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FISHERY RESEARCH

EFFECT OF STEELHEAD TROUT SMOLT SIZE ON RESIDUALISM AND ADULT RETURN RATES

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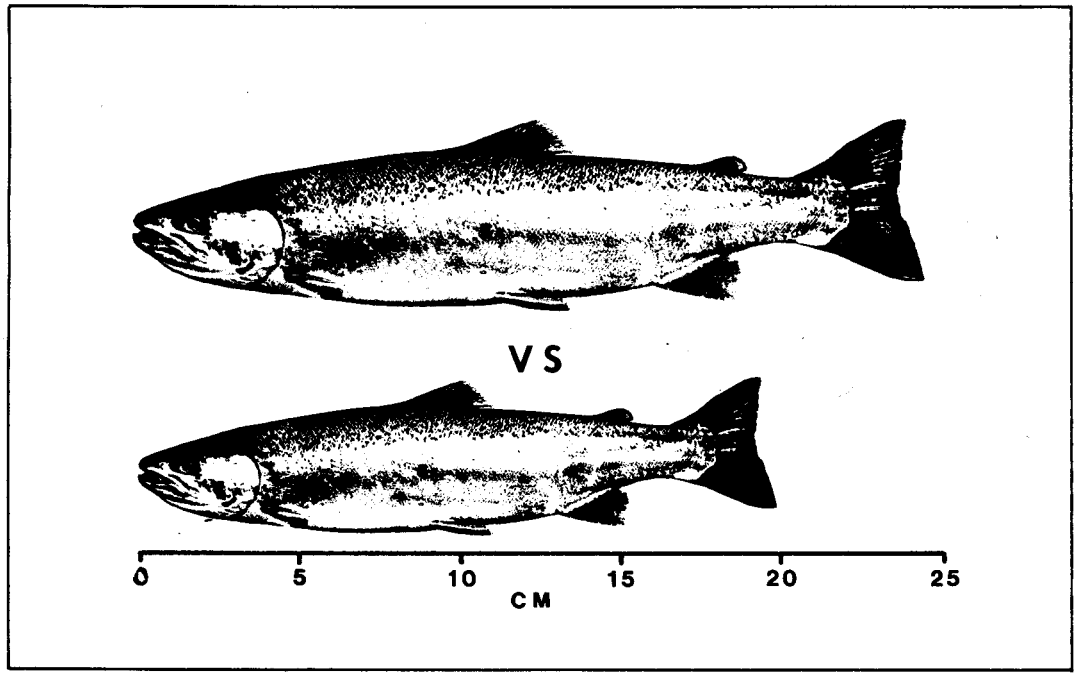

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Effect of Steelhead Trout Smolt Size on Residualism and Adult Return Rates

ABSTRACT

Equal numbers of two marked groups of different size Group A steelhead, Salmo gairdneri, smolts were released in the upper Salmon River in April 1983 to evaluate the effect of large smolt size on residualism and adult returns. The "normal" size group averaged 204.3 mm (108 to 277 mm) and 94.8 g (12 to 273 g) and the "large" size group averaged 260.2 mm (121 to 355 mm) and 219.2 g (16 to 545 g). Total number of Group A steelhead released was 81,121 fish. An additional 26,173 Group B steelhead averaging 222.8 mm (100 to 313 mm) and 137.1 g (8 to 350 g) were released at the same time as part of a stock evaluation.

Steelhead smolts remaining in the release area in excess of a month were classified as residualized and were sampled by angler harvest data, angling, and snorkeling. Anglers harvested significantly more of the "large" size group than the "normal" size steelhead with the "large" fish accounting for 83.8% of the Group A steelhead being harvested. The mean sizes of the residualized Group A steelhead harvested averaged 27.3 mm and 37.7 mm larger than the mean release sizes for the "normal" and "large" groups, respectively.

During May and June, residualized steelhead accounted for 88% of the salmonids being harvested by anglers but by mid-August, residualized steelhead were essentially gone from the upper Salmon River area. In the East Fork Salmon River, where angling pressure was lighter and 328,325 steelhead smolts were released, significant numbers of residualized steelhead remained in the release area in late September.

Residualized steelhead were found to be feeding on available natural food items similar to those used by wild rainbow. Fish (Cottus sp) were found in 2% of the stomachs examined. Of the residualized steelhead from the upper Salmon River, 80.4% were males of which 71.6% were immature.

Downriver migration rates and survival for both the "normal" and "large" steelhead smolts were similar with the median arrival dates at Lower Granite Dam being June 6 and June 8 for the "large" and "normal" groups, respectively. Survival to Lower Granite Dam was estimated at 22.5% for the "large" steelhead and 22.9% for the "normal" size steelhead.

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INTRODUCTION

The influence of the size of steelhead trout (SaImQ gairdneri) released from Idaho hatcheries on parr-smolt transformation and adult survival has received considerable attention in recent years (Chrisp and Bjornn 1978, Bjornn et al. 1979, Reingold 1979). Research has led to the conclusion that parr-smolt transformation in steelhead is primarily size and season dependent although other factors, such as age and water temperature, may be involved. If releases of truly smolted (or smolting) steelhead are made in tandem with acceptable downstream river conditions, a reasonable number of adults can be expected to return.

Because most fish cultural and economic conditions favor a one-year rearing period for steelhead, most of the Idaho research conducted to date has centered on the minimum size that must be achieved in one year in order to release smolted fish in the spring. Some work has been done to determine the size at which juvenile steelhead should be released (M. Reingold, IDFG, pers. comm., Bjornn et al. 1979). In many anadromous stocks, adult survival increased (although at a decreasing rate) as the size of juveniles at release increased (Hallock et al. 1961, Wagner et al. 1963).

