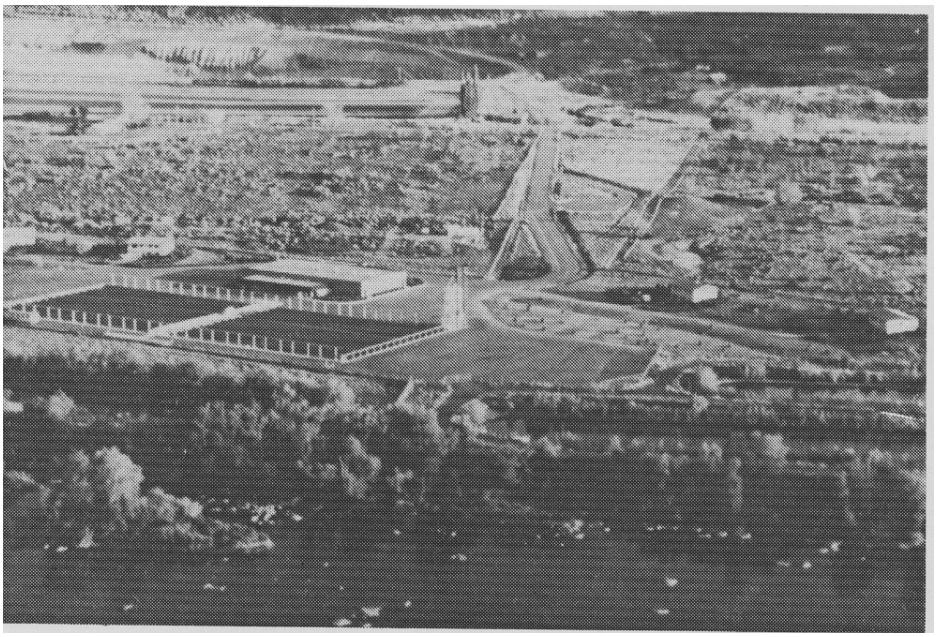
MAGIC VALLEY HATCHERY

1997 STEELHEAD BROOD YEAR REPORT



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ABSTRACT

The eleventh year (May l, l997 to May 7, l998) of steelhead *Oncorhynchus mykiss* production at Magic Valley Hatchery (MVH) was completed with a total of 1,658,825 A-run and B-run steelhead smolts stocked weighing 370,900 lbs. These fish were fed 419,222 lbs of feed for a conversion of 1.14 lbs. of feed per pound of gain.

Four different stocks of steelhead were received as eyed eggs including 325,000 A-run Pahsimeroi Fish Hatchery (PFH) steelhead eggs yielding a total of 291,625 smolts. Another 530,000 Sawtooth Fish Hatchery (SFH) A-run eggs netted 410,225 smolts. B-run East Fork Salmon River eggs included 356,340, which resulted in 301,500 smolts to the East Fork Salmon River. In addition 1,403,900 Dworshak, Clearwater Fish hatcheries B-run eggs were received, contributing 655,475 smolts back to the Salmon River and its tributaries. Further stocking information is located in Appendix C.

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INTRODUCTION

Magic Valley Hatchery (MVH) is part of the Lower Snake River Fish and Wildlife Compensation Plan (LSRCP), compensating for losses of steelhead *Oncorhynchus mykiss* caused by the Lower Snake River Dams. The hatchery was constructed by the Army Corps of Engineers (USACE), is administered and funded by the U.S. Fish and Wildlife Service (USFWS), and operated by the Idaho Department of Fish and Game (Department).

The hatchery is located in Twin Falls County, seven miles northwest of Filer in the Snake River Canyon. The hatchery uses a maximum 125 cubic ft per second (cfs) of 59°F water from Crystal Springs located on the north shore of the Snake River.

All smolts were transported by truck to the Salmon River and tributaries. The brood sources were Dworshak Fish Hatchery (Dworshak) B-run stock, East Fork Salmon River B-run stock, Sawtooth Fish Hatchery (Sawtooth) A-run, and Pahsimeroi Fish Hatchery (Pahsimeroi) A-run stock.

Outside of some higher mortality in our Dworshak stock due to Cold Water Disease, fish health was generally good again this year.

