.78</td>
<td></td>
</tr>
</tbody>
</table>
Table 20 (continued)

Cost of returning adult steelhead trout for the Alsea, Sandy and Wilson rivers
for specific release groups

<table>
<thead>
<tr>
<th>River</th>
<th>Size (fish per pound)</th>
<th>Year of release</th>
<th>Estimated No. of adults returning to river</th>
<th>Cost per pound</th>
<th>Total cost</th>
<th>Cost of adults per fish</th>
<th>Estimated No. of adults in creel</th>
<th>Cost per fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alsea</td>
<td>10.7</td>
<td>1961</td>
<td>43,400</td>
<td>4,041</td>
<td>2.06</td>
<td>$8,324</td>
<td>753</td>
<td>$11.00</td>
</tr>
<tr>
<td></td>
<td>10.8</td>
<td></td>
<td>47,100</td>
<td>4,365</td>
<td>2.06</td>
<td>8,992</td>
<td>587</td>
<td>15.30</td>
</tr>
<tr>
<td>Sandy</td>
<td>9.2</td>
<td>1962</td>
<td>49,900</td>
<td>5,414</td>
<td>2.05</td>
<td>11,099</td>
<td>2,238</td>
<td>4.90</td>
</tr>
<tr>
<td></td>
<td>12.1</td>
<td></td>
<td>127,000</td>
<td>10,536</td>
<td>2.05</td>
<td>21,599</td>
<td>1,865</td>
<td>11.60</td>
</tr>
<tr>
<td>Wilson</td>
<td>9.9</td>
<td>1963</td>
<td>105,900</td>
<td>10,719</td>
<td>1.49</td>
<td>15,971</td>
<td>2,414$\textsuperscript{1/2}$</td>
<td>6.61</td>
</tr>
<tr>
<td></td>
<td>12.4</td>
<td></td>
<td>108,400</td>
<td>8,701</td>
<td>1.49</td>
<td>12,964</td>
<td>1,253$\textsuperscript{1/2}$</td>
<td>10.30</td>
</tr>
<tr>
<td>Totals &amp; means</td>
<td></td>
<td></td>
<td>481,700</td>
<td>43,776</td>
<td>1.80</td>
<td>$78,797</td>
<td>9,110</td>
<td>$8.64</td>
</tr>
</tbody>
</table>

| Year       | Summer run \(1958\) | 10.6                  | 78,500                                      | 7,357          | 1.12       | $8,240                 | 1,652                             | $5.00         |
|           | Summer run \(1959\) | 5.6                   | 12,200                                      | 2,176          | 1.12       | 2,437                  | 197                               | 12.40         |
|           | Winter run \(1960\) | 12.7                  | 89,700                                      | 9,934          | 1.12       | 11,126                | 796                               | 13.90         |
|           | Winter run \(1961\) | 9.3                   | 96,000                                      | 7,566          | 1.02       | 7,717                  | 997                               | 7.70          |
|           | Summer run \(1962\) | 9.5                   | 10,000                                      | 637            | 1.02       | 650                    | 45                                | 14.40         |
|           | Summer run \(1963\) | 8.5                   | 105,700                                     | 12,399         | 0.67       | 8,307                  | 3,323                             | 2.50          |
|           | Winter run \(1964\) | 7.7                   | 119,800                                     | 15,471         | 0.65       | 10,056                 | 4,199                             | 2.40          |
|           | Summer run \(1964\) | 7.6                   | 31,200                                      | 4,100          | 0.67       | 2,747                  | 2,066                             | 1.30          |
|           | Winter run \(1964\) | 7.6                   | 40,000                                      | 5,274          | 0.67       | 3,534                  | 2,232                             | 1.60          |
|           |                     | 8.4                   | 40,900                                      | 4,835          | 0.67       | 3,239                  | 1,265                             | 2.60          |
| Totals & means |                 |                     | 730,930                                     | 31,053         | 0.82       | $67,774                | 18,476                            | $3.70         |

\textsuperscript{1/} Incomplete returns
Cost figures, for an adult fish in the river, range from $1.20 to $13.50 each on the Alsea River for the period 1958-64. The average cost per adult fish was $2.07. It should be kept in mind that the costs are maximal since estimation of catch and escapement are minimal. The cost of placing a fish in the creel ranged from $2.00 to $48.00. The average cost of a fish in the creel was $3.78.

The Wilson River cost figures for a fish in the creel have been similar to the Alsea. Ranging from a low of $1.30 to a high of $14.40. The average being $3.70 for the 1958-64 period.

Returning adult steelhead on the Sandy River have been more expensive than for the other study streams because of the higher rearing costs and lower survival. The cost of an adult fish to the river has averaged $8.64 and a fish in the creel $18.24.

Future costs of producing a pound of yearling steelhead are unknown. The period 1962-65 is probably more in keeping with what can be expected to be the cost level in the immediate future. Savings resulting from future advances in hatchery techniques and nutrition might be offset by increased operating and maintenance costs.

Artificial propagation remains an expensive management technique which requires careful surveillance. The economical and biological justification for its use on a given stream depends on thorough analysis of the status of the wild stock, trends in angler activity, environmental conditions (present and future), and alternative management programs.

2/ Where the estimated catch is less than 100 fish, precision is low.
Literature cited

Chapman, Donald W. 1958.

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Shapovalov, Leo, and Alan C. Taft. 1954.
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