Chrisp and Bjornn (1978) concluded that steelhead parr must reach a minimum total length (TL) of 140-160 mm before they can become smolts and migrate to the sea. This was not viewed as a threshold size because not all of the parr reaching these lengths would eventually smolt and migrate. However, researchers working with the lower Columbia River stocks believed that few steelhead less than 190 mm TL become emigrants and that 190 mm represented a minimum threshold size (Buchanan and Wade 1982, Wade and Buchanan 1983). Using a variety of Idaho hatchery-reared groups of steelhead, Chrisp and Bjornn (1978) showed that the relationship between length at release and the percentage migrating was consistently linear up to 210 mm TL.

Research to date has led managers to conclude that steelhead releases averaging 190 to 210 mm are probably "best" for producing actively migrating downsteam smolts. A stronger adult survival based on the "favorable" outmigration is assumed, and recent adult return rates support this assumption.

The Importance of increased size, however, does not end at release. For a particular released group, the average size of that group increases at each succeeding downriver sampling site. For example, a group of steelhead were released in the Lemhi River in April 1980 at an average size of about 182 mm. When sampled at Lower Granite Dam on the Snake River, the average length was 256 mm (T.C. Bjornn pers. comm.). Even when interim growth was accounted for, it was still evident that the larger individuals of this lot were more successful in their downstream migration than smaller fish. Similar relationships were shown in a variety of hatchery releases made earlier in the Lemhi

River drainage and sampled at a number of locations downstream as far as The Dalles Dam on the Columbia River (Chrisp and Bjornn 1978).

If large size is important to the parr-smolt transformation and successful downstream migration, then perhaps an objective of hatchery management should be to rear as large a smolt as possible within the limits of a one year production program. With the establishment of two Lower Snake River Compensation Plan (LSRCP) steelhead hatcheries in the Hagerman Valley of Idaho, rearing of steelhead smolts larger than the 190 to 210 mm "normal" size can be accomplished. The warm (15 C) Hagerman Valley spring water, introduction of demand (self) feeders, and other fish cultural advances have made it possible to rear steelhead smolts in excess of 250 mm in a one-year program.

Although larger smolts may have higher adult return rates, they also have higher rates of precocialism and residualism (Chrisp and BJornn 1978). However, if the adult return rates for larger smolts is sufficiently high, losses to precocialism and residualism will not harm the effectiveness of the rearing program. For example, if larger smolts return as adults at a theoretical rate of 2% instead of 1% for "normal" sized smolts; and the residual rates were figured at 11% for the "normal" group and 29% for the larger size groups (estimates extracted from Chrisp and Bjornn 1978), the projected rate of adult returns would still be 37% greater for the large size smolts.

Although larger smolts might return as adults more successfully, there are both biological and economic factors that argue against the need or desirability of rearing larger smolts:

1. Hatchery capacities are based on total pounds of fish that can be reared and increased steelhead smolt size reduces the number of fish that can be reared at each facility.

2. Higher rates of precocialism and residual ism in larger steelhead reduce the number of smolts that migrate to the ocean.

3. If large numbers of steelhead residualize in the Salmon River drainage, they could compete with wild steelhead or chinook salmon (*0ncorhynchus tshawytscha*) parr for food and space thereby negatively influencing wild stocks.

These questions tend to complicate the future operation and success of LSRCP programs making it necessary to evaluate the performance of the larger smolts from the Hagerman Valley hatcheries. This two-year study is designed to examine different residualism and adult return rates for "normal" and "large" size steelhead releases. Also, intra- and inter-species interactions between residualized steelhead and wild fish populations in the upper Salmon River will be evaluated.

STUDY AREA

To produce steelhead for the Salmon River drainage under the LSRCP program, adult steelhead will be trapped in the upper Salmon River at the Sawtooth Hatchery (1,440 RKm to the ocean) and on the East Fork Salmon River near Big Boulder Creek (1,405 RKm). Eggs from these adults will be eyed at Sawtooth Hatchery then shipped to Magic Valley Steelhead and Hagerman National Fish hatcheries to be reared to smolt size by the following April. The majority of these smolts will be released near the adult traps to maintain a returning run of spawners.

In 1983, marked steelhead groups were released into the upper Salmon River 11 km south of Stanley, Idaho and 4 km upstream from the Sawtooth Hatchery. To monitor residualized steelhead, 60 km of the Salmon River above and below the release site and the lower 10 km of Valley Creek were selected for angler surveys (Fig. 1). This section of the river meanders through the lower portion of the Sawtooth Valley and has a mean gradient of 5.4 m/km with the elevation at the release site being 1,980 m. Mean river discharge at the USGS gauge station below the mouth of the Yankee Fork during the 1983 water year was 36.9 cms (USGS 1983). River substrate consists mostly of gravel and rubble and most of the river areas are prime spawning area for chinook salmon and steelhead. The entire study area is used as rearing habitat by both these anadromous species. Major resident fish populations include mountain whitefish (*Prosopium williamsonl*), bull trout (*Salvelinus confluentus*), brook trout (*Salvelinus fontinalis*), sculpins (*Cottus sp*) and suckers (*Catostomus sp*).

RECOMMENDATIONS

Maintain fishing regulations at steelhead smolt release areas that will maximize angler harvest of residualized steelhead.

OBJECTIVES

To determine the effect of accelerated hatchery growth of steelhead on outmigration, precocialism, residualism, and adult survival.

To determine survival and harvest rates of residualized steelhead in release areas.

To evaluate potential Intra- and inter-species interactions between residualized steelhead and wild steelhead and chinook salmon stocks.

