BIOLOGY OF SUMMER STEELHEAD (*SALMO GAIRDNERII GAIRDNERII*) IN MAD RIVER, CALIFORNIA

by

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ABSTRACT

Mad River is a small coastal river in northwestern California which has hatchery and native summer steelhead runs. In March and April of 1972, Washougal strain summer steelhead yearling smolts were planted by the California Department of Fish and Game. Returning adults to Mad River Hatchery peaked in early May and again in late October of 1974. Tag returns and underwater surveys showed that summer steelhead which did not enter the hatchery in the spring remained in or near tidewater during the summer, and then moved upstream following the first fall freshet. Native summer steelhead appeared to migrate above the hatchery and past the natural barrier near the mouth of Bug Creek. During the spring of 1974, a positive correlation occurred between summer steelhead upstream movement to the hatchery and water flow and turbidity. During the fall, a positive correlation occurred between movement and turbidity and a negative correlation occurred between movement and water temperature. Marked smolts planted in March and April produced similar adult returns both in numbers and mean fork lengths. Growth in fork length of Washougal steelhead planted in Mad River was similar to that of summer steelhead in the Washougal River, Washington. For three-year-old Washougal steelhead, there was no significant difference in mean fork length between spring and fall-run fish entering Mad River Hatchery, but males were significantly longer than females. Female three-year-olds outnumbered males, but not significantly. Based on differences in their freshwater growth and life history pattern from Mad River native summer steelhead,

half-pounders probably are produced elsewhere but stray into Mad River. Fecundity of three-year-old Washougal steelhead was lower than that of Siletz River and Deschutes River summer steelhead strains, and there was no significant correlation between fork length and fecundity. Although the summer steelhead harvest by the sportfishery was not quantified, angler success appeared to be high during the spring and fall of 1974. For the future management of Mad River summer steelhead, an intensive creel census should be conducted in conjunction with an analysis of hatchery returns.

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INTRODUCTION

The steelhead rainbow trout (Salmo gairdnerii gairdnerii) is an important gamefish in the coastal streams of California. Steelhead are anadromous, spawning in late winter and early spring (Shapovalov and Taft 1954). After hatching, most steelhead in California spend one or two years in freshwater before migrating to sea. They usually spend one or two years in the ocean before ascending their natal streams to spawn (Shapovolov 1967).

Adult steelhead are classed as either summer or winter-run, based on their timing of migration into freshwater. Most summer steelhead enter streams from late spring to early fall. Their gonads are slightly developed upon entry, since spawning does not occur until the following spring. Winter steelhead enter streams from late fall to early spring and have well-developed gonads upon entry, in preparation for spawning within a short time (Withler 1966).

In California, summer steelhead are not as numerous as winter steelhead. A lack of cool holding water during the summer greatly limits their distribution (Shapovolov 1967). Summer steelhead inhabit portions of the Klamath, Trinity, New, Mad, Van Duzen, and Eel Rivers (Puckett et al. 1968).

For the angler, a summer steelhead fishery is desirable because adult fish are available in freshwater for a long period of time. Good fishing conditions occur during the spring, summer and fall. However, summer steelhead are highly vulnerable to predators and high water temperatures during mid-summer.

Water development and diversion have reduced summer and winter steelhead populations in California, increasing the importance of artificially propagating steelhead in hatcheries (Shapovolov 1967).

My general objective was to study adult summer steelhead in Mad River, California. Specific objectives were to determine:

1. Migration and distribution.
2. Correlation of hatchery returns with river flow, temperature and turbidity.
3. Relative hatchery returns from smolts planted in March and in April.
4. Growth, sex ratio and fecundity.

DESCRIPTION OF THE STUDY AREA

The Mad River is a small coastal river in northwestern, California. Detailed descriptions of the physical and biological characteristics of the Mad River drainage have been prepared by Bailey (1952) and the U.S. Army Corps of Engineers (1973).

Physical Characteristics

The Mad River originates in Trinity County, California, and runs through Humboldt County to the Pacific Ocean (Figure 1). Ruth Dam, closed in 1961, is 127 river kilometers upstream from the mouth and blocks upstream fish passage (U.S. Army Corps of Engineers 1973). During some years, a natural barrier blocks steelhead passage 0.4 kilometers below the mouth of Bug Creek (Bailey 1952). Ten kilometers below Mad River Hatchery, water is diverted from Mad River by five Ranney wells operated by the Humboldt Municipal Water District. Below this area, the California Department of Fish and Game has minimum flow requirements (U.S. Army Corps of Engineers 1973).

Summer Steelhead Populations

Native and hatchery summer steelhead runs exist in Mad River. Native summer steelhead enter the Mad River from the ocean primarily in April and May and hold in deep pools along an 18-kilometer section downstream from the barrier near Bug Creek. No precise population estimate exists for this run. Since the 1970 removal of Sweasey Dam, 27 kilometers upstream from the mouth, summer steelhead runs may have increased, but the average run is low, perhaps 500 fish (U.S. Army

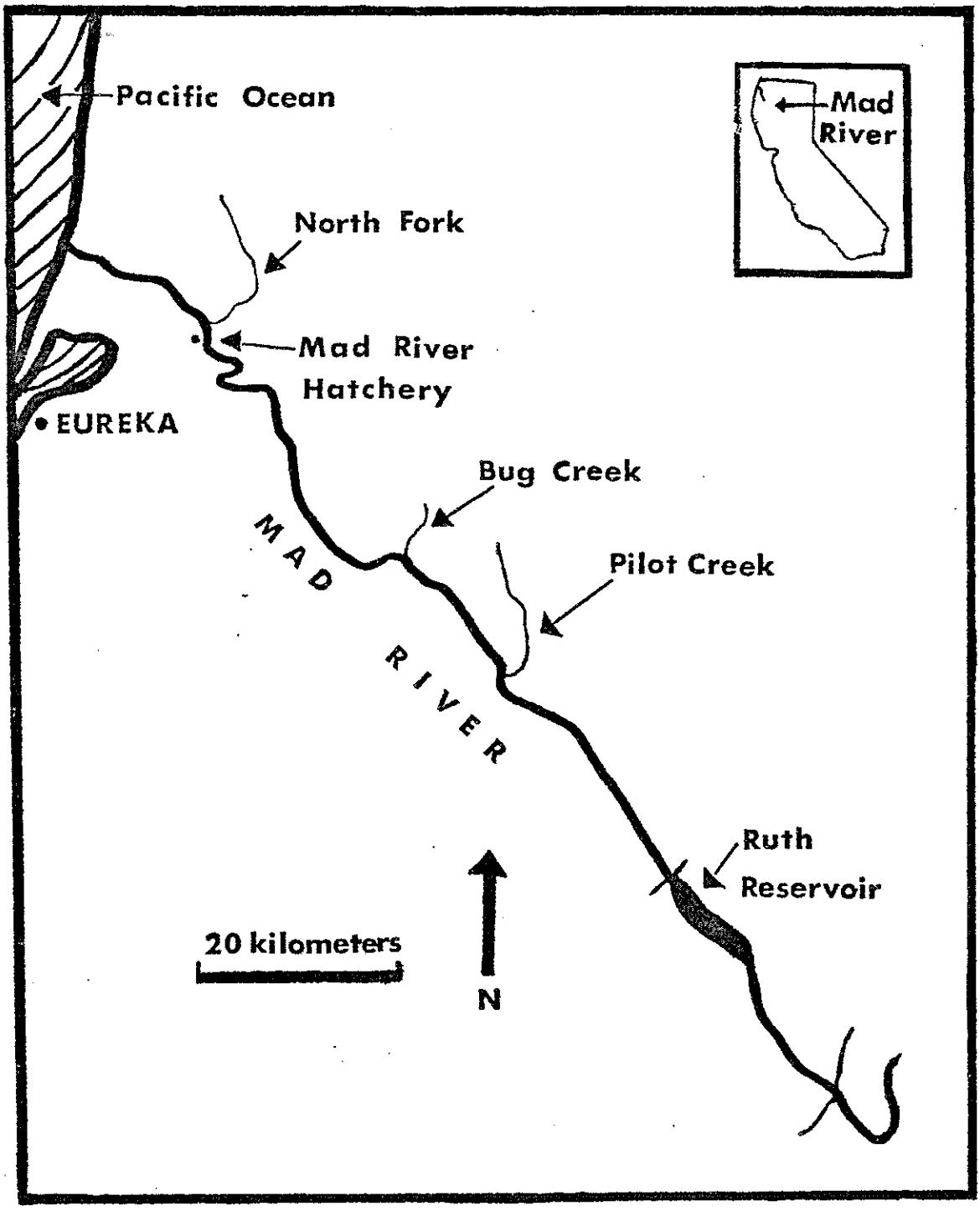

Figure 1. Mad River, California.

Corps of Engineers 1973).

In 1972, the California Department of Fish and Game introduced Washougal strain summer steelhead into Mad River (Table 1). These

Table 1. Yearling smolts planted in Mad River at Mad River Fish Hatchery. Marked fish had two fins removed, the adipose (Ad) fin and either the right ventral (RV) or left ventral (LV) fin.

Date Planted	Number of Fish Planted	Size of Fish	Number Marked	Type of Mark	Observed Loss
3/21	10,400	11.5/kg (5.2/lb)	0		124*
3/21	15,015	15.4/kg (7.0/lb)	15,012	RV-Ad	180*
3/21	32,585	15.4/kg (7.0/lb)	0		391*
4/25	19,430	14.8/kg (6.7/lb)	5,110	LV-Ad	0

* Estimated loss from smothering in tailrace sump.

fish were offspring of a hatchery run whose race is native to the Washougal River, Washington, which is a Columbia River tributary (Hull and Allee, unpublished, Development of summer run steelhead at Skamania Hatchery, University of Washington Cooperative Fisheries Unit, Seattle, Washington).

METHODS AND MATERIALS

Migration and Distribution

Tagging

Tagging began on May 22, 1974. Adult summer steelhead were captured in Mad River using a 7.6 cm (3 inch) bar mesh nylon gill net (45.7 meters long and 1.8 meters deep), fyke net (Figure 2), 1.3 cm (0.5 inch) mesh nylon beach seine (22.9 meters long and 2.7 meters deep) with bag, and weir trap (Figure 3). I sampled at night, except with the weir trap which operated both day and night. I tagged all captured fish with colored Floy FD-67 anchor tags using methods described by Everest (1973) and released them to the river at the tagging sites near Mad River Hatchery and U.S. 101 Bridge. All tags had a different number and the address "Coop Fish Unit HSU Arcata". I also tagged and released adults from Mad River Hatchery. I considered fish with eroded dorsal fins as hatchery fish (Pautzke and Meigs 1940) and tagged them on the left side. I tagged all remaining fish on the right side.