OBJECTIVES

1. To hatch and rear 1.7 million A-run and B-run steelhead smolts for stocking in the Salmon River and its tributaries to achieve the mitigation goal of 11,660 adult steelhead returning back to Idaho waters.

2. Provide smolts and consequently returning adults that could be utilized for harvest, broodstock supplementation, reintroduction, and research purposes.

3. Mark hatchery smolts prior to release to avoid mixed stock harvest and to maximize harvest and natural production management options.

FACILITIES

The hatchery building houses the incubation and early rearing room with 40 upwelling 12-gallon capacity incubators. Each is capable of handling and hatching 50,000-75,000 eyed eggs. Two incubators are placed over each raceway. There are 20 concrete tanks (4 ft x 3 ft x 40 ft, 418 cubic ft of rearing space) with a capacity of 115,000-125,000 steelhead to 200 per pound size. There are 3 automatic feeders that cover the entire length of each inside raceway, for a total of 60. The early rearing room also houses two fiberglass troughs (2 ft x 1 ft x 12 ft). The building also contains an office, laboratory, wet laboratory, shop, dormitory, enclosed storage room, covered vehicle storage area, feed storage room, walk-in freezer, and mechanical room for water pumps, water chiller, and domestic water supply systems.

There are 32 outside rearing raceways (10 ft x 3 ft x 200 ft), with 6,153 cu ft of rearing space. These raceways are divided in the middle by the headrace resulting in 16 East raceways

and 16 West raceways. Each raceway has the capacity to raise 70,000 smolt-size steelhead. The raceways may be further subdivided to result in a total of 64 individual rearing subunits.

A moveable bridge equipped with 16 automatic Neilsen fish feeders spans the outdoor raceways. Two 30,000 pound bulk feed bins equipped with shakers to remove fines and a feed conveyor complete the outside feeding system.

There are two tailraces for the outside raceways, located on opposite ends of the facility. Each flows to the north where they join in a common pipe before entering the flow-through settling pond. The hatchery effluent water is treated by opening valves in the bottom of quiescent zone and sweeping wastes into a cleaning waste water pond (approximately 2.5 surface acres). A hatchery flow-through wastewater pond (about 1.5 surface acres in size) cleans the non-cleaning wastewater. All cleaning effluent must pass through both ponds.

The limiting factors in producing more smolts are space and water flows. Our production is about 25% less than the facility was designed for. This is primarily due to production restrictions placed upon us by the National Marine Fisheries Service in an attempt to protect endangered salmon. Density and flow indices may exceed the maximum desired levels of .30 lbs of fish per cubic foot of rearing space per inch of fish length, and 1.25 lbs per gal per minute per inch of fish length at the end of the rearing cycle. Water flows have increased in recent years and have approached the 125 cfs maximum on several occasions. Our high flows are usually in the 110 to 120 cfs range. Unfortunately, our high flows come earlier in the year than our heavy fish loads.

WATER SUPPLY

The MVH water supply collection facility is located on the north wall of the Snake River canyon. It collects the 59°F spring water from Crystal Springs in a covered concrete channel system, which consolidates the flow in a metal building. A 42-inch pipeline delivers the 125.47 cfs of water via gravity flow to a control tank that degasses and distributes the water to the outside raceways through a 42-inch pipeline. Water may be diverted from the headrace supply line for use in the auxiliary supply water lines. The auxiliary supply line allows us to add water between raceway sections to improve water quality in the lower sections and to clean upper quiescent zones without dewatering the bottom section. The hatchery building receives water through a 14-inch pipeline, which branches off prior to going through the outside degassing tower. Water going to the hatchery building is degassed in packed columns above each individual raceway.

STAFFING

The MVH is staffed with four permanent employees: Bob Moore, Fish Hatchery Manager II; Dave May, Assistant Hatchery Manager; and Kent Hills and Mark Olson both Fish Culturists. In addition, we sometimes hire temporary Bio-aides or Laborers to assist with fish culture duties during peak production, smolt transportation, and adipose (AD) fin clipping. Marcus Day was our Bio-aide again this year. Personnel from this hatchery continue to oversee adipose marking operations at the three steelhead hatcheries located in southern Idaho.