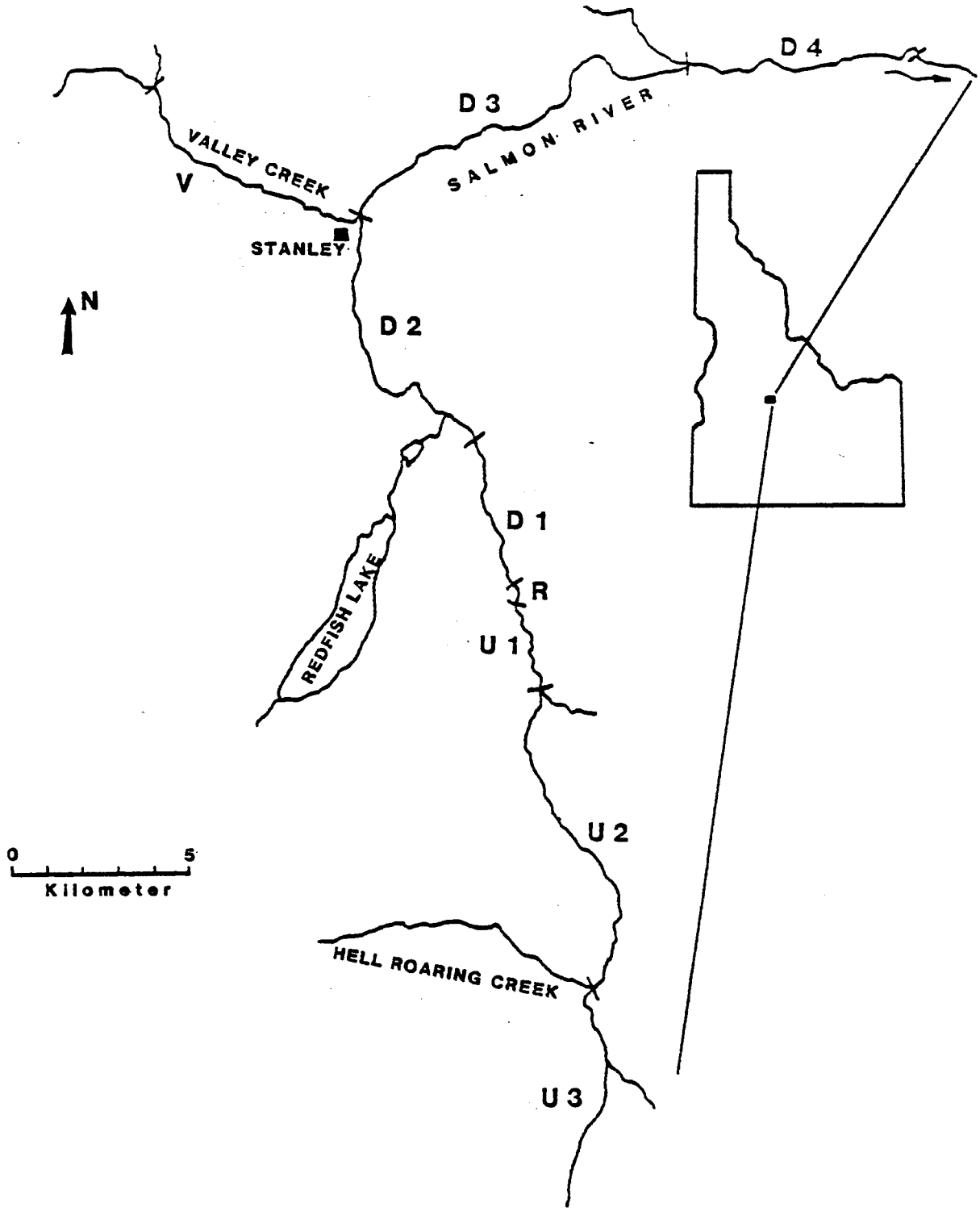

Figure 1. Angler survey study sections on the upper Salmon River.

METHODS

Hatchery Rearing

Two test groups of 40,000 Group A steel head were reared at Hagerman National Fish Hatchery (HNFH) from swim-up fry received from Pahsimeroi Hatchery in May 1982. One test group was reared in six raceways on demand feeders and allowed to achieve a "large" size of approximately 250 mm. The second "normal" group was reared in four raceways and feeding was restricted by hand feeding a predetermined amount of feed so that the fish were approximately 200 mm at release. Each group was identified by coded wire tagging and adipose fin (Ad) clipping all the fish ("large" tag code 5/13/33, "normal" tag code 5/13/34) and freeze branding half the fish ("large" RD-12-1, "normal" RD-12-3). The fish were coded wire tagged on December 7 to 10, 1982 and freeze-branded on March 16 to 17, 1983. Both groups of steelhead were released simultaneously into the upper Salmon River above the Sawtooth Hatchery weir on April 18 to 20, 1983. A total of 40,573 "large" Group A steelhead with 20,124 freeze-branded, and 40,548 "normal" Group A steelhead with 20,393 freeze-branded were released. Just prior to release, a sample of fish from each raceway were individually measured (fork length) and weighed. Condition factors (K) were calculated using Fulton's condition formula, $K = W/L^3 \times 100{,}000$, where W = weight (g) and L = fork length (mm). Comparison of fork and total length values were done by using total length (mm) = fork length (mm) x 1.05 (T. Bjornn, ICFRU, pers. comm.).

In addition to the residualism study, 26,173 Pahsimeroi Group B steelhead were reared at HNFH and released into the upper Salmon River on April 18 to 21, 1983 as part of a stock assessment. These fish were marked with a right ventral clip. Residualized Group B steelhead smolts were included in the sampling program during the summer. There were no unmarked steelhead smolts released in the upper Salmon River in 1983, but 19,840 hatchery catchables were released in the study area on July 15 to 19, 1983.

Residualized Steelhead Sampling

Steelhead remaining in the release area in excess of a month were considered residualized fish. These fish were sampled periodically throughout the summer to determine the length of time the fish remained in the system and if the rate of residualism differed for the two size groups. Sampling methods consisted of alternate angler surveys, angling, and snorkeling. Tributary streams were electrofished to determine if there was habitation by residualized fish.

