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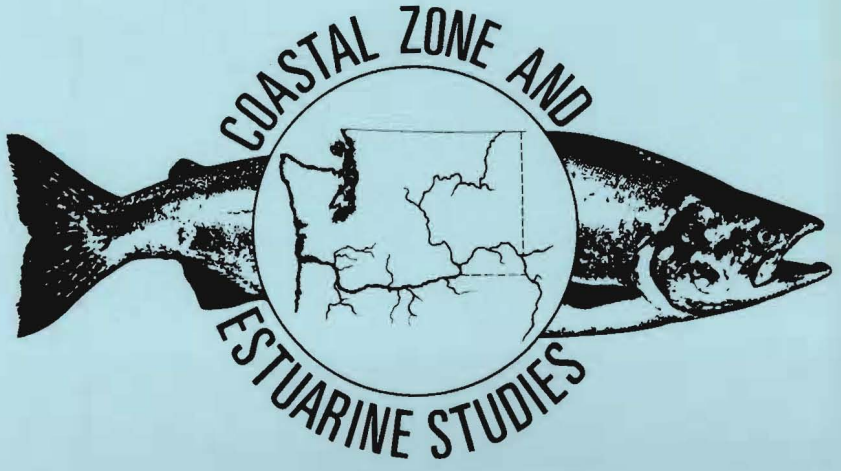

USE OF FISH TRANSPORTATION BARGE FOR INCREASING RETURNS OF STEELHEAD IMPRINTED FOR HOMING

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Northwest and Alaska Fisheries Center
Coastal Zone and Estuarine Studies Division
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ABSTRACT

In 1982, the National Marine Fisheries Service, under contract to the Bonneville Power Administration, began a 5-year study to determine if serially releasing steelhead, Salmo gairdneri, smolts over a 40-day period and transporting them by barge to a release site in the Columbia River below Bonneville Dam would result in increased returns of adults to Dworshak National Fish Hatchery.

Over 252,000 smolts were marked for the study; about 30,000 fish for each of five test lots (transported) and three control lots (released into the Clearwater River at the hatchery). Serial releases of test fish (barged to the Columbia River below Bonneville Dam) were made on 19 April, 30 April, 19 May, and 31 May 1982. Paired control groups (fish released as normal hatchery production into the Clearwater River) were released with the first three tests. In the interest of marking fewer fish, no control group was released with the last test.

Recoveries of control releases at dams along the migration route indicated a high survival to Lower Granite Dam and a low survival from there to John Day Dam. Approximately 57% of the control releases were transported from collector dams (Lower Granite, Little Goose, and McNary), as part of the routine transportation program.

The health and status of smoltification for the juvenile fish were monitored from mid-March to the release date for each group. This phase of the study was conducted under subcontract to the University of Idaho, Moscow, Idaho. The fish sampled were generally determined to be clinically healthy.

Final evaluation of the study will be based on the numbers of adults returning in ensuing years to Columbia River fisheries; adult collector points at Bonneville, McNary, and Lower Granite Dams; fisheries in Idaho; and the Dworshak National Fish Hatchery.

CONTENTS

INTRODUCTION

In 1982, the National Marine Fisheries Service (NMFS) began a 5-year study under contract to the Bonneville Power Administration (BPA) to determine if transporting steelhead, Salmo gairdneri, smolts directly from Dworshak National Fish Hatchery (NFH) to the Columbia River below Bonneville Dam by barge would increase returns of adults to the hatchery and the fishery.

Impetus for the study came from a test conducted in 1978 at Dworshak NFH in which substantially more adults returned to the hatchery and nearby sport fishing areas from a group of smolts that were barged from the hatchery and released below Bonneville Dam than returned from similar groups trucked to below Bonneville Dam or released at the hatchery to migrate downriver on their own volition (Slatick et al. 1982).

Slatick's data suggest that transportation of fish directly from Dworshak NFH enhanced returns of adults to the hatchery and to the sport fishery. His results, though, were based on only one release group at one point in time. Barging of a substantial portion of the hatchery production, however, would take between 30 and 40 days. Before implementing such a program, the management agencies need to know whether steelhead smolts transported throughout a 30-to 40-day period in April and May would return in greater numbers than nontransported smolts. NMFS' 5-year study was designed to provide the needed information.

Our major objective is to determine if groups of steelhead that were reared and imprinted at Dworshak NFH and then transported by truck to a transfer site near Lewiston, Idaho; released into barges; transported via barge to a release site in the Columbia River below Bonneville Dam; and

released will produce a greater percentage of returning adults to the hatchery and to the fishery in Idaho than fish released directly into the river at the hatchery. The groups of fish were scheduled for transportation during a 40-day period (serial releases). Incidental to measuring the benefits of transportation, we will determine the proportion of fish in each serial release that have accepted a homing imprint. We will also monitor fish health and smoltification throughout the test period. This initial report summarizes our research in 1982.

PROCEDURES

The experiment involved marking eight separately identifiable groups of about 30,000 steelhead each (five test and three control groups) (Table 1). Fish for marking were taken from eight ponds in System II (a reuse water system) at Dworshak NFH. All fish in these ponds were progeny of fish spawned on the same day in the spring of 1981 (Egg Take 8). Total fish in the marking ponds and the size (fish per pound and mean length) and condition factor of the fish at time of release are given in Table 2.

From 23 February to 12 March 1982, 252,079 steelhead were marked with an adipose fin excision and injection of a coded magnetic wire tag (Table 1). Fish were also externally marked with a thermal brand so their progress as juveniles and as returning adults could be monitored at key sampling sites along their migration route without sacrificing the fish.

All test and control groups (except T1A) were reared on reuse water in System II at 48°F until 15 April 1982, then the water temperature was reduced to ambient (42°F) and the fish were held for 5 days. On 20 April 1982, System II was switched from reuse to raw North Fork Clearwater River water at 42°F.