FISH PRODUCTION

Egg Shipments And Early Rearing

The hatchery received 1,403,900 B-run (Dworshak) eyed eggs, 356,340 B-run eyed eggs (East Fork Salmon River stock), and 325,000 A-run eyed eggs (Pahsimeroi stock) and 530,000 A-run (Sawtooth stock). All eggs were received in April, May, and June 1997. The survival of eyed eggs to smolts is found in Appendix A.

All eggs received were treated with Povidone Iodine at 100-ppm for ten minutes and put into the upwelling incubators (50,000-75,000 eggs per incubator, 15 gals/min). The eggs hatched within five days and emerged from the incubators into the hatchery tanks twelve days after hatching. Each of the 20 hatchery tanks (with a flow of 100-250 gals/min) averaged 120,000 feeding fry until they reached 300 per pound or almost two inches long. At that time, fish were moved to the larger outside raceways. The highest mortality rate was during the hatching, swim-up, and early-rearing stages. This year as is traditional survival was lower in the Dworshak stock of eggs and fish than in the Pahsimeroi, Sawtooth, and East Fork stocks. Problems with Cold Water Disease hit the Dworshak stock harder than normal and resulted in even lower than normal survival rates for that stock.

All of the feeding fry were started and reared on Bio-Diet soft moist feed while in the hatchery building.

Final Production Rearing

Fish in the outdoor raceways were fed more Biodiet soft moist through the 2.0mm size. They were then fed Rangen 450 extruded salmon diet using Haskell's (1967) feeding rate formula. The feeding rate was calculated using a 10.0 hatchery constant. We start with a one-inch fish (swim-up fry) and end with an 8.4-inch smolt. The fish had a conversion of 1.14 lbs of feed to produce a pound of fish. Last year at this facility a conversion rate of 1.04 was achieved with the use of Rangen 470 extruded salmon diet, which has 47% protein compared to 45% for the 450 diet. It is difficult to say how much of the drop in feeding efficiency is due to the lower protein level and how much is due to the lower survival rates caused by Coldwater disease.

The fish generally grow an inch per month for the first three months when we are feeding every day. An intermittent schedule of five days on and two days off feed was implemented in October to keep the fish from becoming too large. The steelhead maintained an average .65 to .75-inch per month growth using this system. We used this schedule through the middle of March at which time all fish were put on full ration. See Appendix B for feed and total costs for the year.

Density and flow indices (Piper 1970) were calculated for each tank or raceway. Only three raceways reached the maximum desired density index of .30 or 1.25 flow index by the end of the year. The final pond inventories and indices for the individual raceway numbers, densities, and flows are found in Appendix D.

Maximum flows for the year were around 120 cfs from October through March. The majority of the time our flows were around 100-110 cfs. Each of the outside 32 raceways had about 3.4 cfs prior to distribution in April.

Steelhead smolt distribution began on April 10, 1998 and continued five days a week through May 5, 1998. An average of five trucks per day was used for the transportation of 370,850 lbs of fish and involved 79 truckloads (Appendix C). This year we continued to haul 5,000 lbs per load on most trucks to meet Integrated Hatcheries Operation Team (IHOT) recommendations. In addition, highway load limits to the upper East Fork Salmon River held us to only 3,000 lbs per truck. On those loads, we only filled three of the five compartments, so density levels within the compartment were the same as the 5,000 pound loads. As in past years, only two loads per day were allowed at Slate Creek. This is due to road concerns and capacity of the receiving pool for fish.

Length Frequency Data

Length frequencies were taken from all stocks again this year and are shown in Appendix I. The graph is a composite of all four stocks sampled.

FISH HEALTH

Cold Water Disease caused by *Flexibacter psychrophila* was the only significant disease encountered at Magic Valley Hatchery during the 1997-1998 growing season. Two applications of oxytetracycline (OTC) were applied to this epizootic utilizing the WRIP INAD process. The higher dosage rate of 10gm of active drug/100lbs fish/14day treatment was chosen to combat antibiotic resistance noted by diagnostic procedures at Eagle Fish Health Laboratory. The approximate losses to CWD in the B-run steelhead groups were approximately 30%, while A-run steelhead groups lost approximated 5%. Losses on affected populations exceeded 1,000 fish/day and remained elevated in August and into September of 1997.The epizootic ran its course after the second OTC treatment and mortalities dropped to normal levels. No other significant health problems were noted at Magic Valley.

