

AUGMENTED FISH HEALTH MONITORING
FOR
WASHINGTON DEPARTMENT OF WILDLIFE

Annual Report 1988

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Introduction

The augmented fish health monitoring project is funded by the Bonneville Power Administration with the mandate to collect fish health data on anadromous fish stocks of the Columbia River Basin in a standardized manner. The project began in 1986 and the data reported here was collected in the third year. This segment of the project was carried out by the Washington Department of Wildlife and summarizes fish health findings at anadromous game hatcheries in Washington State operated by the BPA.

Information gathered to date has provided impetus to alter facility design and management practices for improved fish health through prevention. Treatment efficacy can be better assessed due to the monthly monitoring of fish stocks and insight is being gained into disease prevention and control. The ultimate goal, of course, is to improve fish health for better survival in the wild. Tagged returns at index hatcheries within this project area will indicate the impact of improving fish health on providing greater adult returns as well as an improved product for the fishery.

Description of Study Area

This project was designed to collect and summarize fish health related data from Washington Department of Wildlife facilities in the Columbia River drainage. Washington Department of Wildlife rears winter run steelhead, summer run steelhead, and sea run cutthroat trout in these facilities though not all three species/strains are raised at all stations. Location of the facilities and rearing programs are indicated on Figure 1 and Table 1.

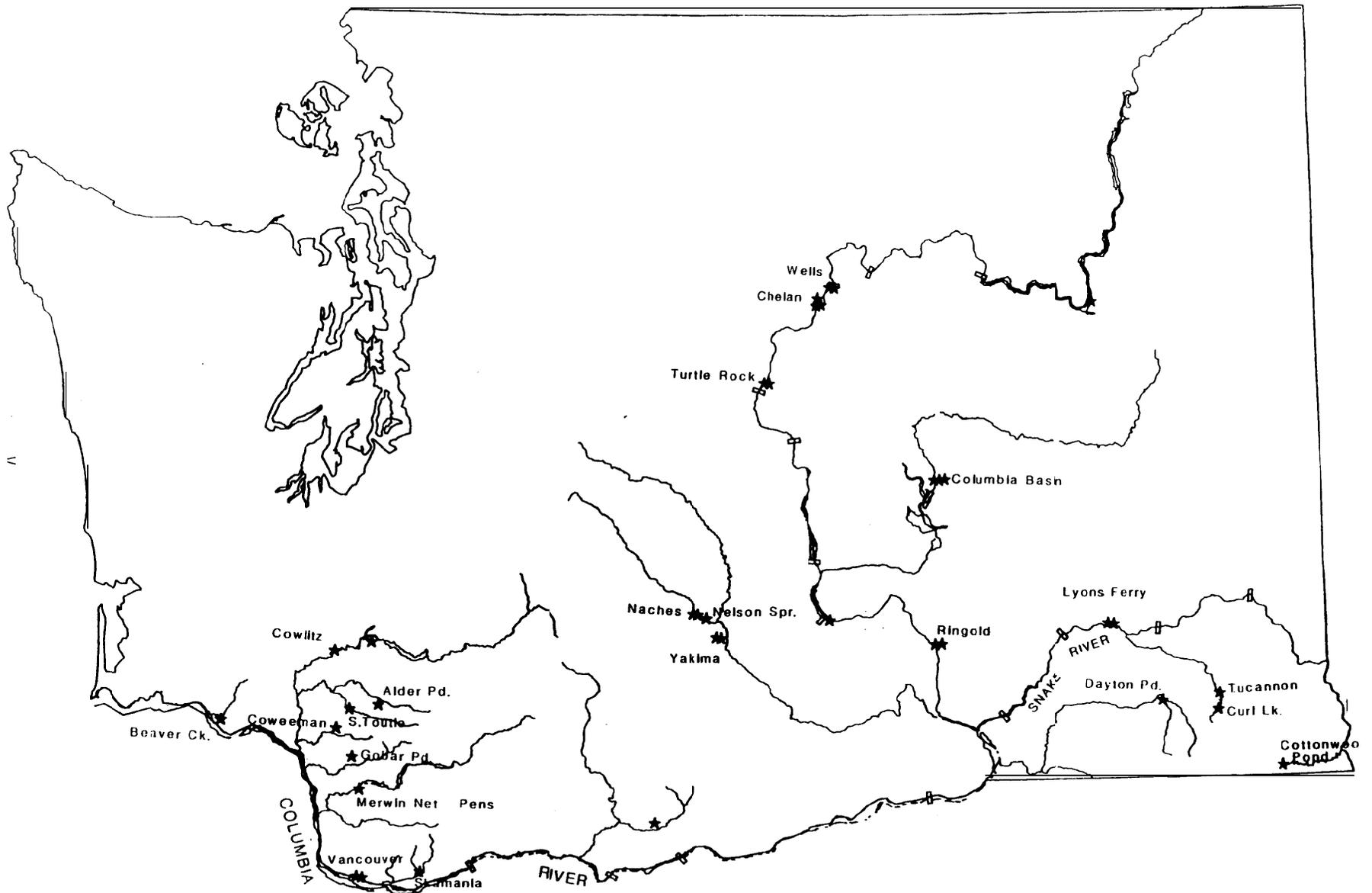


Figure 1. Location of Washington Department of Wildlife Anadromous Fish Production Facilities in the Columbia River Drainage