Table 1.--Steelhead marked in 1982 at Dworshak National Fish Hatchery.

Test number	Coded wire tag code	Brand	Marked fish released	Unmarked fish released	Date released from hatchery	Treatment
Control (C1)	23-6-6	LAK-3	29,838	5,883	4-19-82	Released as normal hatchery production into the Clearwater River.
Test (T1)	23-6-8	RAL-4	33,012	5,207	4-19-82	Trucked directly from hatchery to Clearwater River near Lewiston ID, held in barge for approx. 16 h, and barged for release below Bonneville Dam.
Test (T1A)	23-6-7	RAL-3	32,185	4,237	4-19-82	Pumped from System II to raw water in another raceway and held for 6 days. Then trucked directly from the hatchery to Clearwater River near Lewiston, ID, held in barge approx. 16 h, and barged for release below Bonneville Dam.
Control (C2)	23-16-4	LAK-2	31,048	3,094	4-30-82	Released as normal hatchery production into the Clearwater River.
Test (T2)	23-16-5	RAL-2	32,911	3,776	4-30-82	Trucked directly from hatchery to Clearwater River near Lewiston, ID, held in barge for approx. 16 h, and barged for release below Bonneville Dam.
Control (C3)	23-16-2	LAK-1	31,714	3,629	5-19-82	Released as normal hatchery production into the Clearwater River.
Test (T3)	23-16-3	RA)(-1	29,456	3,636	5-19-82	Trucked directly from hatchery to Clearwater River near Lewiston, ID, held in barge for approx. 16 h, and barged for release below Bonneville Dam.
Test (T4)	23-16-1	RAL-1	31,915	3,051	5-31-82	Trucked directly from hatchery to Clearwater River near Lewiston, ID, held in barge for approx. 16 h, and barged for release below Bonneville Dam.
		TOTAL	252,079	32,513		

Table 2.--Test number, total fish, pounds of fish, fish per pound, mean total length, and K-factor of steelhead at time of release from test ponds at Dworshak National Fish Hatchery in 1982. (Data from hatchery records).

Test number	Total fish in test pond	Pounds of fish	Fish per pound	Mean length (mm)	K-factor[a/]
Control (C1)	35,721	4,465	8.0	179	0.98
Test (T1)	38,219	4,838	7.9	180	0.98
Test (T1A)	36,422	4,497	8.1	184	0.98
Control (C2)	34,142	4,614	7.4	186	0.95
Test (T2)	36,687	5,095	7.2	189	0.93
Control (C3)	35,343	4,650	7.6	186	0.93
Test (T3)	33,092	4,354	7.6	185	0.94
Test (T4)	34,966	4,371	8.0	181	0.96

a/ Condition factor--K-factor = $\frac{\text{wt (gm) x } 100{,}000}{\text{length (mm)}^3}$

Fish for Test T1A were reared on reuse water until 13 April 1982 when they were pumped from the reuse water pond (48°F) in System II to raw North Fork Clearwater River water (40°F) in another pond in System III and held for 6 days before being transported on 19 April to the barge at Lewiston, Idaho. Pumping of this test group to an alternate pond was required to duplicate the successful test treatment in the 1978 Dworshak NFH experiment (Slatick et al. 1982).

All test groups were loaded directly into fish transport trucks via fish pumps and transported to Lewiston, Idaho, on the Clearwater River (approximately 40 miles downstream) where they were off-loaded into a fish transport barge and held in recirculated Clearwater River water for approximately 16 h. The barge then traveled downstream with stops at Lower Granite, Little Goose, and McNary Dams to load fish as part of the transport program operated by the U.S. Army Corps of Engineers (CofE) (Figure 1) (Basham et al. 1983). Fish were released during darkness into the Columbia River below Bonneville Dam at Skamania Light (RM 140).

Serial releases of test fish (barged to below Bonneville Dam) were made on 19 April, 30 April, 19 May, and 31 May 1982 (Table 1). Paired control groups (fish released as normal hatchery production into the Clearwater River) were released with the first three tests. In the interest of marking fewer fish, no control group was released with the last test.

The general health and status of smoltification of each experimental group were monitored from mid March until they were released from the hatchery. This portion of the project was carried out under subcontract to the University of Idaho (U of I), Moscow, Idaho 83843.