Movement of fish from the release site was monitored by dividing the angler survey into nine survey sections covering 60 km of the Salmon River above and below the release site and on the lower portions of Valley and Alturas creeks (Table 1). Survey section boundaries were arbitrarily selected based on easily recognized features and fishing regulation boundaries.

Steelhead sampled were examined for marks, weighed and measured. Stomachs were collected from a portion of the fish to determine feeding habits, and sex and maturity were recorded. Snouts were collected from those Ad-clipped fish which were not identified with a freeze-brand and the coded-wire tag was recovered to identify "large" and "normal" smolts. Snouts and stomach samples were analyzed by 25 mm size classes.

Additional samples of residualized steelhead smolts were collected in the East Fork Salmon River on July 26 to 27 and September 22 to 24, 1983. The East Fork Salmon River received 296,977 Group B steelhead and 31,348 Group A steelhead smolts during April 4 to May 6, 1983.

Downriver survival and migration rates were determined from freeze-branded fish samples taken at Lower Granite Dam (750 km downriver), where steelhead smolts are collected for the fish transportation system and at Jones Beach (1,370 km downriver) in the Columbia River estuary, where emigration is monitored.

RESULTS

Size and Numbers Released

During April 18 to 21, 1983, HNFH released 40,573 "large" (4.7/kg) and 40,548 "normal" Group A steelhead smolts (11.7/kg) in the upper Salmon River. An additional 26,173 Group B steelhead smolts at 8.1/kg were released at the same time. The mean fork lengths of the three groups of steelhead were: "large" A - 260.2 mm, "normal" A - 204.3 mm, and B - 222.8 mm (Fig. 2). The mean weights of the experimental fish were slightly larger in each group when individually measured than when calculated from hatchery pond counts at time of release. The mean weight of the measured groups were: "large" A - 219.2 g (4.6/kg), "normal" A - 94.3 g (10.6/kg) and B - 137.1 g (7.3/kg) (Table 2). The "large" A smolts were in better condition (K = 1.18) than either the Group B smolts (K = 1.16) or the "normal" A smolts (K = 1.08)

On April 20, after 71,545 smolts were released, 144 Group A steelhead and 9 Group B steelhead mortalities were picked up in the Salmon River below the release site (Table 3). These fish were measured and checked for marks and freeze-brands, but snouts were not retained for coded-wire tag analysis. Twenty-seven percent (39) of the Group A steelhead smolts had readable freeze-brands with 95% (37) of the brands being RD-12-1 ("large" smolts). The mean length of all the Group A steelhead smolt mortalities was 266.6 mm which was slightly larger than the mean length of the "large" Group A steel head (260.2 mm)

Table 1. Location, length, and gradient of angler harvest survey sections on the upper Salmon River.

Study section	Section boundaries	Length (km)	Gradient (m/km
U3[a]	Pettit Lake Road on Alturas Creek and county line bridge - Hell Roaring Creek	6.1	3.5
U2	Hell Roaring Creek - Williams Creek	11.2	5.6
U1	Williams Creek - 100 m above release site	3.9	3.5
R	100 m above and 100 m below release area	0.2	4.0
D1	100 m below release area - steel bridge	4.7	4.0
D2	Steel bridge - Valley Creek	10.8	6.8
D3	Valley Creek - Basin Creek	12.6	3.6
D4	Basin Creek Sunbeam Dam	8.1	5.6
V	Valley Creek from Stanley Lake Creek to the Salmon River	9.7	3.6

[a]Includes both lower Alturas Creek and a portion of the Salmon River.