Diver Counts

I divided the lower 19 kilometers of Mad River into the following sections (Figure 4):

Section I - Trestle 1 to U.S. 101 Bridge

Section II - U.S. 101 Bridge to U.S. 299 Bridge

Section III - U.S. 299 Bridge to Trestle 2

Section IV - Trestle 2 to Blue Lake Bridge

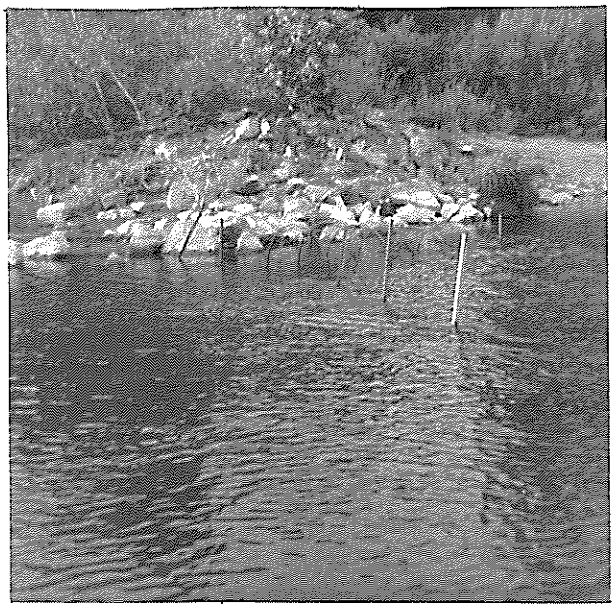

Figure 2. Fyke net in Mad River 0.5 kilometer above U.S. 101 Bridge during July, 1974. Net is 1.2 meters in diameter.

Figure 3. Weir trap near Mad River Hatchery during July, 1974. Trap was 1.7 meters long, 1.2 meters wide and 0.9 meters high. Chicken wire fencing (2.5 centimeter mesh) was 1.2 meters high and held in place by metal fenceposts driven in the stream bottom at 1.5 meter intervals.

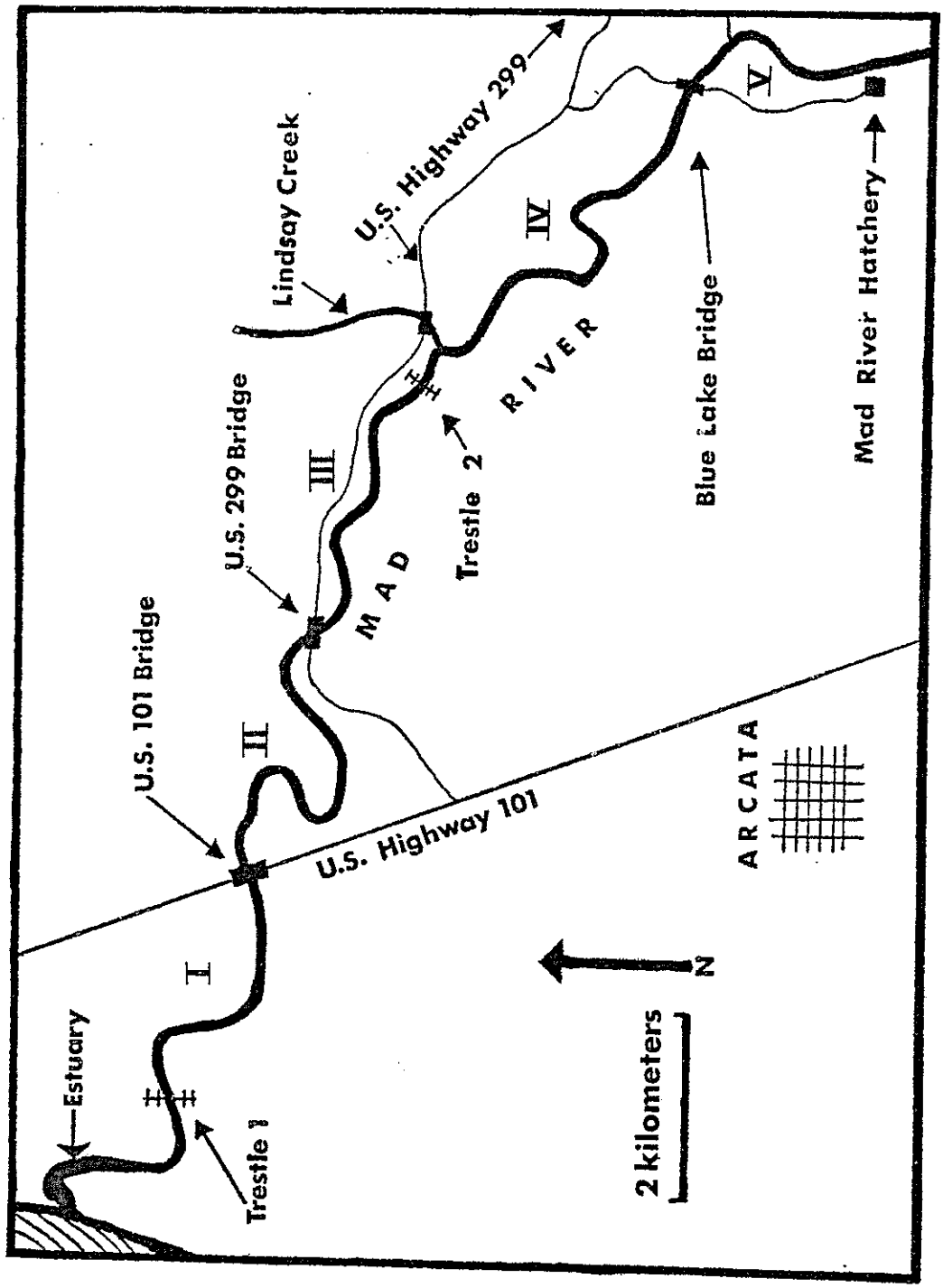

Figure 4. Study Sections, Lower Mad River.

Section V - Blue Lake Bridge to Mad River Hatchery

That portion between Mad River Hatchery and 0.4 kilometer below the mouth of Bug Creek was Section VI. Diving surveys, using mask, fins, and snorkel, occurred during periods of low river flow and low turbidity. For each section, I counted the total number of observed steelhead, the number of tagged steelhead and noted tag colors. Another person walked along the streambank recording diver observations.

Tag Returns

I publicized the tagging study in two local newspapers, asking anglers to telephone their catches of tagged fish to the Cooperative Fisheries Unit, Humboldt State University, and report the date and location of catch, tag number and tag color. I asked personnel at Mad River Hatchery to obtain the same information for tagged fish caught by anglers or entering the hatchery.

Water Flow, Temperature and Turbidity

During the spring of 1974, I made weekly counts of adult fish fish entering Mad River Hatchery. During the fall months of 1973 and 1974, daily counts were made by personnel at Mad River Hatchery. I determined the effect of river flow, temperature and turbidity on fish movement into the hatchery during 1974 by correlation analysis, using data provided by the Humboldt Municipal Water District, Eureka, California.

Returns of Marked Fish

I recorded fin marks of all adults observed in traps, Mad River Hatchery and from anglers. I used Chi-square analysis to test whether

the ratio of RV-Ad to LV-Ad marked returning adults was equal to the ratio of RV-Ad to LV-Ad marked smolts planted. I used analysis of variance to test the hypothesis that the mean fork lengths of RV-Ad and LV-Ad marked three-year-old fish were equal.

Growth, Sex Ratio and Fecundity

Growth

Fork lengths were taken from RV-Ad marked yearlings at Mad River Hatchery and from returning adults captured by anglers, traps and Mad River Hatchery. During May and June, I took weights from adults entering Mad River Hatchery or caught by anglers. I took, mounted and aged scale samples using methods described by Kesner and Barnhart (1972). I back-calculated fork lengths at scale annuli using the proportion method formula (Whitney and Carlander 1956):

$$L = a + \frac{R_1}{R_c} (L_1 - a)$$

where L = back-calculated fork length
a = intercept of body-scale radius linear regression
R_1 = scale radius at annulus
R_c = scale radius at capture
and L_1 = fork length at capture.

Since I had scale samples only from large adult fish, I could not accurately estimate the value of "a". I used 3.5 centimeters for "a" in my back-calculations, a value used by Sumner (Kesner and Barnhart 1972). To check the accuracy of the back-calculations, I compared the actual measured fork lengths of RV-Ad marked yearling smolts with the back-calculated fork lengths at the same age from scales of RV-Ad marked adults using analysis of variance.

Sex Ratio

For angler-caught spring-run fish, I determined the sex by gonad examination. The sex of spring-run fish which entered Mad River Hatchery was determined at Trinity Hatchery during spawning by Gerald W. Bedell, Fish Hatchery Manager II. I determined the sex of fish entering Mad River Hatchery during the fall and winter by external examination (Figure 5). I used Chi-square analysis to test the hypothesis that the sex ratio was 1:1.

Fecundity

I estimated egg numbers volumetrically for three-year-old Washougal females spawned by Mad River Hatchery personnel. For each fish, I counted the number of water-hardened eggs in a 100 cc cylinder of water. The total egg volume was measured in a 500 cc cylinder, and total egg number calculated by direct proportion.