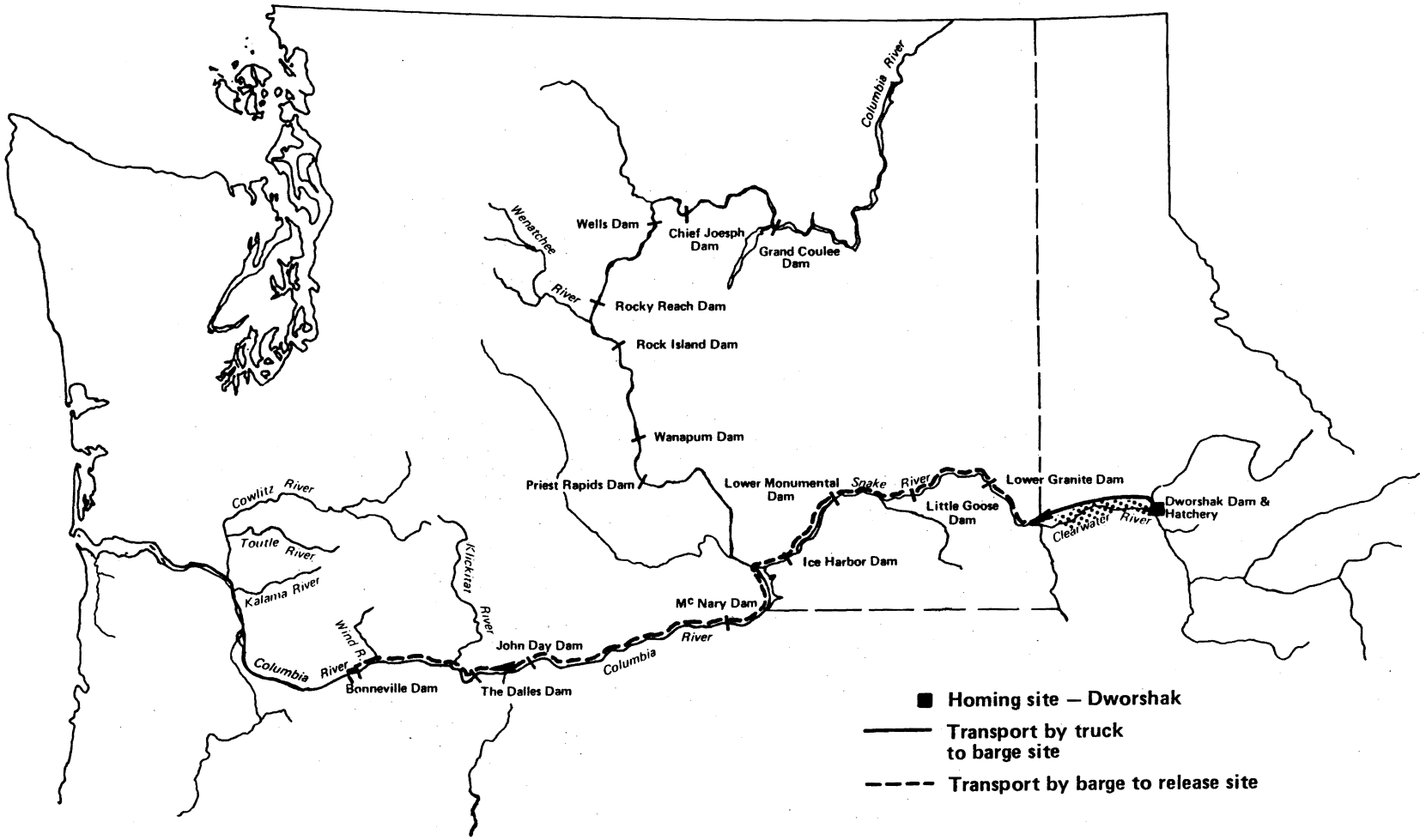

Figure 1.--Study area germane to the 1982 homing experiment with steelhead from Dworshak National Fish Hatchery.

RESULTS

Recapture of Smolts at Dams and in the Estuary

Juveniles from control groups released at the hatchery were monitored at Lower Granite, McNary, and John Day Dams to determine their estimated passage and survival and the number of fish transported in the CofE operation. According to Sims et al. (1983), a high percentage of the control releases reached Lower Granite Dam, and a high percentage were subsequently transported (Table 3). The estimated survival of steelhead for the three control releases to Lower Granite Dam was near 100%, and overall, 57% were transported from Lower Granite, Little Goose, and McNary Dams. Survival of the nontransported controls to John Day Dam was only 1.9 to 3.4%--based on estimated passage of 2,390 fish at John Day Dam out of the 39,497 marked fish that were not collected and transported (Table 3). The apparent low survival of nontransported controls and large numbers of transported controls means that most of the controls that will be returning as adults will be those previously transported as juveniles. It is, therefore, likely that transport benefits shown for test fish will not be substantial.

A summary of recoveries from estuary sampling (Jones Beach, Oregon) is presented in Table 4. Dawley et al. (1983) indicate that recoveries of fish from test and control releases of the third and fourth treatment groups (released on 19 May and 31 May 1982) were substantially higher than from earlier releases of the first and second treatment groups (released on 19 April and 30 April 1982).

Table 3.--Estimated numbers of marked steelhead from control releases at Dworshak National Fish Hatchery that were either transported or migrated downriver of their own volition and survived to John Day Dam (Sims et al. 1983).

Control No.	Tag code	Number released (A)	Collected and transported[a]/ No. (B)	Collected and transported[a]/ %(B)/(A)	Volitional migrants at John Day Dam No. (C)	Volitional migrants at John Day Dam %(C)/(A)
C-1	23-6-6	29,838	19,559	65.6	1,000	3.4
C-2	23-16-4	31,048	14,986	48.3	595	1.9
C-3	23-16-2	31,714	18,558	58.5	795	2.5
Combined	-	92,600	53,103	57.3	2,390	2.6

a/ Transported from Lower Granite, Little Goose, and McNary Dams to release site in Columbia River below Bonneville Dam.

Table 4.--Marked steelhead from Dworshak National Fish Hatchery that were recovered at Jones Beach, Oregon, on the Columbia River in 1982.

Test Number	Coded wire tag code	No. fish recovered[a/]	% recapture of juvenile released	Date of median recapture
Control (C1)	23-6-6	14	0.047	5-11-82
Test (T1)	23-6-8	23	0.070	4-24-82
Test (T1A)	23-6-7	25	0.078	4-25-82
Control (C2)	23-16-4	22	0.071	5-20-82
Test (T2)	23-16-5	14	0.043	5-05-82
Control (C3)	23-16-2	112	0.353	5-29-82
Test (T3)	23-16-3	69	0.234	5-23-82
Test (T4)	23-16-1	126	0.395	6-04-82

a/ Numbers adjusted for catch effort.

Adult Returns

The first recoveries of marked experimental fish returning as adults are expected in the fall of 1983. Returning adults will be sampled at the in-river sampling facilities located at Bonneville, McNary, and Lower Granite Dams. The marked adults will be identified as to treatment groups by their brands; they will then be jaw-tagged and released to provide additional information at upriver recovery areas. An intensive sampling effort will be conducted on the Indian fishery (Columbia River Zone 6), sport fishery, hatcheries, and at the Dworshak NFH homing site. This sampling effort will be coordinated with state and federal sampling agencies for maximum recovery efficiency.