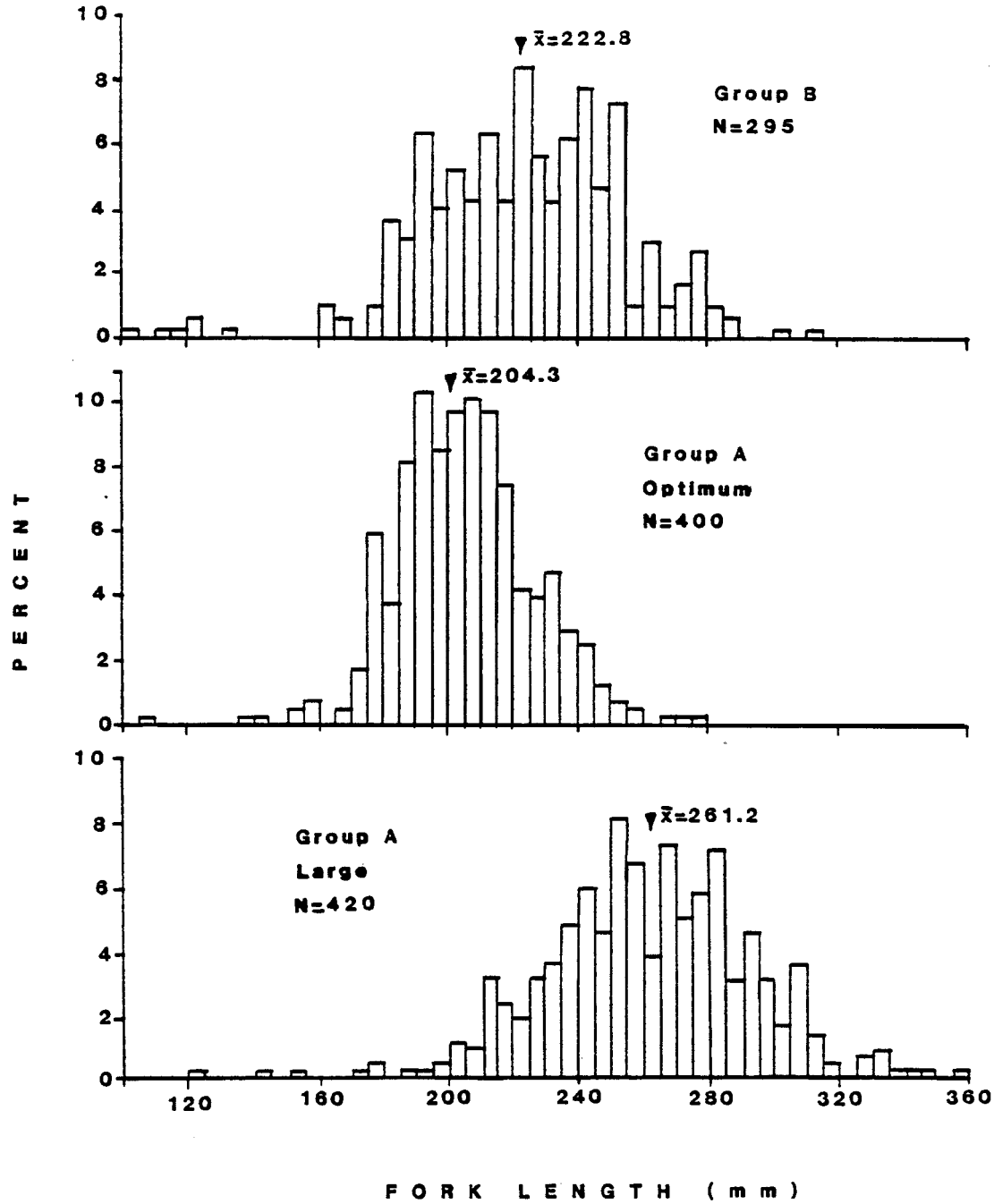

Figure 2. Length distribution of steelhead smolt study groups at release.

Table 2. Size of steel head smolts released into the upper Salmon River above the Sawtooth Hatchery weir, April 18-21, 1983.

	Number sampled	Mean	Standard deviation	Minimum	Maximum
Fork length (mm)					
Group "A" "large"	420	260.2	32.13	121	355
Group "A" "normal"	400	204.3	21.16	108	277
Group "B"	295	222.8	31.66	100	312
Weight (g)					
Group "A" "large"	420	219.2	82.20	16	545
Group "A" "normal"	400	94.8	30.81	12	273
Group "B"	295	137.1	58.07	8	350
Condition factor					
Group "A" "large"	420	1.185	0.08	0.877	1.689
Group "A" "normal"	400	1.079	0.09	0.757	1.518
Group "B"	295	1.160	0.09	0.800	1.587

	Steelhead smolts released[a]	
	Number	Number per kilogram
Group "A" "large"	40,573	4.7
Group "A" "normal"	40,548	11.7
Group "B"	26,173	8.1

[a]Numbers and weight based on hatchery pond counts.

Table 3. Steelhead mortalities at Salmon River release site on April 20, 1983.

Mark	Number	Fork length (mm)			
		Mean	s	Minimum	Maximum
Ad only[a]	105	269.6	40.67	128	364
AD and Rd-12-1[b]	37	262.9	33.22	181	322
AD and RD-12-3[c]	2	176.5	13.44	167	186
Total Ad	144	266.6	40.07	128	364
RV[d]	9	211.6	28.17	185	277

Total smolts released on April 18-19, 1983:

Large A - 26,906, Normal A - 30,397, B - 14,242

[a]Group A steelhead, either "large" or "normal".
[b]"Large" Group A steel head, 50% freeze-branded.
[c]"Normal" Group A steelhead, 50% freeze-branded.
[d]Group B steelhead.

at release. The mean length of the Group B steelhead mortality was 211.6 mm which was smaller than the mean size at release (222.8 mm).

Residualized Steelhead

Survival

Residualized steelhead smolts were sampled in the upper Salmon River from May 28 through August 13, 1983 by snorkeling, angling, and angler surveys. Weekend angler surveys in May and June found that 88% of the salmonids being harvested were residualized steelhead (Table 4). Catch per angler hour during this period for residual ized smolts averaged 0.5. In July, the percent of residualized steelhead in the harvest decreased to 52% and by the August 12-13, 1984 angler survey, no residualized steelhead were harvested.

On July 29, 6 residualized steel head were observed by snorkeling in a 200 m section of the Salmon River at the release site. Along with the steelhead, 30 hatchery rainbow trout, 55 mountain whitefish, 1 bull trout, 2 adult and 150 to 200 Juvenile chinook salmon were observed. The residualized smolts observed were all larger than 250 mm.

Additional information was collected on residualized steelhead survival on the East Fork Salmon River in July and September. Angling samples taken by project personnel found significant numbers of residualized steelhead remaining in the stream near the release site. On July 26, 55 residualized smolts were collected in 4 hours (13.8 fish/hour) in 1.5 km of stream above the release site. On September 22, 42 residualized steelhead were sampled in 7 hours (6.0 fish/hour) in the same area.

Residualized steelhead smolts showed limited movement upriver and into tributaries in 1983. Our angling samples found residualized smolts up to 3.2 km upstream from the release site with most of the smolts being caught in the immediate vicinity of the site or downstream. Smolts were caught by anglers in the two sections immediately above the release area and in all the downstream study sections to Sunbeam Dam, except for Valley Creek (Table 5). The highest catch rate (0.4 smolts/hour) was in the section immediately below the release area. Although no smolts were caught in Valley Creek, two smolts were observed in a 200 m snorkeling transect 1 km above the mouth. We did not find residualized steelhead smolts by electrofishing in the lower 2 km of Basin Creek on July 28.

Table 4. Angler harvest survey and catch per hour of residualized steel head and other fish in the upper Salmon River, 1983.