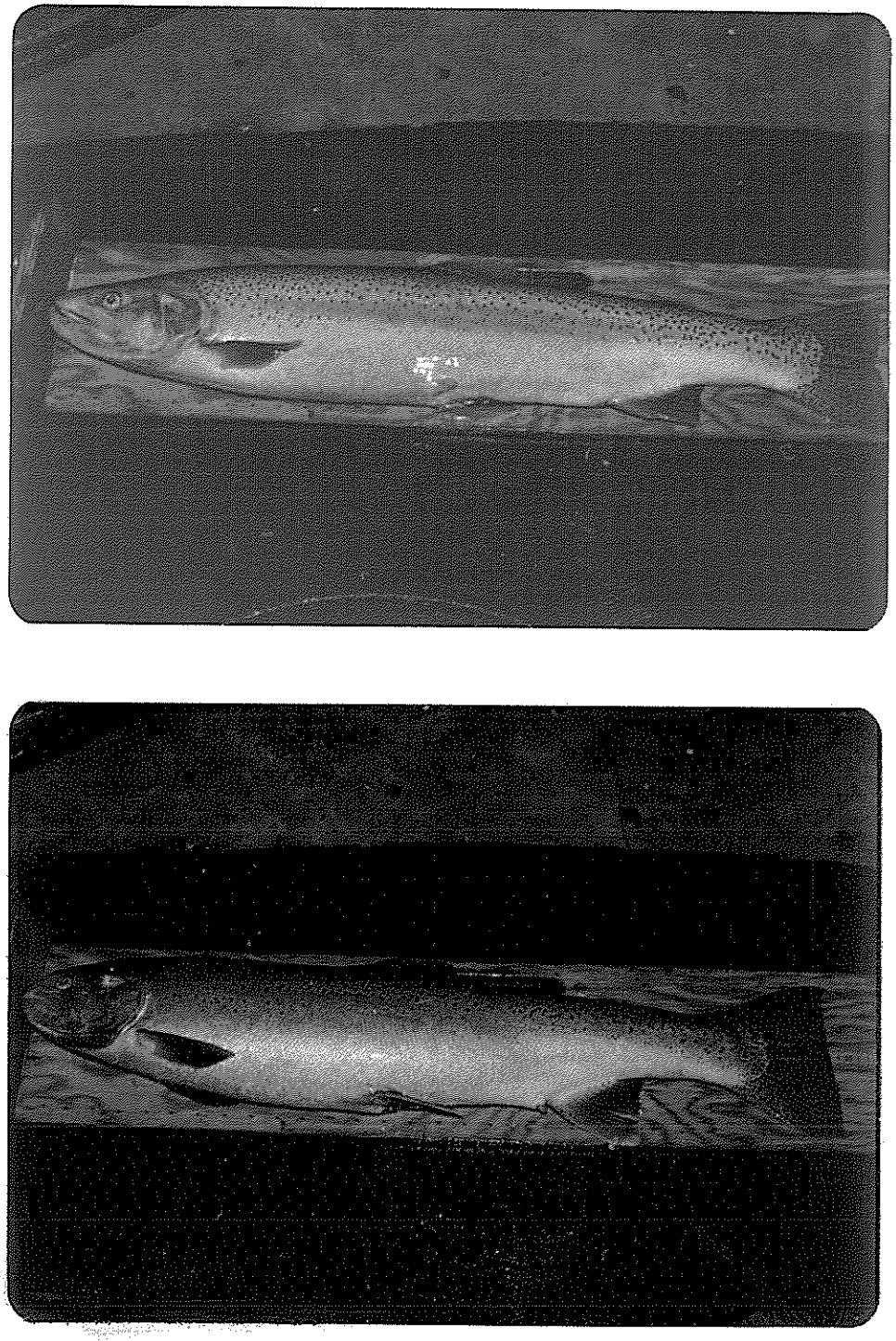

Figure 5. Three-year-old Washougal strain summer steelhead in February, 1975, during spawning. Male (above) is 79.4 centimeters long and marked LV-Ad. Female (below) is 78.1 centimeters long and marked RV-Ad.

RESULTS

Migration and Distribution

The Mad River Hatchery fish ladder did not operate during the spring of 1973 and the summers of 1973 and 1974. During the fall of 1973, 37 steelhead entered the hatchery, including seven marked two-year-old Washougal steelhead (Table 2). Anglers began catching three-year-old Washougal steelhead in Mad River during the fourth week of April, 1974. A surge of fish entered the hatchery when the ladder opened on 4/30/74. Hatchery returns continued until mid-June and occurred again from late October to early December (Table 3). Diver counts (Table 4), tag returns (Appendix I) and trapping data (Appendices II-V) showed that upstream movement to the hatchery continued until mid-July, when it slowed dramatically. After that time, most fish held downstream from U.S. 299 Bridge. On several occasions during the mid-summer, I observed steelhead jumping in Mad River estuary. Anglers caught at least three steelhead in the estuary during the summer, including one tagged fish which migrated downstream from U.S. 101 Bridge. In early June, 1975, one four-year-old Washougal steelhead entered Mad River Hatchery.

Anglers reported steelhead catches in Mad River above the mouth of Bug Creek during the summer and fall of 1974. I analysed scale samples from eight fish caught there. Six were native summer steelhead; the other two were of undetermined origin.

Table 2. Adult summer steelhead entering Mad River Hatchery in 1973.

Week	Total number of steelhead
8/26 to 9/1	1
9/2 to 9/8	1
9/9 to 9/15	0
9/16 to 9/22	2
9/23 to 9/29	8
9/30 to 10/6	1
10/7 to 10/13	0
10/14 to 10/20	3
10/21 to 10/27	7
10/28 to 11/3	1
11/4 to 11/10	1
11/11 to 11/17	3
11/18 to 11/24	1
11/25 to 12/1	8
12/2 to 12/8	0
Grand Total	37

Table 3. Adult summer steelhead entering Mad River Hatchery in 1974.

Week	Total number of steelhead	Hatchery origin	Native origin	Undetermined origin
4/30 to 5/3	58	58	0	0
5/4 to 5/10	34	33	0	1
5/11 to 5/17	8	8	0	0
5/18 to 5/24	18	17	1	0
5/25 to 5/31	9	7	1	1
6/1 to 6/7	18	15	3	0
6/8 to 6/14	21	18	0	3
6/15 to 6/21	6	1	3	2
10/4 to 10/12	0			
10/13 to 10/19	0			
10/20 to 10/26	2			
10/27 to 11/2	16			
11/3 to 11/9	8	51*	5*	5*
11/10 to 11/16	8			
11/17 to 11/23	11			
11/24 to 11/30	11			
12/1 to 12/5	5			
Grand Total	233	208	13	12

* Since scale samples were taken on 12/5 for fall-run fish, origin was determined as a group for fish entering the hatchery after 10/4.

Table 4. Diver counts of summer steelhead in Mad River study sections during 1974.

Date	Section					
	I	II	III	IV	V	VI
7/15					13	
7/16				3		
7/29			2			
7/30		53				
7/31	6(1)					
8/19						14(2)
8/28						1(3)
9/10				5	3	
9/11			14(4)			
9/12	8(6)	35(5)				

(1) Counts for Section I were probably underestimates because of high turbidity causing poor visibility.

(2) Count taken from Mad River Hatchery to 22 kilometers upstream from Hatchery.

(3) Count taken from 22 kilometers upstream from Mad River Hatchery to 0.4 kilometers below the mouth of Bug Creek. Count in upper eight kilometers was hampered by poor visibility in deep pools.

(4) Count includes 3 half-pounders.

(5) Count includes 19 half-pounders.

(6) Count includes 4 half-pounders.

Water Flow, Temperature and Turbidity

Weekly temperature, flow and turbidity data are shown in Table 5. During the spring, I found a significant positive correlation between adult steelhead movement into Mad River Hatchery and river flow ($r = 0.736$, $P < 0.05$, 6 df) and turbidity ($r = 0.903$, $P < 0.01$, 6 df). During the fall, I found a significant positive correlation between steelhead movement and turbidity ($r = 0.779$, $P < 0.05$, 6 df), and a significant negative correlation between movement and river temperature ($r = -0.741$, $P < 0.05$, 6 df). During the summer, the minimum low flow was 19 CFS, the maximum morning temperature was 20.6 C, and the minimum turbidity was 0.9 JTU.

Marked Adult Returns

For 59 marked adults, the RV-Ad to LV-Ad ratio was not significantly different from the ratio for marked smolts ($X^2 = 0.09$, $P > 0.50$, 1 df). Three-year-old Washougal steelhead showed no significant difference in mean fork lengths between marked groups ($F = 1.51$, $P > 0.10$, 1,41 df). Percentage returns to the hatchery were 0.26% from March smolts and 0.23% from April smolts.

Growth, Sex Ratio and Fecundity

Growth

I found no significant difference between the measured and back-calculated fork lengths of RV-Ad marked fish at Age 1 ($F = 2.58$, $P > 0.10$, 1,46 df). Therefore, the back-calculated fork lengths at other annuli should be reasonably accurate. Length data are shown in Table 6 and weight data in Table 7. I found no significant difference

Table 5. Mean weekly water temperature, flow and turbidity for Mad River during spring and fall, 1974. Temperature and turbidity readings were taken about 2.5 kilometers upstream from U.S. 299 Bridge and flow readings were taken at U.S. 299 Bridge.

Week	Mean Temperature (C)	Mean Flow (CFS)	Mean Turbidity (JTU)
4/30 to 5/3	12.2	752.5	13.3
5/4 to 5/10	11.9	536.9	6.3
5/11 to 5/17	11.1	496.6	4.5
5/18 to 5/24	11.3	454.7	4.2
5/25 to 5/31	14.1	312.9	2.6
6/1 to 6/7	15.2	246.0	2.5
6/8 to 6/14	14.7	153.4	1.9
6/15 to 6/21	15.1	89.1	2.0
10/4 to 10/12	12.1	44.4	1.9
10/13 to 10/19	12.7	30.2	1.6
10/20 to 10/26	11.1	33.3	1.9
10/27 to 11/2	10.8	65.7	8.2
11/3 to 11/9	10.0	67.9	5.6
11/10 to 11/16	10.3	58.9	1.9
11/17 to 11/23	9.4	107.2	11.7
11/24 to 11/30	9.3	170.2	11.5

Table 6. Means, standard deviations and ranges of fork lengths (centimeters) at annuli for Mad River summer steelhead.

Age Category	Annulus 1	Annulus 2	Annulus 3	Annulus 4
1/1	$\frac{18.3 \pm 1.4}{14.3\text{-}22.6}(167)$	$\frac{58.7 \pm 0.2}{58.5\text{-}59.0}(4)$		
1/2	$\frac{18.3 \pm 1.4}{14.3\text{-}22.6}(167)$	$\frac{56.1 \pm 4.3}{43.6\text{-}66.9}(120)$	$\frac{72.7 \pm 4.0}{61.6\text{-}85.0}(177)$	
1/2**	$\frac{14.7 \pm 0.6}{14.3\text{-}15.1}(2)$	$\frac{34.5 \pm 2.4}{32.8\text{-}36.2}(2)$	$\frac{43.2 \pm 4.4}{40.1\text{-}46.3}(2)$	
1/3	$\frac{19.9}{19.9}(1)$	$\frac{52.0}{52.0}(1)$	$\frac{79.5}{79.5}(1)$	$\frac{89.4}{89.4}(1)$
2/1**	$\frac{11.0 \pm 0.7}{10.5\text{-}11.4}(2)$	$\frac{21.8 \pm 1.6}{20.7\text{-}22.9}(2)$	$\frac{36.5 \pm 1.6}{35.7\text{-}37.2}(2)$	
2/1***	$\frac{11.2 \pm 1.4}{9.2\text{-}14.0}(15)$	$\frac{20.8 \pm 2.5}{17.8\text{-}25.3}(15)$	$\frac{56.6 \pm 3.2}{49.7\text{-}61.7}(19)$	
2/2***	$\frac{13.6 \pm 2.4}{10.1\text{-}15.2}(4)$	$\frac{19.3 \pm 2.1}{16.2\text{-}21.0}(4)$	$\frac{37.2 \pm 3.6}{33.0\text{-}41.6}(4)$	$\frac{46.6 \pm 2.1}{44.2\text{-}49.1}(4)$
2/2***	$\frac{10.6}{10.6}(1)$	$\frac{22.2}{22.2}(1)$	$\frac{44.7}{44.7}(1)$	$\frac{54.7}{54.7}(1)$
3/1***	$\frac{8.0}{8.0}(1)$	$\frac{14.5}{14.5}(1)$	$\frac{19.4}{19.4}(1)$	$\frac{58.4 \pm 3.7}{55.8\text{-}61.0}(2)$

* $\frac{\text{Mean} \pm \text{standard deviation}}{\text{Range}}$ (Sample size)

** Native half-pounders.

*** Native fish which have spent at least one full year at sea.

Table 7. Means, standard deviations and ranges of weights (kilograms) of Mad River summer steelhead.