The adult return data from these experiments will be collected in the form of counts; discrete multivariate analysis will be used to statistically compare test and control treatments (Bishop et al. 1975). In this procedure, the treatments are structured as contingency tables, and significance is determined by the chi-square statistic.

Juvenile Fish Health and Smoltification

The investigators from the U of I concluded that based on physical, physiological, and histopathological observations, there was no reason to assume that the fish sampled were anything other than clinically healthy. The complete report of studies is presented in Appendix A.

Juvenile smoltification analyses based on gill Na^+-K^+ ATPase levels were also reviewed in the U of I report. Unfortunately, two sample groups of tissue were treated erroneously, resulting in questionable data which may compromise conclusions drawn from Na^+-K^+ ATPase studies in 1982.

SUMMARY

1. In 1982, a 5-year study was initiated to determine if steelhead smolts from Dworshak NFH that were transported downriver by barge and released below Bonneville Dam would contribute a higher percentage of returning adults than smolts released at the hatchery to migrate downriver of their own volition.

2. The first year of research concentrated on marking and releasing 252,079 steelhead smolts. A total of five barge transport test groups and three paired control groups of approximately 30,000 fish each were marked and released at about 10-day intervals.

3. A significant number of the controls were transported to below Bonneville Dam by the routine CofE transportation operations at Lower Granite, Little Goose, and McNary Dams. Recoveries of control fish at Lower Granite, McNary, and John Day Dams indicated a high survival rate to Lower Granite Dam and a low survival of the nontransported fish from there to John Day Dam. As a result, very few actual controls (those not transported) are therefore predicted to be returning as adults. This will be an important consideration when calculating transport benefits based on returning adults. Estuary recaptures suggest that survival and movement rates were higher for the fish released late in the season (released on 19 May and 31 May 1982) than for those released early in the season (19 April and 30 April).

4. The general health of each marked group of fish was monitored through analyses of body measurements; Na^+-K^+ ATPase levels in gill tissues; prevalence of Renibacterium salmoninarum in kidney tissues; and

the histopathological conditions existing in the gill, olfactory, and optic tissues. The fish sampled were generally determined to be clinically healthy.

ACKNOWLEDGMENTS

Support for this research came from the Pacific Northwest's electrical ratepayers through the Bonneville Power Administration.

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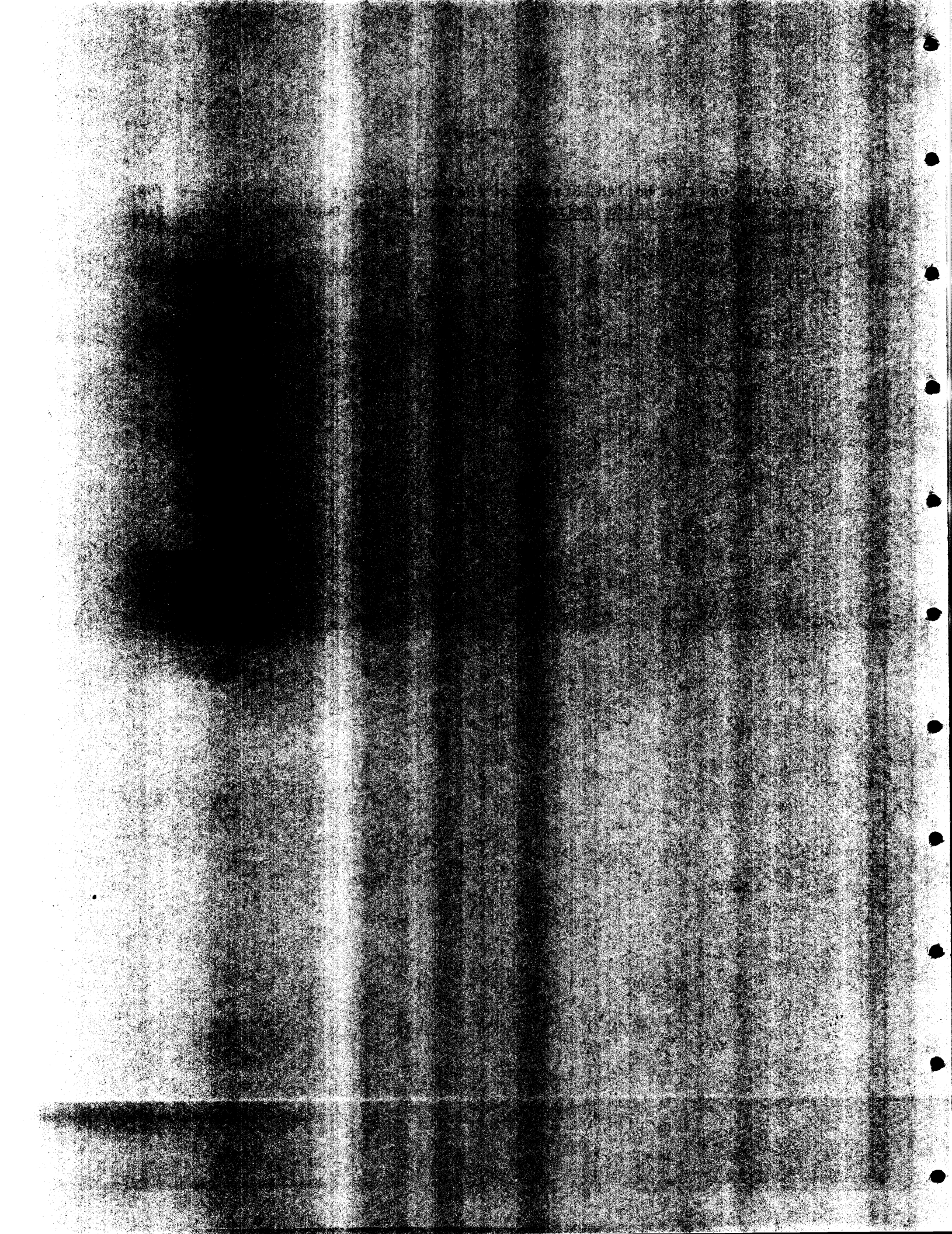