Table 1. WDW Columbia River Drainage Anadromous Fish Rearing Programs

<u>Installation</u>	<u>Drainage</u>	<u>Annual Program/ Transfers to</u>
Beaver Ck. Hatchery	Elochoman	Winter SH Smolts. Winter SH Pre-smolts for Coweeman and Gobar. Summer SH Smolts. Searun CT Smolts. Searun CT Pre-smolts for Coweeman and Skamania. Two Broodstocks.
Coweeman SH Pond	Coweeman	Winter SH Smolts.
Coweeman CT Pond	Coweeman	Searun CT Somots.
Alder Creek Pond	N. Fork Toutle	Summer SH Smolts.
South Toutle Trap	S. Fork Toutle	Winter SH Parr.
Cowlitz Hatchery	Cowlitz	Winter SH Smolts. Summer SH Smolts. Searun CT Smolts. Three Broodstocks.
Gobar Pond	Kalama	Winter SH Smolts. Summer SH Smolts.
Merwin Net Pens	Lewis	Summer SH Smolts.
Vancouver Hatchery	L. Columbia	Summer SH Smolts. Summer SH Fingerlings for Skamania. Winter SH Fingerlings for Skamania.
Skamania Hatchery	Washougal	Winter SH Smolts. Summer SH Smolts Summer SH Pre-smolts for Alder Ck., Gobar and Merwin. Three Broodstocks.
Yakima Hatchery	Yakima	Summer SH Smolts. One Broodstock.
Nelson Springs Raceway	Naches	Summer SH Smolts.

Table 1 (Continued). WDW Columbia River Drainage Anadromous
Fish Rearing Programs

Installation	Drainage	Annual Program/ Transfers to
Naches Hatchery	Naches	Summer SH Fingerlings for Nelson Spring.
Ringold Pond	Upper Columbia	Summer SH Smolts.
Columbia Basin Hatchery	Crab Creek	Sumer SH Fingerlings for Ringold Pond.
Turtle Rock Pond	Upper Columbia	Summer SH Smolts.
Chelan Hatchery	Upper Columbia	Summer SH smolts. Summer SH Fingerlings for Turtle Rock, One Broodstock.
Wells Hatchery	Upper Columbia	Summer SH Smolts. One Broodstock.
Lyons Ferry Hfatchery	Lower Snake	Summer SH Smolts. Summer SH Pre-smolts. for Cottonwood, Curl and Dayton Ponds.
Cottonwood Pond	Grand Ronde	Summer SH Smolts.
Curl Lake	Tucannon	Summer SH Smolts.
Dayton Pond	Touchet	Summer SH Smolts.

SH = Steelhead
CT = Cutthroat

Materials and Methods

Materials and methods were described in Augmented Fish Health Monitoring for Washington Department of Wildlife; 1986. Annual Report (Gearheard et al, 1987).

Results and Discussion

Objective 1.0 Complete Start-up Phase.

Task 1.1 Acquire Competent Staff.

The project leader, Jim Gearheard, retired and the position was filled by John Kerwin. Leni Oman replaced John Kerwin as the Lower Columbia River Basin fish pathologist.

Current project staff are:

Project Leader: John Kerwin
Fish Pathologists: Leni Oman
Steve Roberts
Fish Biologists: Bruce Bolding
Jennifer Hulett

Objective 2.0 Serve on technical steering committee.

Task 2.1 Technical Steering Committee.

Three meetings of the Project Technical Steering Committee were held. The first meeting was held at the Holiday Inn, Couer D'Alene, ID on September **20**, 1988. Jim Gearheard and Steve Roberts attended the meeting. The second meeting was held in Portland, OR on January 19, 1989 and was attended by Jim Gearheard. The third meeting was held at Alderbrook Inn, Union, WA on April 20, 1989. All project personnel attended the meeting at Alderbrook. Current project progress as well as interpretations and modifications of project tasks were discussed at all meetings. Techniques for the detection of Erythrocytic Inclusion Body Syndrome (EIBS) were taught at a workshop held at The Evergreen State College. The sampling method for Renibacterium salmoninarium was discussed and the tissue of choice for sampling switched from kidney to ovarian fluid.

Task 2.2 Technology transfer.

WDW has distributed the 1987 Annual Report to appropriate personnel within the Agency and to the Washington State Library. BPA distributed the publication to other interested parties.

Significant findings are also reported in the WDW fish hatchery newsletter, The Leaky Boot, which is distributed within the agency as well as to the editors of the Anal Fin, the U.S. Fish and Wildlife Service Hatchery newsletter.

Task 2.3 Facility impediments.

This task was detailed in the 1987 Annual Report (Gearheard et al, 1987).

Task 3.1 Organosomatic Analysis at "IndexM Hatcheries.

The organosomatic analysis, based on Goede's method (Ron Goede, personal communication), is designed to quantify departures from a physically "normal" condition in a population of fish. It is not a diagnostic tool, but useful as an indicator of trends in fish condition. The analysis in this study was performed at or close to the smolt stage in conjunction with preliberation exams at "Index" hatcheries (Table 2.).

The overall condition of the smolts at Wells Hatchery was better in all categories than the smolts at the Cowlitz Hatchery. This determination was based on the percent of fish that were closer to normal on the organosomatic index. The fish at Wells were longer, heavier, with a better condition factor and a higher average hematocrit level. In addition, the Wells fish had a greater pyloric fat level, which is desirable at the smolt stage, and all the internal organs were considered normal. In contrast, the fish at Cowlitz had varying degrees of abnormality, such as enlarged spleens, livers and kidneys, or hemorrhaging in the hind gut. The less desirable condition of the fish at the Cowlitz hatchery was directly attributed to the overwhelming numbers of the protozoan parasite Ceratomyxa Shasta in the intestinal tract of the fish. The pathological signs listed above are classic for C. Shasta infections. The parasite was found in all production lots at Cowlitz and has been implicated as the causative agent in the loss of up to 80% of some production lots there. Tables 3 and 4 list the comparative data for all stocks examined with the organosomatic index.