During 1997 the hatchery staff disconnected a security light near the raceway in hopes of reducing precocial males. Health assessments made during preliberation sampling and organosomatic indexing seemed to demonstrate a reduction in precocious males. Sampling was not complete enough to be statistically valid, however.

Cataracts and a higher prevalence of runts are attributed to the early epizootic of CWD. These fish are not expected to return to Idaho as adults. Even though these fish comprise less than 1% of the population, this loss isn't readily apparent, but certain.

Future plans include and netting to ensure total enclosure from birds. This has become more important due to the continuation of the commercial Hagerman aquaculture industry completely netting off their hatcheries. Fencing around the raceways was accomplished this year. Organosomatic index assessments can be seen Appendix F.

FISH MARKING

Adipose Fin Clipping

All of the A-run and B-run hatchery steelhead are required to have an AD fin-clip identifying them from wild steelhead. At MVH the fin-clipping crew AD marked 1,687,479 fish during September. Fin-clipping mortality was negligible. No treatment was necessary after handling.

Coded-wire Tagging

Four groups of steelhead were coded-wire tagged this 1997 brood year. There were 446,169 fish marked with the coded-wire tag (CWT) and 440,903 of those were stocked. See (Appendix E) for CWT details.

PIT Tagging

All four stocks of steelhead had a total of 3,001 Passive Integrated Transponder (PIT) tags inserted in them. The usual number of 300 tags per release group resulted in 2,100 tags and an additional 901 were used in the fin quality experimental and control fish. A total of 16 mortalities of (PIT) tagged fish left us with 2,985 tagged fish released.

MAINTENANCE AND CONSTRUCTION

During this year numerous maintenance and construction projects were undertaken and completed.

The hatchery crew built a small metal building near the domestic well head. The domestic water storage tank was then moved into the building. To date this has eliminated the various problems we had. The electrolysis of the pipeline and the build up of excessive pressure appears to have been eliminated.

The drive lug wheels on the feeding bridge were rebuilt and replaced. Cracks in the parking lot were repaired and filled with tar. Two high-pressure hydrants located near the outside raceways were replaced. The drainline cement plug between inside vat 19 and 20 was cleaned out with a very high-pressure water pump.

Additionally, Several projects were undertaken to comply with the environmental audit by the USFWS. The underground bulk gas tank was dug up and removed from the facility. The engineering crew cleaned out our primary settling pond in an effort to reduce our reservoir of phosphorus that had accumulated there.

FIN QUALITY RESEARCH

During past years various biologists have suggested that hatchery steelhead needed to be produced with better fins. It seems obvious that fish with fins will migrate better than the run of pond fish normally produced here. An experiment was conducted during this brood year to determine if this were true. We also hoped to find production methods that would allow us to produce steelhead with better fins. Fish from the Dworshak stock were used for all treatment groups.

Fish were reared both indoors and outdoors to attain final density levels of .10 and our normal .30 lbs./cu ft/inch length. In addition four fiberglass tanks were divided into individual cubicles which received one fish per cubicle. Fin measurements from these individually raised fish were expected to be the ideal or very best one could attain from hatchery reared steelhead.

Outside raceways and vats inside the nursery building were randomly selected as to which ones would be held at normal rearing densities and which at lower densities. The upper 25 feet of outside raceways were screened for the outside treatments. Raceways 2, 3 and 4 were selected to receive the low-density treatment of .10, while a normal density of .30 was used on the top 25 feet of raceways 5, 6 and 7. The volume of the experimental raceways was 625 cubic feet (25'x 10'x 2.5'). Sample fin length measurements and interrogation of pit tags were also done on raceway 8 as a control for our typical production raceway. More fish also from the same egg lot were reared at the same density levels and kept in the inside vats until the last sampling. Vats 1 and 2 were reared at a 0.10 level and Vat 3 at 0.30 density level. Fish were placed in their respective raceways on July 21st after being adipose clipped. They were left to acclimate until early October before fin measurements were taken. Dorsal, right and left pectoral fin lengths, weight and fork length measurements were taken every month after that. Dean Rhine, biologist for the Clearwater Region performed the statistical analysis.