Age category	n	Weight (kilograms)	
		Mean ± standard deviation	Range
1/2	130	3.8 ± 0.6	2.7-5.7
1/3	1	6.9	6.9
2/1**	6	1.9 ± 0.5	1.3-2.6
2/2*	1	1.5	1.5
3/1**	1	2.0	2.0

* Native half-pounder.
** Native fish which have spent one full year at sea.

in mean fork length between spring and fall-run three-year-old Washougal steelhead entering the hatchery ($F = 0.28$, $P > 0.50$, 1,175 df), but males were significantly longer than females ($F = 12.40$, $P < 0.001$, 1,56 df). The mean fork length was 75.1 centimeters for males and 70.5 centimeters for females. I took fork lengths and scale samples from eight half-pounders. At the first annulus, the Mann-Whitney U-test (Sokal and Rohlf 1969) showed that the back-calculated half-pounder fork lengths were significantly greater than native adults which spent at least one full year at sea ($U = 106$, $P < 0.05$, 17,8 df).

Sex Ratio

The overall sex ratio of three-year-old Washougal steelhead was not significantly different from 1:1 ($X^2 = 2.202$, $P > 0.10$, 1 df). Females outnumbered males for fall-run fish ($X^2 = 4.122$, $P < 0.05$, 1 df) and angler-caught fish ($X^2 = 6.000$, $P < 0.025$, 1 df), but not for spring-run fish ($X^2 = 0.058$, $P > 0.50$, 1 df) (Table 8).

Fecundity

Three-year-old Washougal steelhead showed no significant correlation between fecundity and fork length for 21 fish ranging in fork lengths from 65.1 to 78.1 centimeters ($r = 0.25$, $P > 0.05$, 19 df). The mean fecundity and standard deviation was 3171 $\pm$ 810 eggs per female.

Table 8. Sex Ratios (females to males) for summer steelhead in Mad River.

Capture Method	Strain	Age Category	Number of females	Number of males	Sex Ratio
Hatchery (fall)	Washougal	1/1	2	5	1:2.50
Hatchery (spring)	Washougal	1/2	75	78	1:1.04
Hatchery (fall)	Washougal	1/2	27	14	1.93:1
Angler	Washougal	1/2	18	6	3:1
Hatchery (fall)	Native	2/1	3	2	1.33:1
Angler	Native	2/1	3	1	3:1
Angler	Native	3/1	1	0	-

DISCUSSION

The migration pattern of adult Washougal steelhead into Mad River was similar to that on the Washougal River, where fish normally begin entering Skamania Hatchery in April or May (Hull and Allee, unpublished). The early-run usually peaks in July on the Washougal River (Hull, personal communication), but on the Mad River the 1974 peak was about two months earlier. The earlier Mad River run may occur because Mad River Hatchery is about 160 kilometers closer to the ocean than is Skamania Hatchery, making fish travelling distance shorter. On Mad River, steelhead upstream migration may be inhibited sooner during the summer because low flows and high water temperatures occur in July. Similar water conditions do not occur on the Washougal River until August. Fish numbers entering Skamania Hatchery slow during August and September, as fish hold in the Columbia River (Hull, personal communication). The 1974 Washougal run on Mad River was composed only of fish which had spent two years at sea. On the Siletz River, summer steelhead which spent two years at sea migrate into freshwater about one month earlier than fish which spent one year at sea (Weber and Fortune 1974). The absence of Washougal steelhead which spent one year at sea in Mad River may explain the lack of upstream migrants in July. During the fall, the Washougal and Mad Rivers have a second peak of upstream migration from within the river.

Since I counted few steelhead in Section VI during August, and anglers caught steelhead upstream from that area during the summer and fall, most of the 1974 native summer steelhead run probably migrated

past the natural barrier near the mouth of Bug Creek. I have no evidence that hatchery fish migrated above Section VI.

Water flow and temperature were important factors affecting upstream migration of summer steelhead in the Siletz River (Weber and Fortune 1974). The run generally peaks sometime between late June to mid-July, and then decreases rapidly as the summer progresses because of low flows and high water temperatures. A sharp increase occurs following the first fall freshet. A similar temperature and flow effect occurred for movement of Mad River summer steelhead.

March and April smolt release dates produced similar returns of adult Washougal steelhead to Mad River both in body size and number of fish. Wagner (1968) found that mid-April was more favorable than February or March for stocking hatchery-reared winter steelhead smolts in the Alsea River, Oregon.

The mean fork lengths of Washougal steelhead in Mad River which spent one and two years at sea were 58.7 and 72.7 centimeters, respectively, compared to 58.4 and 71.1 centimeters for Washougal River fish (Hull and Allee, unpublished). Since spring and fall-run Washougal steelhead in Mad River had similar mean fork lengths, I conclude that the fall-run fish did not remain to grow in the ocean longer than spring-run fish. Visual observation of fall-run fish showed coloration and loss of weight from freshwater residence. Males were longer than females for Washougal steelhead in Mad River, for Siletz River summer steelhead (Weber and Fortune 1974) and for summer steelhead in three British Columbia streams (Withler 1966). Since the first year of freshwater growth for Mad River half-pounders was greater than for native adults which spent one full year at sea, the half-pounders

may be produced in other larger more productive rivers with known half-pounder runs, such as the Rogue, Klamath and Eel Rivers. For Klamath River half-pounders, 27% migrated to sea as smolts after one year of freshwater residence (Kesner and Barnhart 1972). This life history pattern was shown by two of the eight half-pounders sampled in Mad River but by none of 22 Mad River natives which spent one full year at sea. On the Rogue River, most half-pounders return again as larger fall-run summer steelhead and the rest as spring-run fish (Everest 1973). Recaptures of tagged Rogue River half-pounders at sea and in California streams indicate that ocean rearing is south of Oregon. Two tagged fish were caught by anglers near Eureka, California. Therefore, it is conceivable that they could have strayed into Mad River.

Sixty-five percent of Siletz River summer steelhead which have spent two years at sea were females (Weber and Fortune 1974). In the Babine River, British Columbia, traps caught more female than male summer steelhead (Narver 1969). On Mad River, although females outnumbered males in 1974, the difference was not significant.

In 1970, the average number of eggs per female for Washougal steelhead at Skamania Hatchery was 2,481 (mean FL = 69.1 cm) (Hull and Allee, unpublished) and 3,171 (mean FL = 71.3) for Washougal steelhead at Mad River Hatchery. Average fecundities of Siletz River summer steelhead (mean FL = 68.5 cm) and Deschutes River summer steelhead (mean FL = 57.8 cm) were 4,270 and 5,529 eggs per female, respectively (McKern, et al. 1974), which are much higher values than for Washougal strain fish.

The lack of significant correlation between fork length and fecundity of Washougal steelhead in Mad River may be due to a greater effect of high water temperature and prolonged lack of food on egg production of large fish. Alsea River winter steelhead, which are not subjected to these conditions, have a significant positive correlation between fork length and fecundity (Bulkley 1967). The short range of fork lengths used may have prevented the demonstration of a significant correlation for Washougal steelhead.

MANAGEMENT IMPLICATIONS

Although a creel census was not done to quantify the summer steelhead harvest by the sportfishery, my observations during field work leads me to believe that angler effort and success was quite high during the spring and fall of 1974, when river conditions were excellent for summer steelhead fishing. Most fishermen I talked to felt that summer steelhead fishing was good, especially from Mad River Hatchery to the estuary. Although the percentage of adult returns to the hatchery was low, the fish ladder was opened after a considerable number of fish had been caught by anglers. The vulnerability of summer steelhead to illegal snagging and spearfishing during low midsummer flows was a problem, especially in the area between Mad River Hatchery and U.S. 101 Bridge. These activities probably decreased the number of fall-run fish returning to the hatchery. To accurately determine the success of future hatchery plants of summer steelhead, I suggest that an intensive creel census be conducted in conjunction with an analysis of hatchery returns.

The natural barrier near the mouth of Bug Creek appears to undergo changes and is not necessarily a block to summer steelhead upstream migration during any given year. Since Sweasey Dam no longer exists and native summer steelhead migrated above the mouth of Bug Creek during 1974, additional spawning habitat is now available and the run may increase. Angler access above the mouth of Bug Creek is poor because of private land ownership. Before any attempt is made to improve angler access, it should be determined whether the native

summer steelhead population can withstand additional angling pressure.

The low fecundity of Washougal strain summer steelhead may become a factor in maintaining a hatchery run of acceptable size, since more spawners would be needed for egg production. Another problem confronting hatchery propagation of summer steelhead on Mad River is the lack of adequate holding facilities for adult summer steelhead during the summer months.

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APPENDICES

Appendix I. Summer steelhead tagged and recovered.

Date Tagged	Location Tagged	Capture Method	Date Recovered	Location Recovered	Recovery Method	Origin
6/21/74	Hatchery	Hatchery	6/24/74	½ km above hatchery	Angler	Hatchery
6/21/74	Hatchery	Hatchery	6/27/74	Near hatchery	Angler	Hatchery
6/28/74	Hatchery	Hatchery	6/28/74	Near Hatchery	Angler	Hatchery
6/21/74	½ km above 101 Bridge	Fyke net	6/30/74	1 km below 101 Bridge	Angler	Hatchery
6/28/74	Near hatchery	Seine	6/30/74	Near hatchery	Angler	Hatchery
6/28/74	Near hatchery	Seine	7/2/74	Near hatchery	Angler	Hatchery
6/30/74	½ km above 101 Bridge	Fyke net	7/4/74	1½ km below 101 Bridge	Angler	Native
6/22/74	½ km above 101 Bridge	Fyke net	7/4/74	101 Bridge	Angler	Hatchery
6/24/74	½ km above 101 Bridge	Fyke net	7/11/74	Near Hatchery	Weir trap	Hatchery
6/27/74	½ km above 101 Bridge	Fyke net	7/11/74	101 Bridge	Angler	Hatchery
6/28/74 to 7/15/74	Near hatchery	Seine or weir trap	7/15/74	Near hatchery	Diving	Hatchery
6/28/74 to 7/15/74	Near hatchery	Seine or weir trap	7/15/74	Near hatchery	Diving	Hatchery
5/22/74 to 7/9/74	½ km above 101 Bridge	Gill or fyke net	7/15/74	Near hatchery	Diving	Hatchery
5/22/74 to 7/9/74	½ km above 101 Bridge	Gill or fyke net	7/15/74	½ km below hatchery	Diving	Hatchery
6/26/74	½ km above 101 Bridge	Fyke net	7/22/74	1 km below 101 Bridge	Angler	Native
6/28/74	Near hatchery	Seine	7/22/74	½ km above hatchery	Angler	Hatchery

Appendix 1. (Continued)

Date Tagged	Location Tagged	Capture Method	Date Recovered	Location Recovered	Recovery Method	Origin
6/28/74 to 7/18/74	Near hatchery	Seine or weir trap	7/29/74	2½ km below Blue Lake Bridge	Diving	Hatchery
5/22/74 to 7/9/74	½ km above 101 Bridge	Gill or fyke net	7/30/74	1 km above 101 Bridge	Diving	Hatchery
5/22/74 to 7/9/74	½ km above 101 Bridge	Gill or fyke net	7/30/74	1 km above 101 Bridge	Diving	Hatchery
5/22/74 to 7/9/74	½ km above 101 Bridge	Gill or fyke net	7/30/74	101 Bridge	Diving	Hatchery
7/6/74	½ km above 101 Bridge	Fyke net	8/16/74	1½ km below Trestle 1	Angler	Native
5/22/74 to 7/9/74	½ km above 101 Bridge	Gill or fyke net	8/18/74	2 km above 101 Bridge	Angler	?
6/28/74 to 7/19/74	Near hatchery	Seine or weir trap	8/19/74	8 km above hatchery	Diving	Hatchery
6/28/74 to 7/19/74	Near hatchery	Seine or weir trap	8/19/74	1½ km above hatchery	Diving	?
5/22/74 to 7/9/74	½ km above 101 Bridge	Gill or fyke net	9/11/74	2 km above 299 Bridge	Diving	?
6/28/74	Near hatchery	Seine	10/27/74	Hatchery	Ladder	Hatchery

Appendix II. Gill net operation for tagging summer steelhead with yellow tags.