A comparison of the 1988 data with that of the previous two years shows almost no change in the Wells summer steelhead. The size and condition of the fish are almost identical. The four stocks of fish examined at the Cowlitz, however, display different values from last year in all measured categories. The size variation may be attributed to the different time of examination of the fish from the previous year (though samples were gathered within 4 weeks of the previous year); or, the severity of Ceratomyxosis this year may have caused stunting due the poor appetite in affected fish. In addition, the index values for internal organs varied from last year; this may also be attributed to Ceratomyxosis in the fish during all three years of the project.

The organosomatic index was helpful in documenting the chronic problem of C. Shasta at Cowlitz and continued use of this evaluation will help document effects of an ozone treatment facility to be installed by Tacoma City Light for control of Ceratomyxosis.

Task 3.2 Test for Specific Pathogens

Viral Pathogens

Standard techniques were employed to assay all samples taken for the project (Gearheard et al., 1987). Assays for replicating viral agents, specifically infectious hematopoietic necrosis virus (IHNV) and infectious pancreatic necrosis virus (IPNV), were carried out under an interagency subcontract with the Washington Department of Fisheries (WDF) virology lab. Assays revealed that six stocks of steelhead broodfish at four hatcheries had detectable levels of IHNV (Table 5) though no mortality was attributed to viremia in these returning adults. Summer steelhead broodfish at Wells carried IPNV for the second consecutive year (Table 5). The adults displayed no clinical signs and suffered no mortality to IPNV; all eggs from positive adults were destroyed. Assays for EIBS, carried out by Washington Department of Wildlife (WDW) staff, revealed no positive results for this virus in any stocks of broodfish.

Viral assays on 1988 smolt samples, taken during the preliberation exam, were positive for IHNV in one lot of summer steelhead at Cowlitz. EIBS samples were positive in summer steelhead stocks at Dayton Pond and Ringold (Table 6). All other samples taken during preliberation were negative for the presence of viruses.

Two stocks of juvenile steelhead suffered significant mortality due to IHNV. Cowlitz summer steelhead fingerlings underwent an epizootic in October, 1988 and Lyons Ferry summer steelhead fry in April, 1989. Associated mortalities are reported under Task 6.1.3.

Bacterial Pathogens

Assays for Renibacterium salmoninarum, the causative agent of bacterial kidney disease (BKD) were conducted and the BPA guidelines for determination of positive samples were utilized. Six positive hatcheries were identified (Figure 2). The percent of positive adult fish ranged from two percent in four stocks to eight percent in one stock.

Assays for the bacterium on 1988 smolt samples, gathered during the preliberation exam, were also positive. Five stocks of steelhead smolts at four hatcheries ranged from two percent to eight percent positive (Table 7). Midterm monitoring for R. salmoninarum in 1988 broodyear searun cutthroat at Beaver Creek, Cowlitz and Skamania revealed positive samples in only the Skamania stock which had a five percent carrier rate (Figure 3).

Parasitic Pathogens

All samples for Myxobolus cerebralis processed were negative for the parasite (Table 8). Processing of samples from additional sites, collected during this reporting year, is currently underway.

Ceratomyxa Shasta continues to cause significant losses in production lots at the Cowlitz hatchery, our only site which is plagued by the parasite. An ozone water treatment plant is being installed to attempt to control the ceratomyxosis.

Objective 4.0 Monitoring Hatchery Water Supplies.

Task 4.1 Sample Hatchery Water Supplies.

A sampling plan was completed in the 1986 annual report (Gearheard et al, 1987). WDW is awaiting the selection of a water testing laboratory by BPA.

Task 4.3 Monitoring Flow and Loading Densities.

Flow loading index and density loading index data have been collected for all WDW Columbia River anadromous fish hatcheries. The data was collected and entered into a Lotus 1-2-3 worksheet for flow and density index calculation for each pond of fish within each lot of fish.

Figure 2.
 W.D.W. Broodstock Monitoring
Renibacterium salmoninarum
 1988-89 Spawning Season