There were significant differences in fin length between the various rearing strategies used. Some of those differences disappeared by the end of the experiment, however. The fish reared at low densities, for example, had significantly better dorsal fins until about two months prior to release when the difference became statistically insignificant. Differences in left and right pectoral fins remained throughout production, with the low density being better for fin quality. The fish were all fed at the same hatchery constant of 10.0.

Unfortunately, the fish reared at low density grew more efficiently than did those reared at normal density levels. So there was also a significant difference in the size of the release groups. Data for the effects of density and fin quality upon downstream migration detection rates is found in Appendix G. The results were unexpected and disagree with many earlier studies (Kent Ball 1998). Fish reared in low densities although being larger were detected at lower rates and took on average about 4 more days to travel to Lower Granite Dam. In fact our fish from Raceway 8, which represented a typical production raceway, was near the top in detection rates and had the shortest travel time despite not being reared in as ideal of conditions as the experimental groups.

PRECOCIAL MALE OBSERVATIONS

In the spring of 1997, it was noted that raceway number 16 West had a very high rate of precocial males. This was noted by the PIT tagging crew and by our own crew while taking length measurements. Although no accurate samples were taken we estimated from length and pound count samples that it was as high as 25% or more of that total population was exhibiting morphological characteristics of precocial males. We were unsure as to what had caused this unusually high rate. Later that year it was noted that the PIT tagged fish of raceway 16 were interrogated at about half the expected rate at the dams on the smolts' downstream migration. Then in the early spring of 1997 it was apparent that the precocial rate was once again high in 16 west. While taking length frequency data, all obviously precocial males were noted for each raceway sampled. It appeared that the main difference between 16 West and the other raceways was its close proximity to a yard light (high-pressure sodium Lucolux LU250). That year we compared the percentage of water surface, which received direct light from various yard lights to the incidence of precocialism. The light was removed once we suspected it to be the cause. In the spring of 1998 precocial rates were once again checked during routine length frequency analysis. The highest rate was detected in raceway East 1 with only 1.3%. Raceway 16 West was at 0.0%, as were most of the raceways tested (See Appendix J). It appears that removing the yard light had a significant impact on precocial frequency.

However, prior to releasing raceway 5 East into Squaw Creek pond, an internal check for precocial males was done on 202 fish. During this investigation, a portion of the population showed early maturation of the testes, but they were not obviously precocial. These fish made up a total of 1.98% of the population sampled. This means there is a hidden portion of the population becoming precocial. Should more security lights be turned off? Most of the remaining lights are much further away than the one already eliminated. Observations will continue and be reported in the future.

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APPENDICES

Appendix A. Brood Year 1997 Steelhead Survival Rates.

Stock	Dworshak	East Fork	Pahsimeroi	Sawtooth	Total
Number Eggs	1,403,900	356,340	325,000	530,000	2,615,240
Swimup	1,245,300	348,500	318,500	522,050	2,434,350
% Swimup	88.7%	97.8%	98.0%	98.5%	93.0%
Fingerling	727,974	307,514	298,416	424,539	1,758,443
% Egg To Fingerling	51.8%	86.3%	91.8%	80.1%	67.2%
% Swimup To Fingerling	58.5%	88.2%	93.7%	81.3%	72.2%
Smolts Planted	655,475	301,500	291,625	410,225	1,658,825
Lbs. Fish	148,400	64,200	69,300	89,000	370,900
Fingerling To Smolt %	90.0%	98.0%	97.7%	78.5%	94.3%
% Egg To Smolt	46.7%	84.6%	89.7%	77.4%	63.4%
Lbs. Of Food Fed	167,042	79,005	75,315	97,860	419,222
Feed Conversion	1.21	1.23	1.09	1.10	1.14

Appendix B. Brood Year 1997 Production Feed Cost And Utilization.

Number Of Fish	1,658,825
Lbs Of Fish	370,850
Feed Cost	$155,410.48
Lbs. Of Feed	419,222
Conversion	1.14
Total Cost	$526,513.71
Cost Per 1000 Fish	$317.56
Cost Per Pound Fish	$1.42

Appendix C. Steelhead Smolt Distribution in the Salmon River and Tributaries.