Date	Tag Number	Location	Time Net (In)	Time Net (Out)	Remarks
5/18/74	-	½ km above Trestle 1	0430	0730	Two male winter steelhead caught.
5/19/74	-	" "	0330	0600	Two female winter steelhead caught.
5/21/74	-	" "	1945	2150	
5/22/74	00249	½ km above 101 Bridge	2040	2400	Caught at 2100.
5/22/74	00251	" "	2040	2400	Caught at 2230. Three male winter steelhead also caught.
5/23/74	-	" "	2015	2335	
5/25/74	-	" "	2000	2300	
5/28/74	-	" "	2020	2320	Fish hit net (2150). Fish jumped over net (2300). Water murky.
5/30/74	-	" "	2000	2315	Water murky.
6/1/74	-	" "	2000	2330	Two fish hit net (2115). Water clear.
6/3/74	-	" "	2030	2400	Fish hit net (2040). Water clear.
6/5/74	-	" "	2010	0615	Winter steelhead caught (2230). Fish hit net (2320). Water clear.

Total fish tagged = 2

Appendix III. Fyke net operation ($\frac{1}{2}$ kilometer upstream from U.S. 101 Bridge) for tagging summer steelhead with yellow tags.

Date Captured	Tag Number	Net (In)	Net (Out)	Eroded Dorsal Fin	Remarks
6/7/74	00263	2130	0600	Yes	Caught at 2230.
6/8/74	-	2045	0530	-	
6/9/74	-	2100	0530	-	
6/10/74	-	2030	0600	-	
6/11/74	-	2045	0600	-	Fish caught at 2145 escaped.
6/17/74	00266	2115	0515	No	Caught at 0100. Very active, robust, bright fish. About 2 kilograms.
6/17/74	00276	2115	0515	No	Caught at 0500. Very active, robust, bright fish. About 2 kilograms.
6/18/74	-	2045	0545	-	
6/21/74	00322	2045	0500	Yes	Caught at 1230.
6/21/74	00323	2045	0500	Yes	Caught at 0430.
6/21/74	00324	2045	0500	Yes	Caught at 0430. Scales taken (#255).
6/21/74	00326	2045	0500	Yes	Caught at 0430.
6/22/74	00328	2100	0600	Yes	Caught at 2300. Marked RV-Ad. Found tagged fish (#00326) mortality below trap.
6/22/74	00333	2100	0600	Yes	Caught at 0300.

Appendix III. (Continued)

Date Captured	Tag Number	Net (In)	Net (Out)	Eroded Dorsal Fin	Remarks
6/24/74	00336	2030	0530	Yes	Caught at 0100.
6/24/74	00337	2030	0530	Yes	Caught at 0100. Scales taken (#256).
6/24/74	00341	2030	0530	Yes	Caught at 0400. About 5 kilograms.
6/26/74	00348	2100	0600	Yes	Caught at 2215. Marked RV-Ad.
6/26/74	00350	2100	0600	No	Caught at 0430. Scales taken (#258).
6/26/74	00351	2100	0600	No	Caught at 0430. Scales taken (#257).
6/27/74	00363	2100	0600	?	Caught at 0130. Scales taken (#260).
6/27/74	00354	2100	0600	Yes	Caught at 0500.
6/27/74	00358	2100	0600	Yes	Caught at 0600.
6/27/74	00360	2100	0600	No	Caught at 0600. Scales taken (#259).
6/30/74	00365	2045	0600	No	Caught at 0415. Scales taken (#264).
6/30/74	00367	2045	0600	Yes	Caught at 0500.
7/2/74	00368	2115	0600	Yes	Caught at 0500. Stream level rose about 20 centimeters.
7/6/74	00349	2030	0600	No	Caught at 0530. Scales taken (#265). Stream level dropped.

Appendix IV. Beach seine operation for tagging summer steelhead with white tags near Mad River Fish Hatchery on 6/28/74.

Tag Number	Eroded Dorsal Fin	Remarks
00003	Yes	Dip netted from hatchery ladder before seining.
00010	Yes	
00011	Yes	
00012	Yes	
00081	Yes	Small fish.
00083	Yes	
00084	Yes	
00085	Yes	Marked RV-Ad.
00086	Yes	
00087	Yes	
00088	Yes	Died shortly after tagging. Scales taken (#263). Male. Gonads fairly large. Warm river water temperature and handling may have combined to cause death.
00089	Yes	
00091	?	Scales taken (#261).
00092	No	Scales taken (#262).

Appendix V. Weir trap operation near Mad River Fish Hatchery for tagging summer steelhead with white tags.

Date Captured	Tag Number	Eroded Dorsal Fin	Remarks
7/3/74	-	-	Trap began operation.
7/4/74	-	-	
7/5/74	-	-	
7/6/74	-	-	
7/7/74	00094	No	
7/7/74	00005	No	Scales taken (#266).
7/8/74	-	-	Part of fencing down due to leaf buildup.
7/9/74	-	-	
7/11/74	-	-	Tagged fish recaptured (Yellow #00336).
7/12/74	00082	Yes	Scales taken (#267). Small fish.
7/13/74	-	-	
7/14/74	-	-	
7/15/74	00001	Yes	Large fish.
7/15/74	00041	No	Scales taken (#268).
7/15/74	00042	?	Scales taken (#269). Escaped downriver.
7/16/74	-	-	
7/17/74	00043	No	Scales taken (#270). Half pounder (35.7 cm).
7/18/74	00044	No	Scales taken (#271).
7/18/74	00045	No	Scales taken (#272).
7/18/74	00047	?	Scales taken (#273).

Appendix V. (Continued)

Date Captured	Tag Number	Eroded Dorsal Fin	Remarks
7/18/74	00048	Yes	Large fish. Only fish caught in evening.
7/19/74	00049	No	Scales taken (#274).
7/20/74	-	-	One large fish escaped trap while netting.
7/21/74 to 7/27/74	-	-	From 7/22/74 to 7/25/74, increased accumulation of plant material caused portions of the trap fencing to lift off the bottom, which may have allowed fish to pass through. Trap was removed on 7/27/74.

Appendix VI. Summer steelhead tagged with red tags in Mad River Hatchery and released to Mad River on 6/21/74. Small fish are less than 61 cm in fork length and large fish greater than 61 cm.

Tag Number	Eroded Dorsal Fin	Remarks
00001	No	
00002	No	Small fish.
00004	Yes	
00005	Yes	Small fish.
00006	No	
00007	No	
00009	Yes	Small fish.
00011	Yes	Small fish.
00012	Yes	Small fish.
00013	Yes	Small fish.
00015	Yes	Small fish.
00016	Yes	Small fish.
00017	Yes	Small fish.
00018	No	Small fish.
00019	No	Small fish.
00023	Yes	Small fish.
00030	Yes	Small fish.
00031	Yes	Small fish.
00033	Yes	Small fish.
00034	Yes	Small fish.
00035	Yes	Small fish.

Appendix VI. (Continued)

Tag Number	Eroded Dorsal Fin	Remarks
00036	Yes	Large fish.
00037	Yes	Large fish.
00039	Yes	Large fish.
00041	Yes	Large fish.
00042	Yes	Large fish.
00043	Yes	Large fish.

Appendix VII. Fork lengths of 167 RV-Ad marked yearling Washougal smolts taken on 3/16/72. Mean = 18.318 cm.

Fork Length (cm)						
18.1	18.2	18.5	18.4	19.2	18.0	18.4
19.3	19.7	17.3	17.2	18.4	18.0	20.4
18.6	18.1	16.1	16.9	19.5	18.3	19.0
17.4	16.4	18.5	18.5	19.1	20.0	17.3
17.3	14.3	21.4	18.5	16.9	16.9	18.4
18.4	18.7	17.7	18.6	18.5	17.1	18.9
18.3	17.2	17.4	17.8	19.4	18.7	18.7
17.8	17.5	19.8	18.5	20.2	18.0	17.9
21.5	18.0	18.4	18.8	17.4	20.7	17.9
20.8	17.8	18.6	17.9	18.0	16.5	18.7
18.6	22.6	16.0	18.9	18.6	20.3	19.6
19.3	17.9	18.7	18.8	18.9	17.1	19.5
18.9	16.1	18.8	16.4	19.2	17.5	18.7
18.5	20.7	16.7	17.6	18.6	20.4	17.1
18.1	19.0	20.2	15.6	19.7	18.3	15.2
19.2	18.2	19.8	19.2	20.6	17.6	16.7
19.0	18.0	15.9	17.0	20.2	17.8	20.5
19.4	16.0	20.5	21.7	16.7	16.1	17.6
18.5	18.1	19.4	22.2	19.1	17.9	20.1
18.3	17.3	17.4	17.5	16.9	17.1	17.5
19.7	18.3	17.6	17.8	17.8	16.7	15.0
17.7	20.1	17.2	20.0	17.8	17.9	19.0
17.6	17.6	15.4	17.2	19.2	18.7	18.9
19.4	17.1	19.0	18.0	17.3	17.4	

Appendix VIII. Forklength, weight, mark, sex, and age of adult summer steelhead from Mad River.