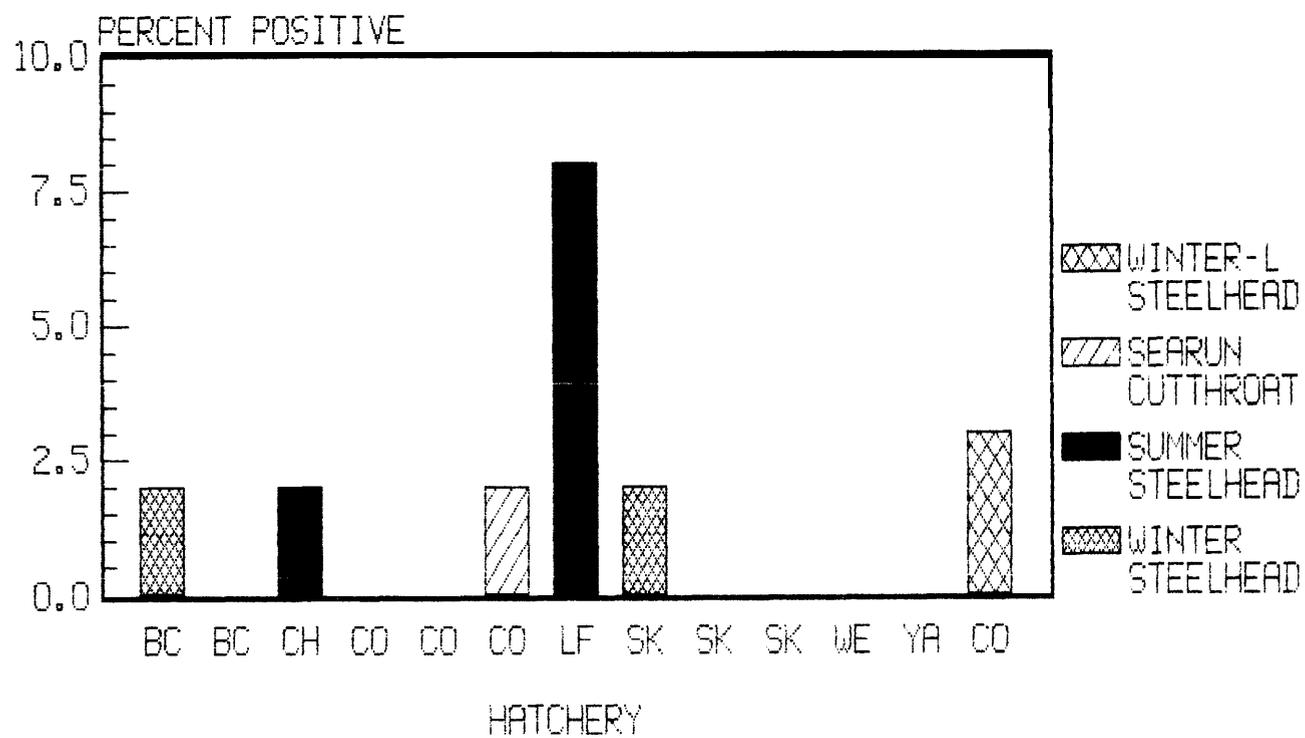
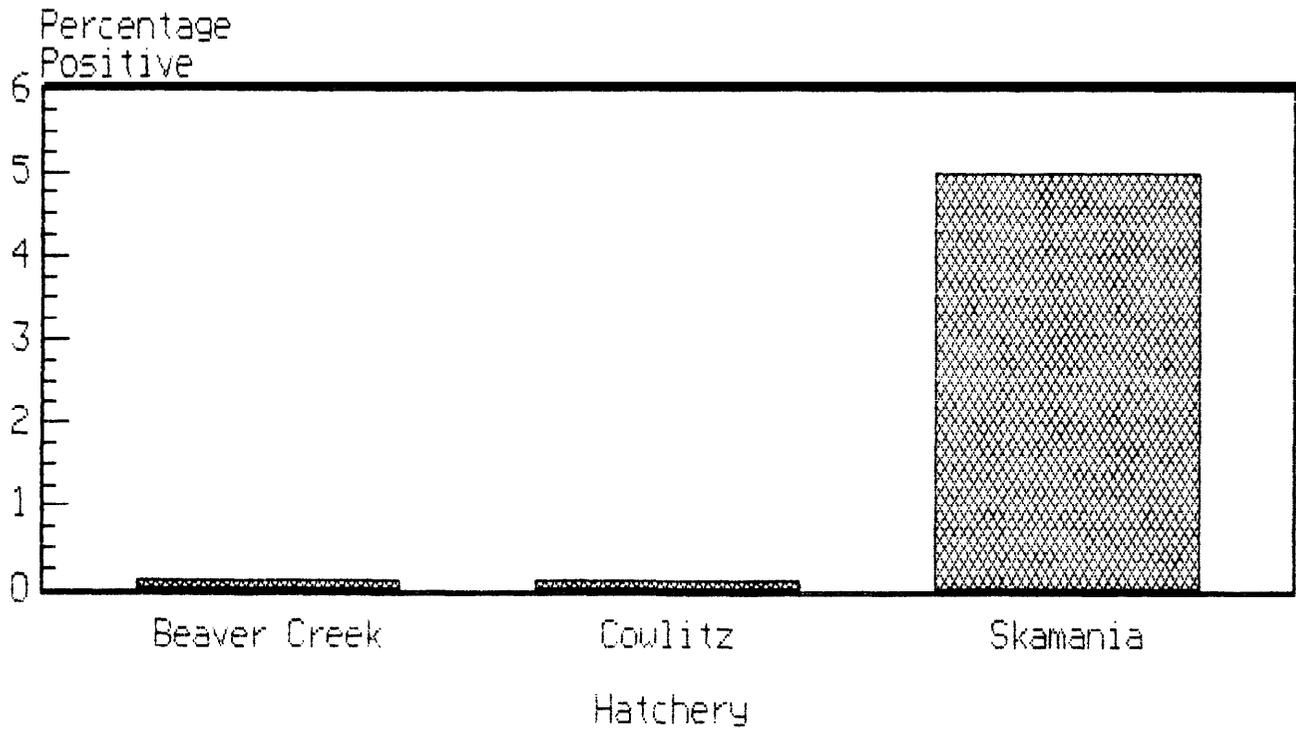


Figure 3.
W.D.W. Searun Outthroat
Renibacterium salmoninarum
1988 Midterm Sampling



The eastern Washington data has been summarized for the 1987 broodyear (Table 9). Western Washington data was incomplete at the time this report was written. Correlation of this data on the condition and health status of fish will be undertaken in the future.

Objective 5.0 Record, Analyze and Report Fish Health Monitoring and Related Data.

Currently, monthly monitoring data and specific pathogen testing information has been entered into a dbase III+ database. The flow and density data has been entered into Lotus 1-2-3 worksheets for each facility.

Objective 6.0 Estimate the Project's Benefits.

Task 6.1.1 Severity of Pathogens and Mortality Caused.

Completed in 1986 annual report (Gearheard et al, 1987).

Task 6.1.2 Total Number and Percent Loss of Each Lifestage of Fish Species,

Lot Production Mortalities

Lot production data from WDW hatchery reports were entered into a Lotus 1-2-3 worksheet. Calculations were made that include total number of fish and percentage loss for each facility.

The average egg mortality for the 1987 broodyear was 17.5%, ranging from 1.1% in the Wallowa stock of summer steelhead at Lyons Ferry hatchery to 57%, due to fungus and culling of excess fish, in winter steelhead at Cowlitz hatchery. The average fry mortality for the 1987 broodyear was 16.1%, ranging from 1.1% in winter steelhead at Beaver Creek hatchery to 73.63, due to C. Shasta, in cutthroat at Cowlitz hatchery. The overall average mortality from egg to smolt was 30% with C. Shasta as the major etiogenic agent. A summary of the egg and fry mortality for the 1987 broodyear is contained in Table 10.