Species	Numbers	Lbs	No./Lb.	Receiving Waters	Dates Released
Dworshak B-run	52,800	12,000	4.4	Squaw Creek Pond	4/10-13/97
Dworshak B-run	280,950	58,450	4.8	Stinky Springs	4/13-15/97
Sawtooth A-run	158,660	33,500	4.7	McNabb	4/16-17/97
Sawtooth A-run	142,650	30,650	4.7	Cottonwood	4/17-20/97
Sawtooth A-run	108,915	24,850	4.4	Shoup Bridge	4/20-21/97
Pahsimeroi A-run	154,565	37,750	4.1	Lemhi R	4/21-23/97
Pahsimeroi A-run	137,060	31,550	4.4	Salmon R @ Redrock	4/23-24/97
Dworshak B-run	321,725	77,950	4.1	East Fork Salmon R	4/24-29/97
East Fork B-run	126,920	27,800	4.6	East Fork Salmon R @Trap	4/30-5/1/97
East Fork B-run	174,580	36,400	4.8	Slate Creek	5/4-7/97
TOTAL: AVERAGE:	**1,658,825**	**370,900**	**4.47**		

Appendix D. Final Raceway Inventory with Flow and Density Indices for 1997 Brood Year.

Raceway	Run	Number	Weight	No/lb	Flow Index	Density
E1	DWOR B	63,000	15,750	4.4	1.25	.33
E2	DWOR B	46,420	10,550	4.3	.83	.22
E3	DWOR B	55,575	12,350	5.6	1.06	.28
E4	DWOR B	48,590	11,300	5.0	.93	.25
E5	DWOR B	52,800	12,000	4.4	.95	.25
E5*	DWOR B	35,700	10,200	5.1	.85	.23
E6	DWOR B	50,840	12,400	4.1	.93	.25
E7	DWOR B	52,100	11,500	4.5	.92	.25
E8	DWOR B	40,480	9,200	4.1	.71	.19
E9	DWOR B	47,000	9,400	4.0	.72	.19
E10	DWOR B	47,530	9,700	3.5	.71	.19
E11	DWOR B	50,880	10,600	4.2	.82	.22
E12	DWOR B	64,560	13,450	4.2	1.04	.28
E13	EFK B	68,385	14,550	4.0	1.11	.30
E14	EFK B	45,795	10,650	4.3	.83	.22
E15	EFK B	49,000	10,000	4.8	.81	.22
E16	EFK B	47,470	10,100	4.7	.82	.22
W1	SAW A	47,475	10,550	4.9	.86	.23
W2	SAW A	47,925	10,650	5.0	.88	.24
W3	SAW A	47,250	9,450	4.6	.76	.20
W4	SAW A	62,880	13,100	4.2	1.02	.27
W5	SAW A	46,560	9,700	4.7	.78	.21
W6	SAW A	49,220	10,700	4.5	.86	.23
W7	SAW A	46,350	10,300	4.8	.84	.22
W8	SAW A	62,565	14,550	4.0	1.11	.30
W9	PAH A	47,025	10,450	4.4	.83	.22
W10	PAH A	46,440	12,900	4.6	1.04	.28
W11	PAH A	47,460	11,300	4.4	.90	.24
W12	PAH A	45,320	10,300	4.8	.84	.22
W13	PAH A	44,200	11,050	5.0	.92	.24
W14	PAH A	61,180	13,300	4.8	1.09	.29
W15	EFK B	49,490	10,100	5.2	.84	.23
W16	EFKB	41,360	8,800	4.5	.70	.19
Total A-run		**701,850**	**158,300**	**4.6**		
Total B-run		**956,975**	**212,600**	**4.4**		
Grand Total		**1,658,825**	**370,900**	**4.5**		