A REPORT OF THE HEALTH STATUS OF SELECTED GROUPS OF BROOD YEAR 1981 STEELHEAD TROUT (*SALMO GAIRDNERI*) RAISED AT THE DWORSHAK NATIONAL FISH HATCHERY

by
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National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Clarkston, Washington

1 November 1982

INTRODUCTION:

This report covers work performed under Contract No. 41 USC 252 (c) (3) during the period 3 March 1982 through 30 September 1982.

OBJECTIVE:

The objective of the study was to assess the general condition of health in groups of juvenile steelhead trout smolts released at intervals from the Dworshak National Fish Hatchery, Ahsaka, Idaho, during the period 23 March 1982 through 28 May 1982. The general condition of health was to be assessed through the following analyses: body (forklength) measurements; Na^+-K^+ ATPase levels in gill tissues; prevalence of Renibacterium salmoninarum in posterior kidney tissues; and the histopathological conditions existing in the gill, olfactory, and optic tissues.

SAMPLING METHODS:

1) Identification of Sample Groups:

Eight groups of fish were identified for the 1982 sampling. All groups were from egg take #8 of the 1981 brood, North Fork Clearwater strain of steelhead trout. The eight groups were divided into test and control lots, identified by a freeze-brand, and further divided into four release groups (Table 1). The established release dates were 19 April 1982, 30 April 1982, 19 May 1982, and 31 May 1982. All groups were in System II ponds at Dworshak NFH.

2) Sampling Collection and Preparation:

A sampling schedule and sequence were established (Table 2). At sampling time, the required number of fish were selected at random from the designated pond by a dip net and placed into a bucket of water. The fish

Table 1: Group identification and numbers during the 1982 sampling period at Dworshak NFH.

Group no.	Pond no.	Release date	Brand	Initial head-count	T/C[a] no.
1	26	4-19-82	RA L/4	37,113	T1
2	20	4-30-82	RA L/2	36,815	T2
3	16	5-19-82	RA)(/1	36,887	T3
4	12	5-31-82	RA L/1	37,114	T4
5	24	4-19-82	RA L/3	37,119	T1A
6	22	4-19-82	LA K/3	36,826	C1
7	18	4-30-82	LA K/2	36,764	C2
8	14	5-19-82	LA K/1	37,131	C3

[a] T = Test; C = Control

Table 2: Sampling schedule and number of fish per sample by group for 1982 at Dworshak NFH.

Sampling date	Number of fish sampled					
	3/23	4/8	4/19	4/29	5/17	5/28
Group no.						
1			30			
2				30		
3					30	
4	30	30	30	30	30	60
5			30			
6			30			
7				30		
8					30	

were taken to the facility laboratory and anesthetized in MS-222 (tricaine methanesulfonate, Ayerst Laboratories). Individual fish were measured (fork length to the nearest mm) and exsanguinated by caudal penduncle severance. The first right gill arch was removed, placed into a numbered vial containing an ATPase preserving solution and frozen in liquid nitrogen. The second right gill arch was removed and placed into a numbered vial containing 10% neutral buffered formalin. Also, into the same vial was placed a portion of the posterior kidney and the head severed just posterior to the eyes. Another portion of the middle and posterior kidney was placed into a numbered plastic bag and frozen at -40°C for subsequent examination for R. salmoninarum, the causative agent of bacterial kidney disease (BKD).

The 3/23, 4/8, and 4/9 samples for gill Na^+-K^+ ATPase levels were removed from the liquid nitrogen after 2-3 hours and stored in a Revco freezer at -25°F. The 4/19, 5/17, and 5/28 gill samples were frozen directly in the -25°F freezer.

The frozen gill samples were shipped in dry ice via Greyhound Bus Lines to the NMFS Field Station at Cook, Washington (Table 3).

3) Histopathological Methods:

The formalin-fixed gill and kidney tissues were processed through the paraffin vacuum-imbedding technique, sectioned at 5 microns and stained using the alum hematoxylin-eosin Y technique. The formalin-fixed heads were cut sagittally, decalcified, and prepared for staining as in the gill and kidney tissues. Most of the sections were stained using the alum hematoxylin-eosin Y technique, and some were stained using the alum hematoxylin-eosin-phloxine-B technique.

Table 3: Schedule for submitting frozen gill samples to the NMFS Cook Field Station.

Arrival date	Sample group	Sampling date
5/26/82	1	4/19
	4	3/23
	4	4/08
	4	5/17
	5	4/19
	6	4/19
6/17/82	4	5/28
7/02/82	2	4/29
	3	5/17
	4	4/19
	4	4/29
	7	4/29
	8	5/17

4) Immunofluorescent Method:

On the day of examination, the frozen samples of kidney tissue were thawed. A section was removed and the cut surface imprinted on a slide and allowed to air-dry on a slide warmer at 60°C. Each imprint was overlayed with an amount of appropriately diluted anti-R. salmoninarum conjugated with fluorescein isothiocyanate serum (National Fisheries Research Center, Leestown, West Virginia). The slides were incubated in 100% humidified chambers for 15 minutes at room temperature (22-24°C), rinsed through two changes of phosphate buffered saline (pH 7.6), and through two changes of distilled water to remove the saline. After air-drying, the imprints were mounted with a PBS-glycerol medium and examined microscopically under oil immersion. A minimum of 20 fields per smear were examined, and the number of organisms per field recorded.