Table 11 contains data on the mortality of eggs and fry from the lower Columbia hatcheries for 1983-85 that was previously unavailable. Figures for this time period vary widely and should be examined on a stock by stock and year by year basis.

Adult Prespawning Mortalities.

Adult prespawning mortality data from WDW hatchery reports were entered into a Lotus 1-2-3 worksheet. Calculations were made that include total number and percentage loss for each broodstock hatchery (Table 12). The only stock which suffered above average mortality was Chelan summer steelhead, Mortality was attributed mainly to Saprolegnia infections while Ichthyophthirius multifiliis and Henneguya salmonicola infestations were identified in fewer cases.

Task 6.1.3 Number and Causative Agents of Epizootics, Type and Amount of Medication Used

Disease outbreaks causing significant mortality occurred at several WDW Columbia Basin hatcheries between July 1, 1987 and June 30, 1989. When possible, epizootics were treated with medication (Table 13).

Task 6.1.4 Feed Conversion

Data from WDW hatchery reports were entered into a Lotus 1-2-3 worksheet. Calculations were made that reflect total pounds of feed fed per total pounds of fish produced or, i.e. feed conversion (Table 14).

Task 6.1.5 Total Survival of Smolts to Adults from Index Hatcheries

No work has been done on this task.

Literature Cited

- Gearheard, J., S. Roberts, D. Chase, and B. Bolding. 1987. Augmented fish health monitoring for Washington Department of Wildlife, 1986 Annual Report. BPA Project No. 86-54.
- Roberts, S., W. Brunson, and D. Chase. 1987. Pathology of fish diseases and promotion of fish health. Progress Report, D-J Project F-56-R-19. 44 pgs.

Acknowledgements

We would like to thank the Bonneville Power Administration for their financial support of this project as well as Washington Department of Wildlife hatchery managers and staff for providing valuable assistance in interpretation of records and collection of samples and data. We would also like to express our appreciation of Kathy Hopper, the staff of the Washington Department of Fisheries virology laboratory, and Jennifer Hulett, WDW, for their continuing efforts in testing collected samples for viral agents.

Special thanks to Jim Gearheard for his guidance in this project.

Tables

Table 2. List of "Index" Hatcheries Species and Stocks in which Organosomatic Analysis was performed.

Hatchery	Species	Stock
Cowlitz	Summer Steelhead	Cowlitz
Cowlitz	Winter Steelhead	Cowlitz
Cowlitz	Sea-Run Cutthroat	Cowlitz
Wells	Summer Steelhead	Wells

Table 3. Organosomatic Index Results. Average Values, by Species and Stock, for Measured Parameters: Length, Weight, Condition Factor and Hematocrit with Standard Deviation.

Hatchery	Species	Length (mm)	SD	Weight (g)	SD	Cond Fact	HCT	SD
Cowlitz	ss	171	17.9	50.9	17.2	1.02	39	4.6
Cowlitz	SW	174	23.2	59.5	24.2	1.13	40	4.7
Cowlitz	SW(late)	180	12.5	60.4	12.2	1.04	49	3.0
Cowlitz	CT	183	25.2	66.8	25.6	1.09	42	5.1
Wells	ss	189	28.6	66.2	16.6	.98	54	5.3

Table 4. Values of Percentage of Population by Species/Stock/Hatchery of Individual Organs.

Summer Steelhead/Cowlitz/Cowlitz						
Score	Fat	Spleen	Hind Gut	Kidney	Liver	Gills
0	40%	45%	57%	100%	97%	97%
1	55%	45%	43%	0%	4%	4%
2	5%	5%	0%	0%	0%	0%
3	0%	5%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%
Winter Steelhead/Cowlitz/Cowlitz						
0	70%	75%	55%	97%	97%	100%
1	30%	20%	43%	3%	3%	0%
2	0%	2%	2%	0%	0%	0%
3	0%	3%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%
Winter Steelhead(late)/Cowlitz/Cowlitz						
0	0%	7%	2%	100%	100%	100%
1	80%	90%	98%	0%	0%	0%
2	20%	3%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%
Sea-Run Cutthroat/Cowlitz/Cowlitz						
0	7%	43%	100%	95%	97%	100%
1	78%	50%	0%	5%	3%	0%
2	15%	7%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%
Summer Steelhead/Wells/Wells						
0	0%	100%	100%	100%	100%	100%
1	33%	0%	0%	0%	0%	0%
2	67%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%

A score of 0 = a normal condition with abnormality increasing numerically to 5 with the exception of fat values, where 2-3 is a desirable value.

Table 5. Results of Viral Assays: 1988-89 Broodstock.

Hatchery	Species	Stock	IPNV	IHNV	EIBS(% pos)
Beaver Creek	W. Steelhead	Elochoman	neg	neg	0
Beaver Creek	SR Cutthroat	Elochoman	neg	neg	0
Chelan	S. Steelhead	Ringold	neg	neg	0
Cowlitz	S. Steelhead	Cowlitz	neg	<u>pos</u>	0
Cowlitz	W. Steelhead	Cowlitz	neg	<u>pos</u>	0
Cowlitz	W. (late) Steelhead	Cowlitz	neg	<u>pos</u>	0
Cowlitz	SR Cutthroat	Cowlitz	neg	neg	0
Lyons Ferry	S. Steelhead	Lyons Ferry	neg	<u>pos</u>	0
Skamania	S. Steelhead	Skamania	neg	neg	0
Skamania	W. Steelhead	Washougal	neg	<u>pos</u>	0
Skamania	SR Cutthroat	Washougal	neg	neg	0
Wells	S. Steelhead	Wells	<u>pos</u>	<u>pos</u>	0
Yakima	S. Steelhead	Yakima	neg	neg	0

Table 6. Results of Viral Assays: 1988 Smolts.