*****Experimental fish which were originally in the top 25 feet of E2-8 and moved to E5 for transport.

Appendix E. Brood Year 1997 Coded-wire Releases

CWT Code	Stock	Number Tagged	Number Stocked	PIT Tag	Site & Purpose
10-21-43 10-21-44 10-21-45	Dwor B	63,827	63,000	300	Slate Cr. contribution
10-21-31 10-21-32 10-21-33	Dwor B	65,524	64,560	300	Little Salmon,@ Stinky Springs contribution
10-47-05 10-47-06 10-47-07	E Fk B	65,802	65,197	300	E Fk Salmon, @ Trap contribution
10-21-40 10-21-41 10-21-42	Saw A	64,362	62,880	300	Sec. 18, Salmon R, Bruno access contribution
10-21-37 10-21-38 10-21-39	Saw A	62,933	62,565	300	Sec. 17, Salmon R @Shoup Bridge contribution
10-21-34 10-21-35 10-21-36	Pah A	61,707	61,180	300	Lemhi R contribution
10-21-46 10-21-47 10-21-48	E Fk B	62,014	61,521	300	Contribution
Subtotals	Dwor B	129,351	127,560	600	
	E Fk B	127,816	126,718	600	
	Pah A	61,707	61,180	300	
	Saw A	127,295	125,445	600	
Totals		446,169	440,903	2,100	

Appendix F. Organosomatic Index Expressed in Percent of Normals.

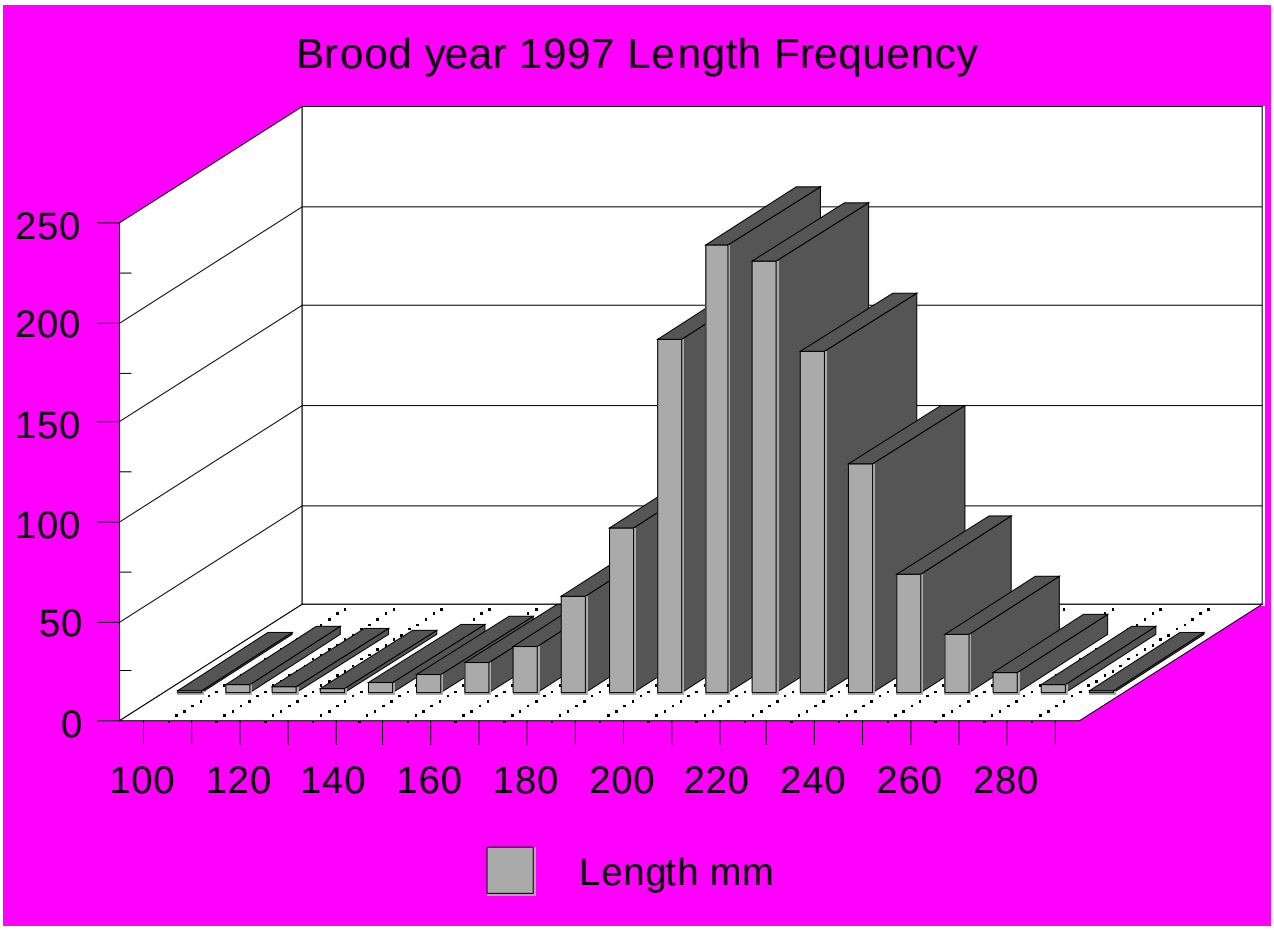
Eyes	Gills	Pseudo-Branch	Thymus	Mes. Fat	Spleen	Hind Gut	Kidney	Liver
100	100	100	100	100	100	100	100	100