	Survey days						
	5/28-31	6/11-12	6/18-19	7/2-4	7/16-17	8/12-13	Total
Number of anglers	142	3	34	210	45	58	492
Hours fished	282	2	32	198	57	78	649
Fish harvested	141	3	21	66	34	40	305
Fish/hour	0.50	2.00	0.66	0.33	0.58	0.38	0.47
Group A steelhead	106	3	18	36	7	0	170
Fish per hour	0.38	1.50	0.56	0.18	0.12	0.00	0.26
Group B steel head	18	0	1	6	2	0	27
Fish per hour	0.06	0.00	0.03	0.03	0.04	0.00	0.04
Hatchery rainbow[a]	7	7	1	6	23	38	77
Fish per hour	0.02	0.00	0.00	0.05	0.40	0.49	0.12
Wild rainbow	7	0	1	9	12	2	21
Fish per hour	0.02	0.00	0.03	0.05	0.04	0.03	0.03
Bull trout	2	0	0	3	0	0	5
Fish per hour	0.01	0.00	0.00	0.02	0.00	0.00	<0.01
Brook trout	0	0	1	1	0	0	2
Fish per hour	0.00	0.00	0.03	<0.01	0.00	0.00	<0.01
Mountain whitefish	1	0	0	2	0	0	3
Fish per hour	<0.01	0.00	0.00	0.01	0.00	0.00	<0.01

[a]Includes any unmarked smolts, 1982 residualized smolts and hatchery catchables.

Table 5. Distribution of residualized steelhead in the upper, Salmon River as shown by angler harvest survey, 1983.

Study section	Tota fish	Total steelhead	Hours fished	Fish per hour	Steelhead per hour	Steelhead per river kilometer
U3	1	0	6	0.17	0.00	0.0
U2	3	1	50	0.06	0.02	0.1
U1	15	14	50	0.30	0.28	3.6
R	31	29	85	0.37	0.34	145.0
D1	122	88	217	0.56	0.41	18.7
D2	42	26	74	0.57	0.35	2.4
D3	56	32	87	0.64	0.37	2.5
D4	30	7	59	0.51	0.19	0.9
V	5	0	21	0.24	0.00	0.0
Total	305	197	649	0.47	0.30	

In the East Fork Salmon River, residualized steelhead smolts were found in decreasing numbers up to 2 km above the release site. Our electrofishing in Big Boulder Creek, which enters the East Fork Salmon River 0.5 km below the release site, indicated that there was limited movement into the lower 0.8 km of the stream.

Size and Condition

The mean fork length of the combined "large" and "normal" Group A steelhead smolts, which residualized in the upper Salmon River, was 288.4 mm compared to 232.9 mm at release. The percent of smolts in the 250+ mm size classes increased from 34.8% at release to 88.2% for the residualized smolts (Fig. 3). The increase in size was caused by a higher percentage of "large" smolts being sampled during the summer. Of the 142 "large" and "normal" Group A steelhead from the angler survey, which were identified by coded-wire tags and freeze-brands, 83.8% (119) were "large" and 16.2% (23) were "normal" fish (Table 6). The mean size of residualized "large" smolts was 297.9 mm and "normal" smolts 231.6 mm.

The condition of all the residualized smolts decreased throughout the summer. The condition factor for the combined release of Group A steelhead dropped from 1.13 in April to 1.02 in July (Table 7). The decrease in condition is most evident when individual size groups are examined, such as the 300+ mm group in which condition decreased from 1.22 in April to 1.03 in July. The condition factor for residualized steelhead smolts in the East Fork Salmon River was 1.00 in July and decreased to 0.95 in September.

Food Habits

Residualized steelhead smolts were found to be actively feeding on available natural food items similar to these found in the stomachs of wild rainbow (Table 8). Tricoptera were the most common item and were found in 94% of the smolt stomachs followed by Ephemeroptera (43%), Annelida (40%), Diptera (32%), Plecoptera (24%), and Hymenoptera (24%). Coleoptera, Arachnida, and fish were found in less than 10% of the stomachs. Fish in the stomachs were all Cottus sp,, and were found only in 2% of the smolts. The smolts which had eaten fish were larger than 275 mm in the upper Salmon River and 250 mm in the East Fork Salmon River. Stomach samples from residualized smolts in the East Fork Salmon River were similar in the frequency of food items except for the occurrence of empty stomachs in the September sample (Table 9).