Location	Species	Stock	IPNV	IHNV	EIBS(% pos)
Alder Cr. Pond	S. Steelhead	Skamania	neg	neg	0
Beaver Cr.	S. Steelhead	Skamania	neg	neg	0
Beaver Cr.	W. Steelhead	Elochoman	neg	neg	0
Beaver Cr.	SR Cutthroat	Elochoman	neg	neg	0
Chelan	S. Steelhead	Wells	neg	neg	0
Cottonwood Pond	S. Steelhead	Wallowa	neg	neg	0
Coweeman Pond	W. Steelhead	Elochoman	neg	neg	0
Coweeman Pond	W. Steelhead	Elochoman	neg	neg	0
Cowlitz	S. Steelhead	Cowlitz	neg	pos	0
Cowlitz	W. Steelhead	Cowlitz	neg	neg	0
Cowlitz	S. (late) Steelhead	Cowlitz	NS	NS	NS
Cowlitz	SR Cutthroat	Cowlitz	neg	neg	0
Curl Lake	S. Steelhead	L. Ferry	neg	neg	0
Dayton Pond	S. Steelhead	L. Ferry	neg	neg	3
Gobar Pond	S/W Steelhead	Skamania/ Elochoman	neg	neg	0
Lyons Ferry	S. Steelhead	L. Ferry	neg	neg	0
Merwin Net Pen	S. Steelhead	Skamania	neg	neg	0
Nelson Springs	S. Steelhead	Yakima	neg	neg	0
Ringold Pond	S. Steelhead	Ringold	neg	neg	5
Skamania	S. Steelhead	Skamania	neg	neg	0
Skamania	W. Steelhead	Washougal	neg	neg	0
Skamania	SR Cutthroat	Washougal	neg	neg	0
So. Toutle Trap	W. Steelhead	Toutle	neg	neg	0
Turtle Rock	S. Steelhead	Ringold	neg	neg	0
Vancouver	S. Steelhead	Skamania	neg	neg	0
Wells	S. Steelhead	Wells	neg	neg	0
Yakima	S. Steelhead	Yakima	neg	neg	0

NS = Not Sampled

Table 7. Results of Renibacterium salmoninarum assays: 1988 Smolts.

Location	Species	Species	Stock	Result
Alder Cr. Pond	S. Steelhead	Skamania	0/60 = 0%	pos
Beaver Cr.	S. Steelhead	Skamania	0/60 = 0%	pos
Beaver Cr.	W. Steelhead	Elochoman	0/60 = 0%	pos
Beaver Cr.	SR Cutthroat	Elochoman	0/60 = 0%	pos
Chelan	S. Steelhead	Wells	0/60 = 0%	pos
Cottonwood Pond	S. Steelhead	Wallowa	0/60 = 0%	pos
Coweeman Pond	W. Steelhead	Elochoman	2/60 = 3%	pos
Coweeman Pond	W. Steelhead	Elochoman	0/60 = 0%	pos
Cowlitz	S. Steelhead	Cowlitz	3/60 = 5%	pos
Cowlitz	W. Steelhead	Cowlitz	1/60 = 2%	pos
Cowlitz	W. (late) Steelhead	Cowlitz	NS	
Cowlitz	SR Cutthroat	Cowlitz	0/60 = 0%	pos
Curl Lake	S. Steelhead	L. Ferry	0/60 = 0%	pos
Dayton Pond	S. Steelhead	L. Ferry	0/60 = 0%	pos
Gobar Pond	S/W Steelhead	Skamania/ Elochoman	0/60 = 0%	pos
Lyons Ferry	S. Steelhead	L. Ferry	0/60 = 0%	pos
Merwin Net Pen	S. Steelhead	Skamania	1/60 = 2%	pos
Nelson Springs	S. Steelhead	Yakima	0/60 = 0%	pos
Ringold Pond	S. Steelhead	Ringold	0/60 = 0%	pos
Skamania	S. Steelhead	Skamania	0/60 = 0%	pos
Skamania	W. Steelhead	Washougal	0/60 = 0%	pos
Skamania	SR Cutthroat	Washougal	0/60 = 0%	pos
Turtle Rock	S. Steelhead	Ringold	0/60 = 0%	pos
Vancouver	S. Steelhead	Skamania	0/60 = 0%	pos
Wells	S. Steelhead	Wells	5/60 = 8%	pos
Yakima	S. Steelhead	Yakima	0/60 = 0%	pos

NS = Not Sampled

Table 8. Results of Renibacterium salmoninarum assays: 1988-89 Broodstock.

<u>Hatchery</u>	<u>Species</u>	<u>Stock</u>	<u>Result</u>
Beaver Creek	W. Steelhead	Elochoman	1/60 = 2% pos
Beaver Creek	SR Cutthroat	Elochoman	0/60 = 0% pos
Chelan	S. Steelhead	Ringold	1/60 = 2% pos
Cowlitz	S. Steelhead	Cowlitz	0/60 = 0% pos
Cowlitz	W. Steelhead	Cowlitz	0/60 = 0% pos
Cowlitz	W. (late) Steelhead	Cowlitz	2/60 = 3% pos
Cowlitz	SR Cutthroat	Cowlitz	1/60 = 2% pos
Lyons Ferry	S. Steelhead	Lyons Ferry	5/60 = 8% pos
Skamania	S. Steelhead	Skamania	0/60 = 0% pos
Skamania	W. Steelhead	Washougal	1/60 = 2% pos
Skamania	SR Cutthroat	Washougal	0/60 = 0% pos
Wells	S. Steelhead	Wells	0/60 = 0% pos
Yakima	S. Steelhead	Yakima	0/20 = 0% pos

Table 9. Results of Myxobolus cerebralis Assays.