Appendix G. Effects of Density and Fin Quality on Outbound Migration									
Raceway	Density	Number Pit Tagged	LGR	LGO	LMN	IHA	Total	Total % Detected	Median Travel Time To Granite
2	Low	100	36	15	4	0	55	55%	19
3	Low	101	37	13	6	3	59	58%	17.5
4	Low	100	36	14	2	0	52	52%	19.9
5	High	100	35	13	6	2	56	56%	12.8
6	High	100	43	12	8	0	63	63%	14.3
7	High	104	38	20	5	0	63	61%	14.8
8	Std.	300	114	39	23	2	178	59%	12.4

Appendix H. Historical Release Data.

Year	Pahsimeroi A-run Eggs	East Fork B-run Eggs	Dworshak B-run Eggs	Total Eggs	Spring/ Smolt Releases	Fall/Fry Releases	Total Fish Released	Fish/ Lb.	Lbs. Released	Lbs. Feed	Food Conver
1982-83				145,206	135,361		135,361	4.23	32,000	57,700	2.24
1983-84	238,000		68,000		264,574		264,574	2.77	95,430	154,120	1.62
1984-85				NONE	231,991		231,991	4.37	52,990	REARED	HNFH
1985-86				NONE	NONE				0		
1986-87				NONE	264,415		264,415	4.39	60,215	REARED	HNFH
1987-88	?	FRY		2,109,780	2,064,661		2,064,661	4.54	454,500	554,000	1.32
1988-89	2,047,748	357,506		2,405,254	2,202,800		2,202,800	4.32	509,100	703,373	1.38
1989-90	1,306,674	333,537	1,212,066	2,852,277	2,285,800		2,285,800	4.67	489,430	687,077	1.40
1990-91	1,269,000	463,730	900,000	2,632,730	2,062,000		2,062,000	4.11	501,100	662,326	1.32
1991-92	1,127,928	91,317	1,207,699	2,426,944	2,160,400		2,160,400	4.21	513,000	624,573	1.22
1992-93	1,031,274	133,826	1,322,740	2,487,840	1,925,700		1,925,700	5.75	334,500	529,936	1.58
1993-94	1,081,500	179,080	1,507,033	2,767,613	1,919,250	392,300	2,311,550	4.73	405,450	654,693	1.61
1994-95	800,785	75,395	1,520,160	2,396,340	1,731,355	26,531	1,757,886	4.41	391,825	548,400	1.49
1995-96	803,000	40,000	1,502,200	2,396,340	1,868,085		1,868,085	4.63	402,926	453,662	1.13
1996-97	947,796	139,400	940,391	2,027,587	1,643,210		1,643,210	4.50	364,775	380,647	1.03
1997-98	855,000	356,340	1,403,900	2,615,240	1,658,825		1,658,825	4.47	402,926	419,222	1.14

Appendix I. Brood Year 1997 Length Frequency.



Minimum: 100 mm **Maximum: 285 mm** **Mean: 211 mm**

Appendix J. Precocial Males as Percent of Total Population.

POND #	1996	1997	1998	POND #	1996	1997	1998
16W	25.0%	13.3%	0.0%	16E			
15W		11.3%		15E		1.3%	
14W		5.8%	0.0%	14E			
13W				13E			0.6%
12W				12E			
11W				11E			
10W		5.5%		10E			
9W				9E			
8W				8E			
7W				7E		0.0%	0.0%
6W				6E			
5W		0.0%		5E		0.0%	
4W				4E			
3W				3E			
2W		0.0%		2E		0.6%	
1W				1E		0.6%	1.3%

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