RESULTS:

1) Water Temperature:

The water temperatures at the scheduled times decreased from 47.7°F (8.72°C) on 23 March to 41.8°F (5.44°C) on 28 May 1982 (Table 4).

Table 4: Water temperatures at the time of the 1982 fish samplings from Dworshak NFH.

Date	Water temperature (°F)
23 March	47.7
8 April	47.0
19 April	42.0
29 April	42.5
17 May	44.0
28 May	41.8

2) Fork Lengths:

The fork lengths (mm) of individual fish show a gradual increase with time (Table 5). This is especially evident when the mean fork lengths and range of fork lengths recorded in the Group 4 samples are examined (Tables 6 and 7).

3) ATPase Analyses:

The samples taken for Na^+-K^+ ATPase levels in gill tissues were sent to the NMFS Field Station, Cook, Washington, in three shipments. The first, sent on 25 May 1982, was scheduled to arrive on 26 May 1982; however, it did not arrive until late the following day because of an error in routing during shipment. As a result, some of the samples were thawed and were unsuitable for ATPase determination. The specific samples unsuitable were from Group 4, the 3/23 and 4/8 samples.

In general, there was a gradual increase in gill Na^+-K^+ ATPase levels during the overall sampling period (Tables 8 and 9).

4) Prevalence of Renibacterium salmoninarum:

Using the method of direct immunofluorescence, R. salmoninarum, the causative agent of BKD, was detected only in samples collected on 17 May 1982 (Table 10). Since the samples were examined at several points in time by sampling date, it is possible to assume that the reagent(s) were contaminated with R. salmoninarum at that point in time. This assumption is somewhat validated by not detecting the organism in any other samplings of Group 4--before or after the 17 May sample. It is further validated by closely examining the histopathological sections of the specific fish involved and not detecting any evidence of pre-clinical BKD.

Table 5: Fork lengths of fish sampled from raceways at Dworshak, NFH prior to the 1982 release.

Sampling date	3/23	4/8	4/19				4/29			5/17			5/28
Pond no.	4	4	1	4	5	6	2	4	7	3	4	8	5
Fish no.													
1	176	181	135	132	140	166	120	170	205	137	205	184	130
2	172	192	201	129	146	190	185	175	140	199	137	205	195
3	114	134	196	210	189	124	170	185	155	232	202	165	185
4	154	156	208	136	155	220	155	185	165	202	194	192	195
5	142	178	184	201	132	155	150	200	165	132	180	174	150
6	144	215	140	106	216	161	165	205	150	114	126	145	165
7	163	182	206	204	221	191	135	150	170	187	189	203	160
8	165	190	142	190	118	196	170	145	185	83	226	186	175
9	128	174	168	142	105	159	165	170	190	190	176	170	175
10	161	101	140	197	138	205	200	185	145	127	207	198	195
11	134	113	190	177	190	179	220	190	160	170	186	168	210
12	143	160	166	105	168	146	175	190	175	149	192	135	180
13	166	135	124	190	196	110	160	180	175	207	144	180	145
14	160	168	172	165	184	224	155	160	190	195	211	200	135
15	138	139	186	125	158	209	135	165	155	127	159	178	195
16	95	119	182	182	195	152	170	180	205	178	155	128	205
17	115	121	178	173	171	212	205	160	210	165	170	159	195
18	199	140	104	198	123	171	185	145	150	218	134	191	190
19	113	90	194	170	157	185	190	140	175	210	164	185	175
20	134	195	93	175	149	143	165	175	165	182	196	196	185
21	164	180	132	149	135	155	155	190	165	109	184	188	150
22	145	117	204	219	176	178	180	185	190	174	130	150	155
23	170	115	138	194	231	213	205	185	195	159	173	219	140
24	138	132	179	191	127	128	210	155	205	116	167	165	165
25	142	120	200	184	170	118	145	140	145	130	150	203	175
26	157	87	217	180	174	193	155	210	185	205	220	220	155
27	119	170	193	188	210	200	170	205	190	215	121	190	190
28	128	205	127	169	169	135	165	190	160	218	205	218	195
29	139	185	188	161	160	212	145	160	185	180	139	181	210
30	116	199	191	175	193	188	180	165	170	194	225	234	195
31													210
32													180
33													185
34													170
35													170
36													165
37													205
38													155
39													210
40													170
41													175
42													180
43													180
44													155
45													205
46													185
47													165
48													170
49													175
50													175
51													155
52													150
53													180
54													200
55													195
56													205
57													180
58													180
59													165
60													160

Table 6: Average fork lengths (mm), range (mm), and standard deviations of lengths in sample groups of fish at Dworshak NFH.

Lot no.	Sampling date	Mean length (mm)	Length range (mm)	Standard deviation
1	19 April	169.26	93-217	33.310
2	29 April	169.50	120-220	23.647
3	17 May	170.13	83-218	39.176
4	23 March	144.47	95-176	22.994
	08 April	153.10	87-215	36.418
	19 April	170.56	129-219	30.097
	29 April	174.66	140-210	19.736
	17 May	175.56	121-226	30.905
	28 May	177.08	130-210	20.696
5	19 April	166.53	127-221	32.033
6	19 April	173.93	110-224	32.388
7	29 April	174.00	140-210	19.880
8	17 May	183.60	135-204	25.100

Table 7: Mean fork length (mm) and length range (mm) in sample groups by sampling times.