Location	River Drainage	Species/Stock	Date	Result
Cottonwood Pond	Grande Rhonde	SS/Wallowa	0488	neg
Cowlitz	Cowlitz	SW/Cowlitz	0388	neg
Curl Lake	Tucannon	SS/Lyons Ferry	0488	neg
Gobar Pond	Kalama	SS-SW/Elochoman	0388	neg
Merwin Reservoir	Lewis	SW/Elochoman	0388	neg
Turtle Rock	Columbia	SS/Ringold	1287	neg
Wells	Columbia	SS/Wells	0288	neg

Table 10. Density and Flow Indexes for 1987 Broodyear Fish reared at eastern Washington WDW facilities.

Location	Species	Stock	BY	Pond Type	Water Temp.	Density Index lb/ft ³ /in			Flow Index lb/gpm/in		
						Avg.	Min.	Max.	Avg.	Min.	Max.
Ringold	ss	Ringold	87	RP	50-60	0.02	0.01	0.03	2.51	1.32	4.52
Wells	ss	Wells	87	RP	37-62	0.01	0.00	0.02	1.89	0.48	3.21
Lyons Ferry	SS	Wallowa	87	RP	52-53	0.01	0.00	0.02	0.65	0.28	1.32
Lyons Ferry	SS	Lyons F.	87	RP	52	0.01	0.00	0.02	0.90	0.34	1.49
Lyons Ferry	ss	Lyons F.	87	R	48-54	0.10	0.04	0.16	0.66	0.37	1.38
Columbia Basin	SS	Ringold	87	R	58	0.22	0.17	0.29	0.79	0.62	1.04
Lyons Ferry	SS	Wallowa	87	R	50-54	0.06	0.03	0.08	0.39	0.15	0.58
Turtle Rock	SS	Ringold	87	R	37-47	0.13	0.12	0.14	1.05	0.99	1.11
Chelan	ss	Wells	87	R	54-56	0.16	0.09	0.29	1.12	0.53	2.94
Chelan	ss	Ringold	87	R	54-56	0.15	0.05	0.27	0.88	0.33	1.54
Nelson Springs	SS	Yakima	87	R	49-51	0.31	0.24	0.37	1.41	1.37	1.51
Naches	ss	Yakima	87	R	52-59	0.36	0.10	0.59	1.39	0.85	1.90
Columbia Basin	SS	Skamania	87	R	58-60	0.19	0.06	0.30	0.70	0.22	1.06
Wells	ss	Wells	87	R	52-53	0.21	0.08	0.41	1.08	0.41	1.98
Yakima	ss	Yakima	87	C	52-58	0.11	0.03	0.19	2.55	0.67	4.49

ss = Summer steelhead

RP = Rearing pond

R = Raceway

C = Circular

Table 11. Summary of Egg and Fry mortality for the 1987 Broodyear.

Hatchery	Species/Stock	Starting No.	Egg Mort. No.	%	Fry Mort. No.	%	Total Mort. No.	%
Beaver Creek	SS/Skamania	158,112	7,918	5.0	16,669	11.1	24,587	15.
Beaver Creek	SW/Elochoman	890,000	239,248	26.9	6,798	1.1	896,798	27.
Beaver Creek	CT/Elochoman	144,400	55,986	38.8	26,137	29.6	82,123	56.
Chelan	SS/Wells	251,400	12,200	4.9	15,400	6.5	27,600	11.
Chelan/T.Rock	SS/Ringold	244,800	72,900	29.8	23,617	13.7	96,517	39.
C.Basin/Ring.	SS/Ringold				31,900	8.8	31,900	8.
Cowlitz	SS/Cowlitz	608,750	46,125	7.6	224,076	39.8	270,201	44.
Cowlitz	SW/Cowlitz	1,668,947	389,691	23.3	479,672	37.5	869,363	52.
Cowlitz	SW(late)/ Cowlitz	197,800	61,396	10.1	1,703	3.7	63,099	58.
Cowlitz	CT/Cowlitz	438,723	68,005	15.5	272,670	73.6	340,675	77.
Lyons Ferry	SS/Lyons Ferry	1,167,500	191,300	16.4	47,376	4.9	238,700	20.
	SS/Wallowa	500,000	5,300	1.1	19,900	4.0	25,200	5.
Naches/ Nelson Spgs.	SS/Yakima	117,300	8,800	7.5	29,532	27.2	38,332	32.
Skamania	SS/Skamania	1,946,500	333,716	17.1	129,865	8.1	463,851	23.
Skamania	SW/Washougal	320,000	31,919	10.0	6,486	2.3	38,405	12.
Skamania	CT/Washougal	55,485	4,360	7.9	3,361	6.6	7,721	13.
Vancouver	SS/Skamania	1,030,752	123,168	11.9	165,988	18.3	289,156	28.
Wells	SS/Wells	1,895,500	167,000	8.8	34,900	2.4	201,900	10.
Yakima	SS/Yakima	396,100	101,000	25.5	22,100	7.5	123,100	31.

Table 12. Summary of Egg and Fry Mortality for Broodyears 1983 - 85 (Lower Columbia Hatcheries, not included in previous reports).