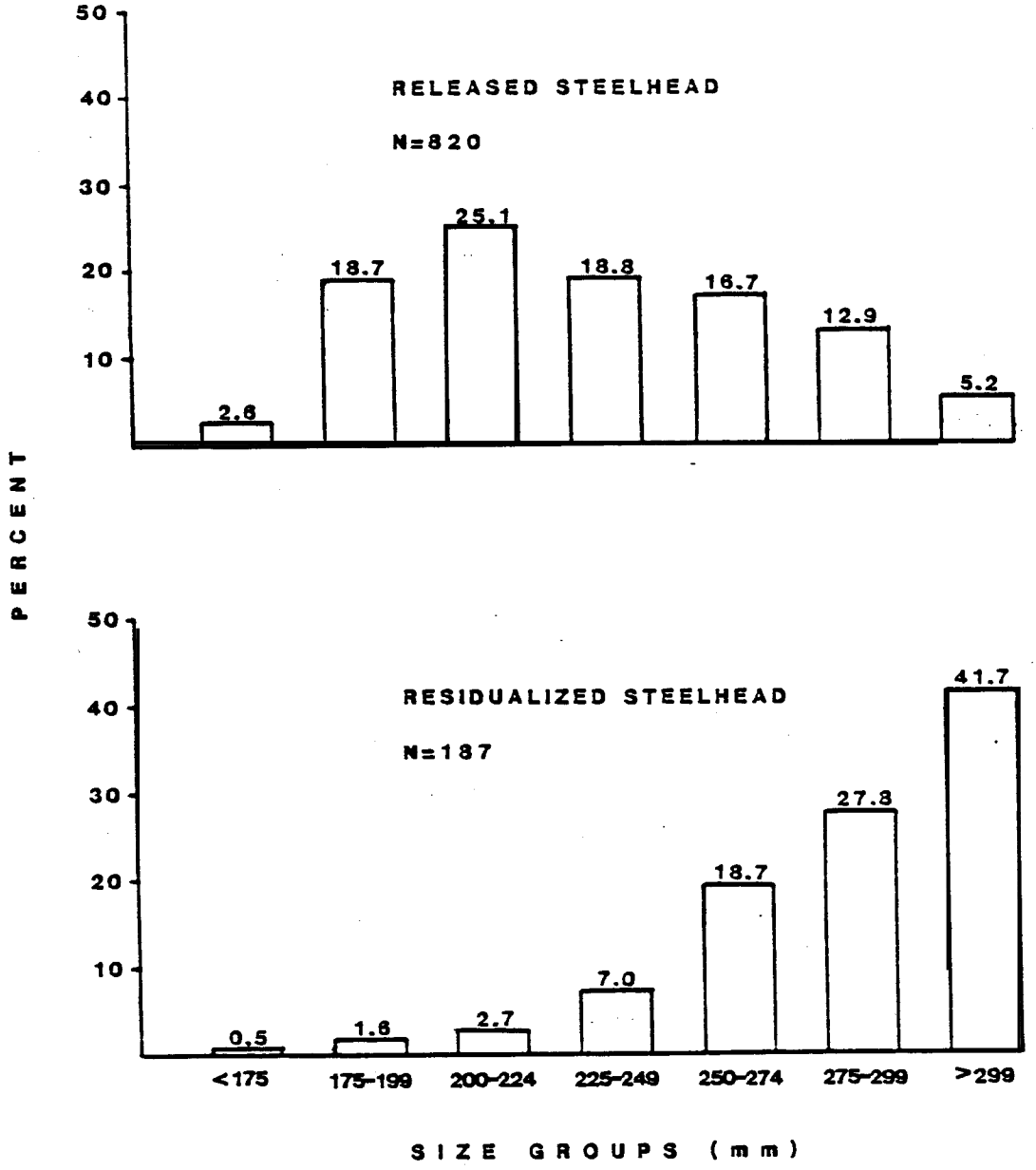

Figure 3. Comparison of the percent of fish in each 25 mm size group for steelhead smolts at release and those that residualized.

Table 6. Size classes of residualized "large" and "normal" Group A steelhead from the upper Salmon River, 1983 as determined by freeze-brands and coded-wire tag recoveries.

Date	Sample group	Fork length (mm) <175	175-199	200-224	225-249	250-274	275-299	2300	Total	Percent
5/28-30/83	Normal	0	0	3	2	3	0	0	8	9.3
	Large	0	0	0	1	17	24	36	78	90.7
6/11/83	Normal	0	1	0	0	1	0	0	2	66.7
	Large	0	0	0	0	0	1	0	1	33.3
6/18-19/83	Normal	1	1	2	3	0	0	0	7	46.7
	Large	0	0	0	0	0	4	4	8	53.3
7/1-4/83	Normal	0	1	0	3	1	0	0	5	15.6
	Large	0	0	0	0	2	9	16	27	84.4
7/16-17/83	Normal	0	0	0	0	1	0	0	1	16.7
	Large	0	0	0	0	0	2	3	5	83.3
8/12-13/83	Normal	0	0	0	0	0	0	0	0	-
	Large	0	0	0	0	0	0	0	0	-
Total	Normal	1	3	5	8	6	0	0	23	16.2
	Large	0	0	0	1	19	40	58	119	83.3
Percent	Normal	100.0	100.0	100.0	88.9	24.0	0.0	0.0		
	Large	0.0	0.0	0.0	11.9	76.0	100.0	100.0		

Table 7. Condition (K) of steel head smolts at release and after residualizing in the upper Salmon River in 1983. Sample sizes are in parentheses.

	April	May	July
"A" normal	1.079 (400)		
"A" large	1.185 (420)		
"A"	1.133 (820)	1.060 (79)	1.022 (40)
"B"	1.160 (295)	1.080 (16)	0.973 (9)
Size class (mm)			
<175	1.062 (32)	- (0)	- (0)
175-199	1.087 (205)	0.904 (1)	1.064 (1)
200-224	1.114 (297)	1.014 (5)	- (0)
225-249	1.147 (242)	1.067 (7)	1.003 (6)
250-274	1.185 (170)	1.029 (22)	0.955 (7)
275-299	1.197 (124)	1.073 (28)	1.022 (13)
2300	1.224 (45)	1.092 (32)	1.026 (22)

Table 8. Frequency of occurrence of food items in residualized steelhead (STH) and wild rainbow trout (WRB) stomachs from the upper Salmon River, 1983. Number of stomachs in parentheses.

	Pisces[a]	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Hymenoptera	Coleoptera	Annelids	Arachnida	Empty
May										
STH (42)	2	21	88	43	36	14	17	38	2	0
WRB (2)	0	0	100	100	0	50	0	0	0	0
June										
STH (17)	0	6	94	12	6	12		65	0	0
WRB (0)										
July										
STH [35)	2	38	98	58	42	40	8	30	2	0
WRB (5)	0	40	100	80	80	20	0	20	0	0
Total										
STH (94)	2	24	94	43	32	24	6	40	2	0
WRB (7)	0	29	86	71	43	29	0	14	0	0
STH size class [mm)										
175-199 (2]	0	0	100	0	0	50	0	100	0	0
220-224 (6)	0	0	83	17	33	17	0	50	0	0
225-249 (9)	0	33	89	22	11	33	0	33	0	0
250-274 (19)	0	21	95	63	32	26	16	11	5	0
275-299 (25)	4	24	100	44	40	12	0	56	0	0
>300 (33)	3	30	91	42	33	30	9	42	3	0
WRB (7)	0	29	86	71	43	29	0	14	0	0

[8]All fish observed were Cottus sp.