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
1	9/24/73	58.6	-	RV-Ad	-	F	1/1	Bright
3	2/11/74	58*	-	RV-Ad	-	F	1/1	Bright
6	2/11/74	59.0	-	RV-Ad	-	M	1/1	Slender, dark
9	2/11/74	59*	-	LV-Ad	-	M	1/1	Slender, dark
10	2/11/74	57*	-	RV-Ad	-	M	1/1	Slender, dark
11	2/11/74	58.5	-		-	M	1/1	Slender, dark
13	2/11/74	58.5	-	RV-Ad	-	M	1/1	Slender, dark
51	5/2/74	69*	3.4	RV-Ad	Yes	F	1/2	Gonads sampled. Creel.
52	5/3/74	70*	3.5		Yes	F	1/2	Gonads sampled. Creel.
53	5/3/74	74.2	3.4		Yes	-	1/2	Hatchery
54	5/3/74	74.9	4.3		Yes	-	1/2	Hatchery
55	5/3/74	80.0	5.0		Yes	-	1/2	Hatchery
56	5/3/74	67.5	2.8		Yes	F	1/2	Hatchery, gonads sampled.
57	5/3/74	71.6	3.8		Yes	-	1/2	Hatchery
58	5/3/74	75.2	4.2		Yes	-	1/2	Hatchery
59	5/3/74	72.0	3.8		Yes	-	1/2	Hatchery
60	5/3/74	72.2	3.5		Yes	-	1/2	Hatchery
61	5/3/74	75.5	3.9		Yes	-	1/2	Hatchery
62	5/3/74	68.7	3.4	RV-Ad	Yes	-	1/2	Hatchery
63	5/3/74	70.5	3.6		Yes	-	1/2	Hatchery
64	5/3/74	75.2	4.4		Yes	-	1/2	Hatchery
65	5/3/74	74.0	3.8		Yes	-	1/2	Hatchery
66	5/3/74	77.2	4.4		Yes	-	1/2	Hatchery
67	5/3/74	74.4	4.2	RV-Ad	Yes	-	1/2	Hatchery
68	5/3/74	72.3	3.9	LV-Ad	Yes	-	1/2	Hatchery
69	5/3/74	75.3	3.9	RV-Ad	Yes	-	1/2	Hatchery
70	5/3/74	77.3	4.9		Yes	-	1/2	Hatchery
71	5/3/74	72.8*	3.8*		Yes	-	Reg**	Hatchery
72	5/3/74	69.6	3.2	RV-Ad	Yes	-	1/2	Hatchery
73	5/3/74	75.8	3.8		Yes	-	1/2	Hatchery
74	5/3/74	71.0	3.4		Yes	-	1/2	Hatchery

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
75	5/3/74	67.9	3.1	RV-Ad	Yes	-	1/2	Hatchery
76	5/3/74	73.2*	4.1*		No	-	1/2	Hatchery
77	5/3/74	76.1	4.1	RV-Ad	Yes	-	1/2	Hatchery
78	5/3/74	74.5	3.7		Yes	-	1/2	Hatchery
79	5/3/74	70.3	3.5		Yes	-	1/2	Hatchery
80	5/3/74	66.5	2.7		Yes	-	1/2	Hatchery
81	5/3/74	71.0	3.5	LV-Ad	Yes	-	1/2	Hatchery
82	5/3/74	72.4	3.4		Yes	-	1/2	Hatchery
83	5/3/74	76.8	4.3	RV-Ad	Yes	-	1/2	Hatchery
84	5/3/74	80.1	5.7	RV-Ad	Yes	-	1/2	Hatchery
85	5/3/74	72.6	3.5	LV-Ad	Yes	-	1/2	Hatchery
86	5/3/74	69.8	3.0	RV-Ad	Yes	-	1/2	Hatchery
87	5/3/74	80.8	4.8		Yes	-	1/2	Hatchery
88	5/3/74	79.0*	4.6*		Yes	-	Reg	Hatchery
89	5/3/74	68.8	3.4	LV-Ad	Yes	-	1/2	Hatchery
90	5/3/74	68.0	3.5		Yes	-	1/2	Hatchery
91	5/3/74	81.1	5.4		Yes	-	1/2	Hatchery
92	5/3/74	69.9	3.6		Yes	-	1/2	Hatchery
93	5/3/74	70.6	3.6		Yes	-	1/2	Hatchery
94	5/3/74	73.4	3.8		Yes	-	1/2	Hatchery
95	5/3/74	70.7*	5.1*		Yes	-	?	Hatchery
96	5/3/74	74.7*	4.9*		Yes	-	Reg	Hatchery
97	5/3/74	71.5	3.5		Yes	-	1/2	Hatchery
98	5/3/74	68.0	3.2		Yes	-	1/2	Hatchery
99	5/3/74	72.3	3.4	RV-Ad	Yes	-	1/2	Hatchery
100	5/3/74	68.1*	3.2*		Yes	-	Reg	Hatchery
101	5/3/74	68.9	3.0		Yes	-	1/2	Hatchery
102	5/3/74	75.3	4.2		?	-	1/2	Hatchery
103	5/3/74	71.8	3.0		Yes	-	1/1	Hatchery
104	5/3/74	73.6*	3.9*		Yes	-	Reg	Hatchery
105	5/3/74	73.4	3.8		Yes	-	1/2	Hatchery

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
106	5/3/74	72.9	4.2		Yes	-	1/2	Hatchery
107	5/3/74	73.9	4.2	RV-Ad	Yes	-	1/2	Hatchery
108	5/3/74	74.3	4.1	RV-Ad	Yes	-	1/2	Hatchery
109	5/3/74	75.4	4.2		Yes	-	1/2	Hatchery
110	5/3/74	74.5	4.3		Yes	-	1/2	Hatchery
112	5/3/74	77.9	4.8		Yes	-	1/2	Creel
113	5/3/74	70.4	3.5		Yes	-	1/2	Creel
114	5/3/74	70.9	3.3		Yes	-	1/2	Creel
115	5/3/74	68.2	2.9		Yes	-	1/2	Creel
116	5/3/74	73.4	3.9		Yes	M	1/2	Creel. Gonads sampled.
117	5/4/74	68.5*	3.6*		Yes	F	?	Creel. Gonads sampled.
118	5/4/74	69.3	3.6		Yes	F	1/2	Creel. Gonads sampled.
119	5/4/74	69.0	3.4		Yes	F	1/2	Creel. Gonads sampled.
120	5/4/74	71.8*	3.7*		?	F	-	Creel. Gonads sampled.
121	5/5/74	75.2	4.4		Yes	F	1/2	Creel. Photo.
122	5/5/74	74.1	-		Yes	M	1/2	Creel. Gutted.
124	5/5/74	75.4	-		Yes	M	1/2	Creel. Gutted.
125	5/5/74	66.4	3.1		?	F	1/2	Creel. Gonads sampled.
127	5/10/74	73.7*	4.0*		No	-	Reg	Hatchery
128	5/10/74	72.2*	4.0*		Yes	-	Reg	Hatchery
129	5/10/74	74.0*	3.9*		Yes	-	Reg	Hatchery
130	5/10/74	70.9*	3.6*		Yes	-	Reg	Hatchery
131	5/10/74	79.7	5.0		Yes	-	1/2	Hatchery
132	5/10/74	76.7	4.9		Yes	-	1/2	Hatchery
133	5/10/74	79.4*	5.2*		Yes	-	Reg	Hatchery
134	5/10/74	73.5	4.1		Yes	-	1/2	Hatchery
135	5/10/74	69.9	3.5	LV-Ad	Yes	-	1/2	Hatchery
136	5/10/74	77.2*	4.6*		Yes	-	Reg	Hatchery
137	5/10/74	76.2	4.4	RV-Ad	Yes	-	1/2	Hatchery
138	5/10/74	73.7*	3.9*		Yes	-	Reg	Hatchery
139	5/10/74	70.0	3.3		Yes	-	1/2	Hatchery

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
140	5/10/74	79.5	5.2		Yes	-	1/2	Hatchery
141	5/10/74	69.1*	3.3*		Yes	-	Reg	Hatchery
142	5/10/74	70.0	3.8		Yes	-	1/2	Hatchery
143	5/10/74	69.0	3.1		Yes	-	1/2	Hatchery
144	5/10/74	67.9	3.3		Yes	-	1/2	Hatchery
145	5/10/74	74.7*	4.4*		Yes	-	Reg	Hatchery
146	5/10/74	64.7	2.8		Yes	-	1/2	Hatchery
147	5/10/74	73.2*	3.5*		Yes	-	Reg	Hatchery
148	5/10/74	77.9	4.8		Yes	-	1/2	Hatchery
150	5/10/74	72.8*	4.0*		?	-	Reg	Hatchery
151	5/10/74	72.7*	3.5*		Yes	-	Reg	Hatchery
152	5/10/74	70.2*	3.5*		Yes	-	Reg	Hatchery
153	5/10/74	71.0*	3.5*		Yes	-	Reg	Hatchery
154	5/10/74	72.0*	3.8*		No	-	1/2	Hatchery
155	5/10/74	69.1*	3.6*		Yes	-	Reg	Hatchery
156	5/10/74	74.2	4.3	RV-Ad	Yes	-	1/2	Hatchery
157	5/10/74	71.6	3.7		Yes	-	1/2	Hatchery
158	5/10/74	69.3	3.3		Yes	-	1/2	Hatchery
159	5/10/74	71.3	3.5		Yes	-	1/2	Hatchery
160	5/10/74	72.2*	3.7*		Yes	-	Reg	Hatchery
161	5/10/74	69.5*	3.6*		Yes	-	Reg	Hatchery
162	5/11/74	73.7*	4.0*		Yes	M	?	Creel. Gonads sampled.
163	5/12/74	72.9	-	LV-Ad	Yes	F	1/2	Creel. Gutted. Gonads sampled.
164	5/17/74	72.0*	3.8*		Yes	-	Reg	Hatchery
165	5/17/74	64.5	2.8		Yes	-	1/2	Hatchery
166	5/17/74	71.0	3.8		Yes	-	1/2	Hatchery
167	5/17/74	68.8	3.3	RV-Ad	Yes	-	1/2	Hatchery
168	5/17/74	76.5	4.8		Yes	-	1/2	Hatchery
169	5/17/74	69.9	3.4		Yes	-	1/2	Hatchery
170	5/17/74	69.0	3.2	RV-Ad	Yes	-	1/2	Hatchery
171	5/17/74	67.8*	3.0*		Yes	-	Reg	Hatchery

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
172	5/24/74	73.8	-		Yes	-	1/2	Creel. Gutted.
173	5/24/74	74.9	3.8		Yes	-	1/2	Hatchery
174	5/24/74	74.5	4.0	LV-Ad	Yes	-	1/2	Hatchery
175	5/24/74	73.2	3.8		Yes	-	1/2	Hatchery
176	5/24/74	72.6	3.5		Yes	-	1/2	Hatchery
177	5/24/74	74.7	4.1		Yes	-	1/2	Hatchery
178	5/24/74	77.5	-		Yes	-	1/2	Hatchery
179	5/24/74	74.3	-		Yes	-	1/2	Hatchery
180	5/24/74	68.1	3.3		Yes	-	1/2	Hatchery
181	5/24/74	76.8	4.6		Yes	-	1/2	Hatchery
182	5/24/74	80.4	5.0		Yes	-	1/2	Hatchery
183	5/24/74	70.9	3.5	LV-Ad	Yes	-	1/2	Hatchery
184	5/24/74	69.2	3.3		Yes	-	1/2	Hatchery
185	5/24/74	56.2*	-		Yes	-	1/2	Hatchery
186	5/24/74	77.3	4.3		Yes	-	1/2	Hatchery
187	5/24/74	67.8	4.0	LV-Ad	Yes	-	1/2	Hatchery
188	5/24/74	72.8	3.8		Yes	-	1/2	Hatchery
189	5/24/74	71.7*	3.7*		Yes	-	Reg	Hatchery
190	5/24/74	52.9	1.7		No	-	2/1	Hatchery
192	5/31/74	76.9	4.9		Yes	-	1/2	Hatchery
193	5/31/74	79.1	5.0	RV-Ad	Yes	-	1/2	Hatchery
194	5/31/74	70.4	4.1		Yes	-	1/2	Hatchery
195	5/31/74	73.1	4.1		Yes	-	1/2	Hatchery
196	5/31/74	56.2	1.8		No	-	2/1	Hatchery
197	5/31/74	57.4*	2.1*		No	-	?	Hatchery
198	5/31/74	73.9	4.3	RV-Ad	Yes	-	1/2	Hatchery
199	5/31/74	65.7*	2.9*		Yes	-	Reg	Hatchery
200	5/31/74	69.3*	3.1*		Yes	-	Reg	Hatchery
201	6/7/74	59.4	2.6		No	-	2/1	Hatchery
202	6/7/74	61.6	3.9		Yes	-	1/2	Hatchery
203	6/7/74	69.2*	3.5*		Yes	-	Reg	Hatchery