Sample date	Group 1	2	3	4	5	6	7	8	Mean
3/23				144.47 (96-176)					144.47
4/08				153.10 (87-215)					153.10
4/19	169.26 (93-217)			170.56 (129-219)	166.53 (127-221)	173.93 (110-224)			170.07
4/29		169.5 (120-220)		174.66 (140-210)			174.00 (140-210)		172.72
5/17			170.13 (83-218)	175.56 (121-226)				183.6 (135-204)	172.85
5/28				177.08 (130-210)					177.08

Table 8: Gill Na^+ - K^+ ATP-ase levels in steelhead trout sampled from Dworshak, N.F.H. during 1982.

Sampling Date:	3/23	4/8	4/19				4/29			5/17			5/28
Pond No.:	4	4	1	4	5	6	2	4	7	3	4	8	4
Fish No.													
1	5.5	5.6	5.9	12.9	-	14.7	9.3	15.0	9.5	7.5	18.2	12.1	14.4
2	1.1	6.6	4.7	10.8	2.0	15.6	18.3	12.4	14.6	9.7	9.0	13.1	13.4
3	2.4	2.5	3.6	13.8	4.3	5.1	17.0	18.0	9.4	8.9	11.6	8.6	17.3
4	1.5	2.7	15.2	10.4	5.6	8.3	19.0	5.5	11.5	12.0	12.6	8.1	10.6
5	-1.9	5.7	6.5	15.0	2.5	6.3	26.2	8.5	13.5	9.7	13.4	11.3	11.6
6	1.2	6.7	2.2	10.2	8.1	7.8	11.2	8.6	10.3	12.6	8.0	6.5	10.5
7	0.6	5.0	7.8	9.4	9.7	10.7	16.0	15.8	12.0	9.3	8.7	6.9	9.0
8	1.0	3.8	5.4	16.4	5.1	8.1	10.9	8.8	11.5	13.6	18.9	8.5	21.6
9		2.8	7.8	10.1	2.0	7.0	11.0	10.6	8.2	15.8	21.5	14.1	4.2
10		0.8	9.3	11.5	3.2	8.2	7.7	14.5	7.8	6.9	11.6	21.2	9.7
11		-1.2	11.3	16.5	10.2	13.3	6.3	11.8	4.8	12.8	14.5	18.6	-
12		4.8	3.7	10.5	9.9	3.2	11.5	10.3	7.5	6.8	16.3	10.8	8.7
13		2.9	3.1	13.9	7.1	5.2	6.0	7.7	4.6	18.0	10.7	17.4	10.9
14		0.2	7.2	9.7	12.7	9.3	11.4	7.3	10.1	12.8	10.3	9.9	9.4
15			13.4	4.4	9.5	9.7	15.3	22.7	6.3	-	11.7	18.0	22.2
16			14.6	10.3	8.0	10.0	11.8	19.9	14.3	14.3	6.7	10.7	7.5
17			7.5	8.9	7.3	21.9	12.3	14.6	5.9	10.0	12.8	16.1	4.7
18			-	8.9	3.0	11.8	10.1	16.8	16.7	11.3	7.0	16.7	14.9
19			10.6	5.6	11.4	11.2	15.1	10.7	6.1	8.3	9.7	16.9	15.1
20			1.8	6.4	5.4	7.8	12.7	13.5	8.1	9.8	8.9	17.1	19.9
21			1.5	5.3	6.5	10.0	9.2	8.2	10.3	3.4	16.1	12.9	16.3
22			10.2	13.1	7.6	8.5	8.1	6.3	9.6	5.4	7.5	13.7	11.2
23			4.3	6.7	13.5	4.6	10.4	5.9	8.3	7.4	6.4	17.9	10.9
24			2.2	12.3	5.3	5.9	14.6	9.8	10.1	6.0	5.0	15.7	9.8
25			6.1	8.7	5.7	8.4	9.3	4.6	11.3	4.7	4.6	12.9	10.9
26			9.8	7.5	3.0	12.5	10.4	11.7	7.7	8.4	11.2	11.0	11.4
27			14.8	8.9	4.8	5.1	7.2	10.9	21.8	9.5	4.8	13.5	3.4
28			6.8	9.6	4.7	9.8	9.3	11.4	11.9	11.8	8.8	18.0	12.5
29			7.5	8.9	6.2	10.3	14.9	9.6	11.0	13.1	7.7	13.9	8.1
30			8.5	15.3	9.2	12.9	12.0	11.3	8.5	9.3	10.0	11.5	7.1
31													7.5
32													12.2
33													23.9
34													13.2
35													25.5
36													12.8
37													12.9
38													11.5
39													11.9
40													14.3
41													15.2
42													11.3
43													21.1
44													13.5
45													24.3
46													9.6
47													15.0
48													13.3
49													15.0
50													14.2
51													19.9
52													13.5
53													13.7
54													21.5
55													19.7
56													16.7
57													7.4
58													16.2
59													11.2
60													13.4

Samples thawed - accurate analysis not possible.

Samples thawed - accurate analysis not possible.

Table 9: Statistical analyses of gill Na^+ - K^+ ATP-ase levels in Dworshak N.F.H. steelhead.

Sample Date		1	2	3	4	5	6	7	8	Mean
3/23/82	mean				1.43					1.43
	range				-1.9-5.5					
	st'd dev.									
4/8/82	mean				3.49					3.49
	range				-1.2-6.7					
	st'd dev.									
4/19/82	mean	7.49			10.39	6.67	9.44			8.49
	range	1.5-15.2			5.3-16.4	2.0-13.5	3.2-15.6			
	st'd dev.	4.02			10.39	3.15	3.84			
4/29/82	mean		12.15		11.42			10.10		11.22
	range		6.0-26.2		4.6-22.7			4.8-16.7		
	st'd dev.		4.29		4.31			3.62		
5/17/82	mean			9.96	10.80				13.45	11.40
	range			4.7-15.8	4.6-21.5				6.5-21.2	
	st'd dev.			3.37	4.27				3.82	
5/28/82	mean				13.36					13.36
	range				4.2-25.5					
	st'd dev.				4.99					

Table 10. Prevalence of Renibacterium salmoninarum in posterior kidney tissues of steelhead from Dworshak N.F.H.