Table 9. Frequency of occurrence of food items in residualized steelhead stomachs from the East Fork Salmon River, 1983. Number of stomachs in parentheses.

	Pisces°	Plecoptera	Tricoptera	Ephemeroptera	Diptera	Hymenoptera	Coleoptera	Orthoptera	Arachnids	Empty
July (34)	3	35	91	47	65	74	12	3	0	0
Sept. [36]	6	3	44	31	50	29	29	11	3	14
Total (70)	4	18	67	38	57	50	20	7	1	7
Size class (mm)										
° <175 (1)	0	0	100	100	100	100	0	0	0	0
175—199 [3)	0	67	100	100	100	100	33	0	0	0
200—224 (5)	0	40	80	40	80	80	60	0	0	0
225—249 (19)	0	16	69	74	42	26	21	11	5	0
250—274 [17)	6	6	88	13	53	35	13	13	0	0
275—299 (20)	5	25	55	25	60	70	15	0	0	10
300 (5]	20	0	40	0	60	40	20	20	0	40

°All fish observed were Cottus sp.

Sex and Maturity

Residualized steelhead were predominately males. In the upper Salmon River, 80.4% (74) of the residual ized fish sampled during 1983 were males with 28.4% of these males being mature. All of the females examined were immature. In the East Fork Salmon River, the residual ized steelhead were also predominately male (93.2% [69]), but the percent of males with developed gonads was 79.7%. Two of the five females examined also had developed gonads. The upper Salmon River samples were taken in the early summer while the East Fork Salmon River fish were sampled in late July and late September. The percent of mature males increased from 75.0% in July to 84.8% in September in the East Fork Salmon River.

Downriver Migration and Survival

Downriver migration and survival rates were similar for both the "large" and "normal" Group A steelhead smolts. Survival estimates at Lower Granite Dam on the Snake River were nearly equal with 22.5% of the "large" and 22.9% of the "normal" steelhead estimated to have reached the dam (Al Giorgi, NMFS, pers. comm.) (Table 10). Migration rates were similar with the median arrival date at Lower Granite Dam being June 6 for the "large" smolts and June 8 for the "normal" smolts. Travel rates for the 750 km to Lower Granite Dam averaged 15.6 km/day for "large" smolts and 15.0 km/day for the "normal" smolts. The median arrival date at Jones Beach for both groups was on June 13.

An additional group of freeze-branded steelhead was released in the upper Salmon River drainage in 1983. They were Group B steelhead which were released in the East Fork Salmon River on April 12 and 13. The fish moved at an average rate of 15.8 km/day, and the median arrival date at Lower Granite Dam (710 km downriver) was May 27. Estimated survival to Lower Granite Dam was 33.6%.

DISCUSSION

This was the first year of a two-year evaluation of the effect of steelhead smolt size on residualism and the resulting effect on wild anadromous fish Juveniles and resident fish. A complete discussion will be presented in the final report because the number of steelhead released in 1984 in the study area will be considerably larger.

Table 10. Migration and survival of freeze-branded steelhead smolts released in the upper Salmon River drainage in 1983.

	Group A normal	Group A large	Group B
Release area	Sawtooth Salmon River	Sawtooth Salmon River	East Fork Salmon River
Kilometers from ocean	1,443	1,443	1,406
Total number released	40,548	40,573	201,587
Number branded released	20,393	20,124	19,808
Percent branded	50.29	49.60	9.83
Brand	RD-12-3	RD-12-1	LD-12-1
Release date	18-20 April	18-20 April	12-13 April
Number/kilogram	11.7	4.7	7.9
Sampling site			
Lower Granite Dam			
Kilometers from ocean - 695			
Number sampled	172	185	331
Percent	0.84	0.92	1.67
Estimated passage	4,667	4,527	6,666
Percent	22.90	22.50	33.65
Median arrival date	8 June	6 June	27 May
Travel time (days)	50	48	45
Jones Beach			
Kilometers from ocean - 76			
Number sampled	25	12	19
Percent	0.12	0.06	0.10
Median arrival date	13 June	13 June	3 June
Travel time (days)	55	55	52

In 1983, when 107,294 steelhead smolts were released in the upper Salmon River, downriver emigration, angler harvest, and natural mortality resulted in the removal of nearly all hatchery steelhead in the river by mid-July. In the East Fork Salmon River, which received 328,325 steelhead smolts and had limited angling pressure, numerous residualized steelhead remained in the river in late September. Because numerous fish remained in the East Fork Salmon River, any potential problems between residualized steelhead and resident and Juvenile fish would increase as the LSRCP programs at Sawtooth, Magic Valley Steelhead, and Hagerman National Fish hatcheries come into full operation. By 1986, the hatcheries will have the capacity to produce 4.4 million smolts with most of these fish being released in the upper Salmon River drainage.

The number of residualized smolts in the upper Salmon River in 1983 was low enough that most anglers kept most of the fish that they caught. Consequently, the resulting size data for the harvested fish was probably representative of the size of the residualized steelhead remaining in the river. The high percentage (83.8%) of the "large" sized smolts in the angler harvest and the increased percent of fish in excess of 250 mm indicates that increased smolt size will definitely increase the rate of residualism, as was found by Chris-p and Bjornn, 1978. Since the residualized smolts are actively feeding in the river, they may be competing for food with resident fish and natural juvenile salmon and steelhead. This may become more of a problem as increased steelhead releases result in more residualized fish remaining in the river system.

Although the larger smolts have a higher rate of residualism, they may also have a greater rate of survival to adult. If the adult survival rates are high enough for the larger smolts, it may be more beneficial to raise larger smolts, especially if the rate of residualism can be reduced.

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