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
204	6/7/74	66.8	3.3		Yes	-	1/2	Hatchery
205	6/7/74	51.8*	1.6*		Yes	-	?	Hatchery
206	6/7/74	52.9*	1.7*		Yes	-	?	Hatchery
207	6/7/74	54.9*	1.8*		Yes	-	1/1	Hatchery
208	6/7/74	71.0	3.5		Yes	-	1/2	Hatchery
209	6/7/74	77.6	4.6	RV-Ad	Yes	-	1/2	Hatchery
210	6/7/74	69.2	3.3		Yes	-	1/2	Hatchery
211	6/7/74	71.8	3.8		Yes	-	1/2	Hatchery
212	6/7/74	68.9*	3.7*		Yes	-	Reg	Hatchery
213	6/7/74	72.0	3.6		Yes	-	1/2	Hatchery
214	6/7/74	68.0	3.0		Yes	-	1/2	Hatchery
215	6/7/74	71.9	3.6	RV-Ad	Yes	-	1/2	Hatchery
216	6/7/74	56.3*	2.1*		Yes	-	?	Hatchery
217	6/7/74	76.8	4.8		Yes	-	1/2	Hatchery
218	6/7/74	53.6*	1.7*		Yes	-	?	Hatchery
219	6/7/74	71.2*	3.6*		Yes	-	?	Hatchery
220	6/7/74	78.2*	4.6*		Yes	-	Reg	Hatchery
221	6/7/74	53.6	1.6		No	-	2/1	Hatchery
222	6/7/74	48.4*	1.3*		Yes	-	1/1	Hatchery
223	6/7/74	49.7	1.3		No	-	2/1	Hatchery
224	6/7/74	75.9	4.5	RV-Ad	Yes	-	1/2	Hatchery
225	6/14/74	72.7	3.6	RV-Ad	Yes	-	1/2	Hatchery
226	6/14/74	76.4	4.4		Yes	-	1/2	Hatchery
227	6/14/74	77.4	4.8		Yes	-	1/2	Hatchery
228	6/14/74	79.6	5.3		Yes	-	1/2	Hatchery
229	6/14/74	71.1	3.3		Yes	-	1/2	Hatchery
230	6/14/74	71.2*	3.6*		Yes	-	Reg	Hatchery
231	6/14/74	72.7	3.7		Yes	-	1/2	Hatchery
232	6/14/74	72.0	3.7		Yes	-	1/2	Hatchery
233	6/14/74	74.9	3.7		Yes	-	1/2	Hatchery
234	6/14/74	73.5	3.6		Yes	-	1/2	Hatchery

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
235	6/14/74	80.9*	5.1*		Yes	-	Reg	Hatchery
236	6/14/74	58.9*	2.2*		No	-	?	Hatchery
237	6/14/74	69.7	3.4		Yes	-	1/2	Hatchery
238	6/14/74	69.5	3.0	RV-Ad	Yes	-	1/2	Hatchery
239	6/14/74	71.9	3.6	RV-Ad	Yes	-	1/2	Hatchery
240	6/14/74	68.8	3.3		Yes	-	1/2	Hatchery
241	6/14/74	69.4	3.4	RV-Ad	Yes	-	1/2	Hatchery
242	6/14/74	69.3	3.3		Yes	-	1/2	Hatchery
243	6/14/74	68.9	3.6		Yes	-	1/2	Hatchery
244	6/14/74	51.9*	1.5*		Yes	-	?	Hatchery
245	6/14/75	48.0*	1.3*		No	-	?	Hatchery
246	6/14/75	53.8*	1.6*		Yes	-	?	Hatchery
247	6/14/74	52.4*	1.8*		No	-	?	Hatchery
248	6/14/74	48.6*	1.3*		Yes	-	?	Hatchery
249	6/21/74	49.1	1.5		No	-	2/2	Hatchery
250	6/21/74	57.8	2.2		No	-	2/1	Hatchery
251	6/21/74	58.9*	2.4*		No	-	?	Hatchery
252	6/21/74	53.3*	1.6*		No	-	?	Hatchery
253	6/21/74	55.8	2.0		No	-	3/1	Hatchery
254	6/21/74	54.2*	2.7*		Yes	-	?	Hatchery
-	6/21/74	-	-	RV-Ad	-	-	1/2	Hatchery
255	5/22/74	65.7*	-		Yes	-	?	Fyke net
256	6/24/74	53.9	-		?	-	1/1	Fyke net
257	6/26/74	53.7	-		No	-	2/1	Fyke net
258	6/26/74	46.3	-		No	-	1/2	Fyke net
259	6/27/74	37.2	-		No	-	2/1	Fyke net
260	6/27/74	55.0	-		?	-	2/1	Fyke net
261	6/28/74	58.8*	-		?	-	1/2	Seine
262	6/28/74	47.3	-		No	-	2/2	Seine
263	6/28/74	-	-	-	?	M	1/2	Seine
264	6/30/74	55.0	-		No	-	2/1	Fyke net

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
265	7/6/74	56.8	-		No	-	2/1	Fyke net
266	7/6/74	59.5	-		No	-	2/2	Weir trap
267	7/12/74	58.5*	-		Yes	-	?	Weir trap
268	7/15/74	45.6	-		No	-	2/2	Weir trap
269	7/15/74	60.0*	-		Yes	-	Reg	Weir trap
270	7/17/74	35.7	-		No	-	2/1	Weir trap
271	7/18/74	53.9	-		No	-	2/1	Weir trap
272	7/18/74	40.1	-		No	-	1/2	Weir trap
273	7/18/74	60.9	-		?	-	2/1	Weir trap
274	7/19/74	44.2	-		No	-	2/2	Weir trap
275	9/27/74	60.5	-		No	F	2/1	Pilot Creek, creel, photo #7.
276	9/27/74	25"*	-		-	F	?	Pilot Creek, creel.
279	10/23/74	58.9	-		No	F	2/1	Pilot Creek, creel, Gonads sampled.
280	10/23/74	61.7	-		No	M	2/1	Pilot Creek, creel, photo #8 & #9.
281	10/30/74	27"*	-		Yes	F	1/2	Creel, gonads sampled.
282	10/30/74	28¼"*	-		Yes	F	1/2	Creel, gonads sampled.
283	10/30/74	30"*	-		Yes	F	1/2	Creel, gonads sampled.
284	10/31/74	59.9*	2.1*		Yes	F	?	Creel, gonads sampled.
285	10/31/74	61.7	1.9	RV-Ad	Yes	F	1/2	Creel, gonads sampled.
286	10/31/74	70.5	3.2		Yes	M	1/2	Creel, gonads sampled.
287	11/10/74	24"*	-		-	-	3/1	Pilot Creek, creel.
288	11/9/74	51.0	-		No	F	?	Pilot Creek, creel.
289	12/5/74	57.5*	-		Yes	F	?	Hatchery
290	12/5/74	81.4	-		Yes	M	1/2	Hatchery
291	12/5/74	74.1	-	RV-Ad	Yes	F	1/2	Hatchery
292	12/5/74	57.2*	-		Yes	F	?	Hatchery
293	12/5/74	75.5	-		Yes	F	1/2	Hatchery
294	12/5/74	74.7	-		Yes	M	1/2	Hatchery
295	12/5/74	79.4	-	LV-Ad	Yes	M	1/2	Hatchery
296	12/5/74	72.4	-		Yes	-	1/2	Hatchery
297	12/5/74	70.0	-		Yes	F	1/2	Hatchery

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
298	12/5/74	73.2	-		Yes	F	1/2	Hatchery
299	12/5/74	69.7	-		Yes	F	1/2	Hatchery
300	12/5/74	75.5	-	RV-Ad	Yes	F	1/2	Hatchery
301	12/5/74	69.6	-		Yes	F	1/2	Hatchery
302	12/5/74	70.2	-		Yes	F	1/2	Hatchery
303	12/5/74	78.7	-		Yes	F	1/2	Hatchery
304	12/5/74	63.7	-		Yes	F	1/2	Hatchery
305	12/5/74	69.6	-	RV-Ad	Yes	F	1/2	Hatchery
306	12/5/74	55.3*	-		Yes	F	?	Hatchery
307	12/5/74	54.7	-		No	F	2/2	Hatchery
308	12/5/74	67.3	-		Yes	M	1/2	Hatchery
309	12/5/74	72.0	-		Yes	F	1/2	Hatchery
310	12/5/74	69.6	-		Yes	F	1/2	Hatchery
311	12/5/74	68.3*	-		?	F	1/2	Hatchery
312	12/5/74	77.2	-	RV-Ad	Yes	M	1/2	Hatchery
313	12/5/74	73.6	-		Yes	F	1/2	Hatchery
314	12/5/74	72.6	-	RV-Ad	Yes	M	1/2	Hatchery
315	12/5/74	70.4	-		Yes	F	1/2	Hatchery
316	12/5/74	72.9*	-		Yes	M	Reg	Hatchery
317	12/5/74	68.2	-		Yes	F	1/2	Hatchery
318	12/5/74	71.9	-		Yes	F	1/2	Hatchery
319	12/5/74	69.5	-		Yes	F	1/2	Hatchery
320	12/5/74	82.2	-		Yes	M	1/2	Hatchery
321	12/5/74	74.3	-		Yes	F	1/2	Hatchery
322	12/5/74	65.2	-		Yes	F	1/2	Hatchery
323	12/5/74	56.5*	-		No	F	?	Hatchery
324	12/5/74	72.4	-		Yes	M	1/2	Hatchery
325	12/5/74	68.5	-		Yes	M	1/2	Hatchery
326	12/5/74	61.2*	-		No	F	?	Hatchery
327	12/5/74	73.2	-		Yes	M	1/2	Hatchery
328	12/5/74	72.3	-		Yes	F	1/2	Hatchery

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
329	12/5/74	48.7*	-		No	M	?	Hatchery, species unidentified.
330	12/5/74	74.4	-		Yes	F	1/2	Hatchery
331	12/5/74	55.1	-		No	F	2/1	Hatchery
332	12/5/74	70.0*	-		Yes	F	Reg	Hatchery
333	12/5/74	88.5*	-		?	M	Reg	Hatchery
334	12/5/74	79.4	-		Yes	M	1/2	Hatchery
335	12/5/74	80.1	-		Yes	F	1/2	Hatchery
336	12/5/74	85.0	-		Yes	M	1/2	Hatchery
337	12/5/74	65.7*	-		Yes	F	?	Hatchery
338	12/5/74	75.3*	-		?	F	1/2	Hatchery
339	12/5/74	65.1	-	LV-Ad	Yes	F	1/2	Hatchery
340	12/5/74	73.3	-		Yes	F	1/2	Hatchery
341	12/5/74	72.4*	-		Yes	F	Reg	Hatchery
342	12/5/74	72.8	-		Yes	M	1/2	Hatchery
343	12/5/74	73.5	-		Yes	F	1/2	Hatchery
344	12/5/74	58.6	-		No	F	2/1	Hatchery
345	12/5/74	74.6	-		Yes	M	1/2	Hatchery
346	12/5/74	69.7*	-		Yes	F	Reg	Hatchery
347	12/5/74	58.2	-		No	M	2/1	Hatchery
348	12/5/74	56.5	-		No	M	2/1	Hatchery
349	12/5/74	57.3*	-		No	F	?	Hatchery
350	5/3/74	34½"*	12.75 lb*		-	-	Reg	Creel
351	5/3/74	24"*	4.75 lb*		-	-	-	Creel
352	5/3/74	28½"*	8¼ lb*	LV-Ad	-	-	1/2	Creel
353	5/3/74	31"*	10 lb*		-	-	1/2	Creel
354	5/6/74	77.5	4.0	RV-Ad	-	-	1/2	Creel
355	5/12/74	28½"*	7½ lb*		-	F	1/2	Creel
356	5/11/74	72.1*	3.6*	RV-Ad	-	F	Reg	Creel
357	5/10/74	73*	3.5*	RV-Ad	-	-	1/2	Creel
358	6/28/74	75*	-		Yes	F	Reg	Hatchery. White tag #0003.
359	7/3/74	55.4	5½ lb*		No	F	2/1	Creel, 101 Bridge.