Beaver Creek Hatchery

Species/Stock	Year	Starting Egg Mort.			Fry Mort.		Total Mort.	
		No.	No.	%	No.	%	No.	%
SS/Skamania	1983	122,576	265	0.0	10,611	8.7	10,876	8.9
	1984	128,444	9,288	7.2	15,025	12.6	24,313	18.9
	1985	149,940	150	0.0	15,800	10.5	15,950	10.6
SW/Elochoman	1983	858,000	44,944	5.2	425,538	64.8	470,482	54.8
	1984	1,187,380	314,184	26.5	147,578	17.6	461,762	38.9
	1985	980,000	120,124	12.2	153,756	18.1	273,880	27.9
CT/Elochoman	1983	219,100	109,102	49.8	112,843	56.7	221,945	71.8
	1984	163,848	53,848	32.9	15,702	14.3	69,550	42.4
	1985	251,000	32,277	12.9	52,374	28.7	84,651	33.7

Cowlitz Hatchery

Species/Stock	Year	Starting Egg Mort.			Fry Mort.		Total Mort.	
		No.	No.	%	No.	%	No.	%
SS/Cowlitz	1983	813,495	24,887	3.1	127,361	16.2	152,248	18.7
	1984	684,502	51,463	7.5	71,047	11.2	122,510	17.9
	1985	612,400	41,647	6.8	261,083	45.7	302,730	44.4
SW/Cowlitz	1983	1,417,595	79,110	5.6	365,788	27.3	444,898	31.4
	1984	1,697,302	64,953	3.8	495,346	30.3	560,299	33.0
	1985	1,958,017	136,602	7.0	398,498	21.9	535,100	52.1
SW(late)/ Cowlitz	1983	217,048	45,634	21.0	18,000	10.5	63,634	29.3
	1984	109,944	13,896	12.6	9,473	9.9	23,369	21.3
	1985	132,000	22,374	17.0	5,634	5.1	28,008	21.2
CT/Cowlitz	1983	528,930	7,660	1.4	118,487	22.7	126,147	23.8
	1984	400,000	49,680	12.4	95,003	27.1	144,683	36.2
	1985	352,368	57,552	16.3	111,172	37.7	168,724	77.7

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Table 12 (continued).

Skamania Hatchery

Species/Stock	Year	Starting			Egg Mort.		Fry Mort.		Total Mort.	
		No.	No.	%	No.	%	No.	%	No.	%
SS/Skamania	1983	1,774,000	548,637	30.9	12,198	1.0	560,835	31.6		
	1984	1,747,500	395,059	22.6	285,561	21.1	680,620	38.9		
	1985	2,216,400	76,050	3.4	24,178	1.1	100,228	23.8		
SW/Washougal	1983	176,000	124,488	72.4	1,951	4.0	129,439	73.5		
	1984	454,912	73,692	16.2	175,711	46.1	249,403	54.8		
	1985	181,824	6,017	3.3	5,411	3.1	11,428	6.3		
CT/Washougal	1983	72,790	2,915	4.0	59,358	84.9	62,273	85.6		
	1984	61,056	6,164	10.1	46,037	83.9	52,201	85.5		
	1985	63,360	1,342	2.1	7,812	12.6	9,154	14.4		

Vancouver Hatchery

Species/Stock	Year	Starting			Egg Mort.		Fry Mort.		Total Mort.	
		No.	No.	%	No.	%	No.	%	No.	%
SS/Skamania	1983	940,256	77,795	8.3	1,574	0.2	79,369	8.4		
	1984	1,075,822	2,500	0.2	69,853	6.5	72,353	6.7		
	1985	1,093,808	109,022	10.0	147,370	15.0	256,392	23.4		

Table 13. Summary of Prespawning Mortality for the 1987-88 Broodstock.

Hatchery	Species/Stock	No. Trapped	Mortality	
			No.	%
Beaver Creek	SW/Elochoman	553	13	2.4
	CT/Elochoman	929	23	2.5
Chelan	SS/Ringold	394	153	38.8
Cowlitz	SS/Cowlitz	938	NA	-
	SW/Cowlitz	5,070 (1)	NA	-
	CT/Cowlitz	508	NA	-
Lyons Ferry	SS/Lyons Ferry	1,120	0	0.0
Skamania	SS/Skamania	2,057	104	5.0
	SW/Washougal	300	5	1.7
	CT/Washougal	115	0	0.0
Wells	SS/Wells	603	0	0.0
Yakima	SS/Yakima	157	9	4.7

NA = Not Available

(1) This figure includes both run times of winter steelhead broodfish.

Table 14. Summary of Epizootics at WDW Columbia Basin Rearing Facilities;
July 1, 1987 to June 30, 1989.

Hatchery	Date	Species	Disease	Mortality		Medication
				No.	%	Type
Beaver Creek	7/87	ss	FUR	17,245	= 6%	Romet
		SW	FUR	8,760	= 2%	Romet
		CT	FUR	6,071	= 10%	Romet
	7/88	ss	FUR	81,109	= 19%	Romet
		SW	FUR	25,265	= 6%	Romet
	Cowlitz (1)	10/88	ss	IHNV	40,988	= 3%
Lyons Ferry	4/89	ss	IHNV	542,886	= 58%	None
Skamania	7/87	ss	IHNV	111,423	= 19%	None

(1) Chronic annual ceratomyxosis affects all production lots at Cowlitz hatchery

FUR = Furunculosis

IHNV = Infectious Hematopoietic Necrosis Virus

Table 15. Feed Conversion Rates at WDW Columbia Basin Rearing Facilities for the 1987 Broodyear.

Facilities	Species/Stock	Conversion Rate
Beaver Creek	SS/Skamania	0.65
	SW/Elochoman	1.19
	CT/Elochoman	1.14
Chelan	SS/Wells	1.25
Chelan - Turtle Rock	SS/Mixed	1.12
Columbia Basin - Ringold	SS/Mixed	1.36
Cowlitz	SS/Cowlitz	1.72
	SW/Cowlitz	1.68
	SW(late)/Cowlitz	1.14
	CT/Cowlitz	0.99
Lyons Ferry	SS/Lyons Ferry	1.25
	SS/Wallowa	1.28
Naches - Nelson Springs	SS/Yakima	1.53
Skamania	SS/Skamania	1.25
	SW/Washougal	1.25
	CT/Washougal	1.12
Vancouver	SS/Skamania	1.19
Wells	SS/Wells	1.36
Yakima	SS/Yakima	1.00