Sampling Date	Sample Group 1	2	3	4	5	6	7	8
3/23/82				0/30				
4/8/82				0/30				
4/19/82	0/30			0/30	0/30	0/30		
4/29/82		0/30		0/30			0/30	
5/17/82			1/30	6/30				1/30
5/28/82				0/60				

5) Histopathological Examinations:

In general, there were no significant life-compromising histopathological changes observed in gills, kidneys, nasal sac, and post-orbital tissues (Table 11). The most consistent finding in the gill tissues was a mild to moderate lamellar hypertrophy, to which no clinical significance was attached. In one sampling (Group 4 on 4/19), there were several fish exhibiting lamellar necrosis. The clinical significance of this is unkown, but given the general histopathological conditions of the kidney, nasal, sac, and post-orbit tissues, it is unlikely that the gill condition was anything more than transitory.

The most consistent finding in the kidney tissues was a mild to moderate generalized fatty infiltration which was probably due more to dietary composition rather than to renal dysfunction, given the condition of the renal tubules and glomeruli. There were isolated instances of mild to moderate hydropic changes in the renal tubules, but no clinical significance was attached to this given the lack of more serious lesions in the renal tissues.

The nasal sac and post-orbit tissues were consistently without abnormalities. The observations of free blood in the nasal cavities of some samples was probably due to hemorrhage induced through sampling technique because the underlying tissue were without notable degenerative changes.

CONCLUSIONS:

Based upon the foregoing physical, physiological, and histopathological observations, there is no reason to assume that the fish sampled were anything other than clinically healthy. Throughout the 420

Table 11: Histopathological changes in gill, kidney, nasal sac, and post-orbital tissues of steelhead sampled in 1982 from Dworshak N.F.H.

Group No.	Sampling Date	Observations
1	4/19	Gills: Occasional mild epithelial-capillary separation and lamellar hypertrophy. Kidney: Some hydropic change and fatty infiltration. The larger fish were more affected. Nasal sac: No abnormalities noted. Post-orbital: No abnormalities noted.
2	4/29	Gills: Generalized mild hypertrophy and epithelial-capillary separation. Occasional mild to moderate lamellar engorgement. Kidney: Mild fatty infiltration. Nasal sac: Some free blood in nasal cavity (sampling technique?) Post-orbital: No abnormalities noted.
3	5/17	Gills: Generalized mild to moderate hypertrophy. Occasional focal hyperplasia and lamellar congestion. Kidney: Focal hydropic change. Nasal sac: No abnormalities noted. Post-orbit: No abnormalities noted.
4	3/23	Gills: Generalized mild lamellar hypertrophy. Kidney: Mild fatty infiltration. Nasal sac: No abnormalities noted. Post-orbit: No abnormalities noted.

Table 11: Continued

Group No.	Sampling Date	Observations
4	4/8	Gills: Generalized mild lamellar hypertrophy. Mild epithelial-capillary separation.
		Kidney: Mild fatty infiltration and hydropic change.
		Nasal sac: Some free blood in nasal cavity.
		Post orbit: No abnormalities noted.
	4/19	Gills: Mild terminal lamellar hypertrophy. Focal areas of lamellar necrosis with and without hemorrhage.
		Kidney: Mild to moderate fatty infiltration.
		Nasal sac: Free blood in nasal cavity.
		Post-orbit: Free blood in retro-orbital space.
	4/29	Gills: Mild focal terminal lamellar hypertrophy.
		Kidney: Mild fatty infiltration and hydropic change.
		Nasal sac: No abnormalities noted.
		Post-orbit: No abnormalities noted.
	5/17	Gills: Mild generalized lamellar hypertrophy. Occasional epithelial capillary separation.
		Kidney: Mild fatty infiltration.
		Nasal sac: No abnormalities noted.
		Post-orbit: No abnormalities noted.
	5/28	Gills: Mild generalized lamellar hypertrophy. Occasional lamellar hyperplasia.
		Kidney: No abnormalities noted except in two samples - one with marked renal tubular necrosis and one with intratubular crystals.
		Nasal sac: No abnormalities noted.
		Post-orbit: No abnormalities noted.

Table 11: Continued

Group No.	Sampling Date	Observations
5	4/19	Gills: Mild to moderate generalized lamellar hypertrophy. Occasional lamellar engorgement and lamellar hyperplasia. Kidney: Mild to moderate fatty infiltration and hydropic change. Nasal sac: No abnormalities noted. Post-orbit: No abnormalities noted.
6	4/19	Gills: Moderate lamellar necrosis with hemorrhage. One sample with a mild Dermocystidium infection. Kidney: Mild to moderate fatty infiltration and hydropic change. Nasal sac: Some samples with free blood in nasal cavity. Post-orbit: No abnormalities noted.
7	4/29	Gills: Mild generalized hypertrophy. Kidney: Mild generalized fatty infiltration. Nasal sac: No abnormalities noted. Post-orbit: No abnormalities noted.
8	5/17	Gills: Mild focal lamellar hypertrophy. Several fish with moderate epithelial capillary separation. Kidney: Mild generalized fatty infiltration. Nasal sac: No abnormalities noted. Post-orbit: No abnormalities noted.

fish examined intensively, there was not a single indication of a potentially life-compromising condition. The gill tissues were in the best condition of any ever examined from a hatchery environment.

If there were one recommendation to be made from these observations, it would be to evaluate the influence of dietary composition and feeding rate on the presence of fatty infiltration in the kidney. Another suggestion would be to examine more fish from more facilities to gain a broader base of knowledge.