Appendix VIII. (Continued)

Scale Sample Number	Date	Fork Length(cm)	Weight (kg)	Mark	Dorsal Erosion	Sex	Age	Remarks
360	7/3/74	53.4*	5½ lb*		No	F	1/1	Creel, 101 Bridge.
361	summer/74	-	-	-	-	-	2/1	Showers Creek. DFG.
362	summer/74	-	-	-	-	-	2/1	Showers Creek. DFG.
363	6/11/75	89.4	6.9	LV-Ad	Yes	-	1/3	Hatchery. Photo.

* Data not included in calculations. It should be noted that Eel River strain summer steelhead smolts were released from Mad River Hatchery in 1973. Some returned to Mad River in 1974 at Age 1/1. Data was collected for these fish but not included in the calculations.

** Reg = Regenerated scales.

Appendix IX. Single classification analysis of variance test comparing measured fork lengths of RV-Ad marked yearling Washougal strain smolts and back-calculated fork lengths from scales of RV-Ad marked adults.

Measured fork length (cm)*	Back-calculated fork length (cm)
21.4	16.0
19.2	18.1
18.2	19.9
19.4	18.9
15.2	20.4
15.9	18.7
17.7	17.6
16.9	21.3
15.6	21.5
19.0	18.0
17.6	19.0
19.6	18.8
18.9	18.5
18.5	19.2
19.8	20.2
18.6	20.3
19.7	15.7
17.3	17.7
17.1	19.6
17.8	18.9
17.2	18.7
17.8	17.8
19.8	20.2
n = 24	24
Mean = 18.2	18.9

Source of Variation	df	SS	MS	F_s
Among groups	1	5.54	5.54	2.58
Within groups	46	99.09	2.15	
Total	47	104.63		

$F_{.05\ (1,46)} = 4.05$

Conclusion: There is no significant difference between the measured and back-calculated fork lengths of yearling smolts.

* Chosen from 167 fork length measurements using a table of random numbers.

Appendix X. Test for significant difference between the variance of measured yearling smolt fork lengths and variance of back-calculated fork lengths.

Measured fork length	$n_1 = 24$	Mean = 18.2	$s_1^2 = 2.14$
Back-calculated fork length	$n_2 = 24$	Mean = 18.9	$s_2^2 = 2.18$

$$F_s = \frac{2.14}{2.18} = 0.98$$

Two-tailed test

$$F_{.025(24,24)} = 2.27$$

Conclusion: The two variances are not significantly different.

Appendix XI. Single classification analysis of variance test comparing fork lengths of hatchery spring-run and fall-run three-year-old Washougal strain summer steelhead.

n (spring fish) = 134 Mean fork length = 72.5 cm

n (fall fish) = 43 Mean fork length = 72.9 cm

Source of Variation	df	SS	MS	F_s
Among groups	1	5.5	5.5	0.28
Within groups	175	3386.2	19.3	
Total	176	3391.7		

$F_{.05\ (1,175)} = 0.45$

Conclusion: There is no significant difference in fork length between spring and fall-run fish.

Appendix XII. Mann-Whitney U-Test comparing mean back-calculated fork lengths at Age 1 of half-pounders and native adult steelhead which spent at least one full year at sea.

Half-pounders		Native Adults	
Fork Length (cm)	Rank	Fork Length (cm)	Rank
10.1	4	8.0	1
10.5	7.5	9.2	2
11.4	15.5	9.4	3
14.3	21	10.2	5.5
14.5	22	10.2	5.5
14.7	23	10.5	7.5
15.1	24	10.6	9.5
15.2	25	10.6	9.5
		10.7	11
		11.0	12
		11.3	13.5
		11.3	13.5
		11.4	15.5
		11.9	17
		13.3	18
		13.3	19
		14.0	20

$n_2 = 8$ $n_1 = 17$

$U_s = 106$

2-tailed test: $U_{.025(17,8)} = 102$

Conclusion: The fork lengths of half-pounders are significantly greater than native adults at Age 1.

Appendix XIII. Single classification analysis of variance test comparing fork lengths of three-year-old male and female Washougal strain summer steelhead.

n (females) = 39 Mean fork length = 70.5 cm

n (males) = 18 Mean fork length = 75.1 cm

Source of Variation	df	SS	MS	F_s
Among groups	1	259.1	259.1	12.4**
Within groups	56	1170.4	20.9	
Total	57			

** $F_{.01(1,56)} = 12.1$

Conclusion: Male fish are significantly longer in fork length than female fish.

Appendix XIV. Fecundity-fork length data for three-year-old female Washougal summer steelhead at Mad River Hatchery.

Sample Number	Date	No. of Eggs per 100 cc	Total Egg Volume (cc)	Total No. of Eggs	Fork Length (cm)	Eroded Dorsal Fin	Remarks
1	1/13/75	526**	890	4,681	73.2	Yes	RV-Ad. Some eggs overripe.
2*	1/13/75	696**	480	3,341	56.7	No	
3*	1/13/75	-	-	-	75.8	Yes	RV-Ad. Dead. Eggs unripe (354.5 gm).
4	1/16/75	610**	680	4,148	73.3	Yes	
	1/21/75	-	-	-	-	-	
	1/27/75	-	-	-	-	-	
5	1/30/75	492**	450	2,214	71.4	Yes	
6	1/30/75	646**	430	2,778	69.7	Yes	
7*	2/3/75	-	-	-	62.7	?	
8	2/6/75	551**	350	1,929	74.7	Yes	
9	2/10/75	617	400	2,468	69.5	Yes	
10	2/10/75	554	700	3,878	72.3	Yes	
11	2/10/75	749	280	2,097	70.1	Yes	

Appendix XIV. (Continued)

Sample Number	Date	No. of Eggs per 100 cc	Total Egg Volume (cc)	Total No. of Eggs	Fork Length (cm)	Eroded Dorsal Fin	Remarks
12	2/10/75	586	730	4,278	74.8	Yes	
13*	2/10/75	-	-	928	67.3		Considered spawned out.
14	2/10/75	519	650	3,374	66.7	Yes	
15	2/10/75	687	510	3,504	65.1	Yes	
16*	2/13/75	-	-	957	60.2	No	Considered spawned out.
17	2/13/75	586	400	2,344	68.8	Yes	
18	2/13/75	558	670	3,739	77.8	Yes	RV-Ad.
19*	2/13/75	651	500	3,255	58.0	?	
20	2/13/75	635	530	3,366	70.4	Yes	
21	2/18/75	534	610	3,257	78.1	Yes	
22	2/18/75	899	240	2,158	68.0	Yes	
23	2/18/75	480	700	3,360	71.7	Yes	
24	2/18/75	486	570	2,770	69.7	Yes	

Appendix XIV. (Continued)

Sample Number	Date	No. of Eggs per 100 cc	Total Egg Volume (cc)	Total No. of Eggs	Fork Length (cm)	Eroded Dorsal Fin	Remarks
25*	2/18/75	901	510	4,595	58.8	No	
26	2/18/75	607	500	3,035	73.8	Yes	
27	2/18/75	924	470	4,343	69.9	Yes	
28	2/18/75	694	410	2,870	68.6	Yes	
	2/21/75	-	-	-	-	-	Two fish spawned today but no samples were taken.

Total number of samples used = 21

* Sample not included in calculations.

** Average of two readings. An error of less than 5% was found between trials. After sample number 8, only one reading was taken.

Appendix XV. Correlation test for fecundity and fork length of three-year-old Washougal summer steelhead.

	Fork length (cm)	Fecundity (number of eggs)
	65.1	3504
	66.7	3374
	68.0	2158
	68.6	2870
	68.8	2344
	69.5	2468
	69.7	2778
	69.7	2770
	69.9	4343
	70.1	2097
	70.4	3366
	71.4	2214
	71.7	3360
	72.3	3878
	73.2	4681
	73.3	4148
	73.8	3035
	74.7	1929
	74.8	4278
	77.8	3739
	78.1	3257
n =	21	21
Mean =	71.3	3171

r = 0.25

$r_{.05(19)} = 0.433$

Conclusion: There is no significant correlation between fecundity and fork length.

Appendix XVI. Chi-square test for marked steelhead returns to Mad River.

Mark	f	f	f-f	$(f-f)^2$	$\frac{(f-f)^2}{f}$
RV-Ad	45	43.88	1.12	1.25	0.03
LV-Ad	14	15.12	-1.12	1.25	0.07
				$X^2 =$	0.10

$X^2_{.50(1)} = 0.455$

Conclusion: There is no significant difference between the observed and expected return ratio of marked groups.

Appendix XVII. Single classification analysis of variance test comparing mean fork lengths of RV-Ad and LV-Ad marked three-year-old Washougal steelhead.

Fork length (cm) (LV-Ad)	Fork length (cm) (RV-Ad)
72.3	68.7
71.0	74.4
72.6	75.3
68.8	69.6
69.9	67.9
72.9	76.1
74.5	76.8
70.9	80.1
67.8	69.8
79.4	72.3
65.1	73.9
	74.3
	76.2
	74.2
	68.8
	69.0
	79.1
	73.9
	77.6
	71.9
	75.9
	72.7
	69.5
	71.9
	69.4
	61.7
	74.1
	75.5
	69.6
	77.2
	72.6
	77.5
n = 11	32
Mean = 71.4	73.0

Appendix XVII. (Continued)

Source of Variation	df	SS	MS	F_s
Among groups	1	22.69	22.69	1.51
Within groups	41	616.50	15.04	
Total	42	639.19		

$F_{.10(1,41)} = 2.84$

Conclusion: There is no significant difference in mean fork length between RV-Ad and LV-Ad marked fish.