Evaluation of the Juvenile Fish Collection, Transportation, and Bypass Facility at Little Goose Dam, 1990

by
Bruce H. Monk,
Benjamin P. Sandford,
and John G. Williams

April 1992

COASTAL ZONE AND ESTUARINE STUDIES

EVALUATION OF THE JUVENILE FISH COLLECTION, TRANSPORTATION, AND BYPASS FACILITY AT LITTLE GOOSE DAM, 1990

by

Bruce H. Monk,
Benjamin P. Sandford,
and
John G. Williams

Annual Report of Research
Funded by
U.S. Army Corps of Engineers
Walla Walla District
Project E86900057

and

Coastal Zone and Estuarine Studies Division
Northwest Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
2725 Montlake Boulevard East
Seattle, Washington 98112-2097

April 1992

CONTENTS

INTRODUCTION

The juvenile fish collection and bypass facility at Little Goose Dam was constructed in 1971 by the U.S. Army Corps of Engineers (COE) and the National Marine Fisheries Service to study the benefits of juvenile salmonid transportation (Trefethan and Ebel 1973). In 1981, this facility became part of the mass transportation program operated by the COE. Several areas of concern arose during the years of facility operation. At times, the physical condition of juvenile salmonids at the facility was poorer than expected, and it was thought that this could be related to the hydraulics of the pipe that carried juveniles from the powerhouse collection system to the juvenile handling facility. In addition, there were concerns about the lack of an adequate barge loading area, the lack of sufficient gravity flow at high tailwater for barge loading, insufficient raceway capacity, and a need for a better outfall location for fish bypassed at the dam. To resolve these problems, a new juvenile fish collection, transportation, and bypass facility was constructed downstream from the exit of the original collection gallery prior to the 1990 outmigration.

Pertinent features of the new system include: 1) primary and secondary dewatering systems off the end of the original powerhouse collection gallery; 2) an open corrugated transport flume (1.5-ft radius) extending from the dewatering section to either the juvenile fish facility (approximately 1,130 ft total distance) or to a surface exit at the river approximately 150 ft offshore and 10 to 15 ft above the water surface (approximately 1,900 ft total distance with an elevation change of 80 ft); 3) an emergency bypass pipe, which consists of two entrance chambers (above and below the dewatering section) leading into a 1,200-ft pressurized pipe that exits 200 ft offshore at a depth of 10 to 15 ft; 4) a new wet separator, and new raceways and loading facilities; 5) new sampling and holding facilities; and 6) a new laboratory-office building for enumeration and examination of sampled fish (Figs. 1-2).

Our research objectives in 1990 were 1) to determine if there were any areas in the new facility which caused either excessive descaling, injury, or stress to juvenile or adult salmonids and 2) to evaluate the reliability and efficiency of the new sampling system. Because the new juvenile fish facility will handle an estimated 3 to 3.5 million juvenile salmonids and over 3,000 adult salmonids (as fallbacks) annually, it was important to evaluate the entire system early in the spring so that any major problems could be corrected before the principal 1990 spring migration arrived at the dam.

OBJECTIVE 1 - DETERMINE IF THE CONDITION AND SURVIVAL OF JUVENILE SPRING CHINOOK SALMON, JUVENILE STEELHEAD, AND ADULT STEELHEAD ARE ADVERSELY AFFECTED BY PASSAGE THROUGH THE COLLECTION FACILITY

Approach

Mortality and Injury Evaluation

To determine if there were any areas in the new facility that caused injury or descaling to juvenile fish, we released marked groups of hatchery fish (and, in one case, a mix of hatchery fish and in-river migrants) into selected sections within the system and recaptured them at various downstream locations. The quality of each section of the collection facility was then determined by examining the fish for descaling and eye/head injuries; some of the release groups were then held for 48-hour delayed mortality tests. The hatchery fish used were yearling chinook salmon, Oncorhynchus tshawytscha, and steelhead trout, O. mykiss, that were transported from Dworshak National Fish Hatchery (NFH), then anesthetized, marked with a caudal fin clip, and held for 48 hours in holding tanks before release into selected sections of the collection facility. These hatchery fish were not as smolted as in-river migrants and did not descale as easily; however, it was

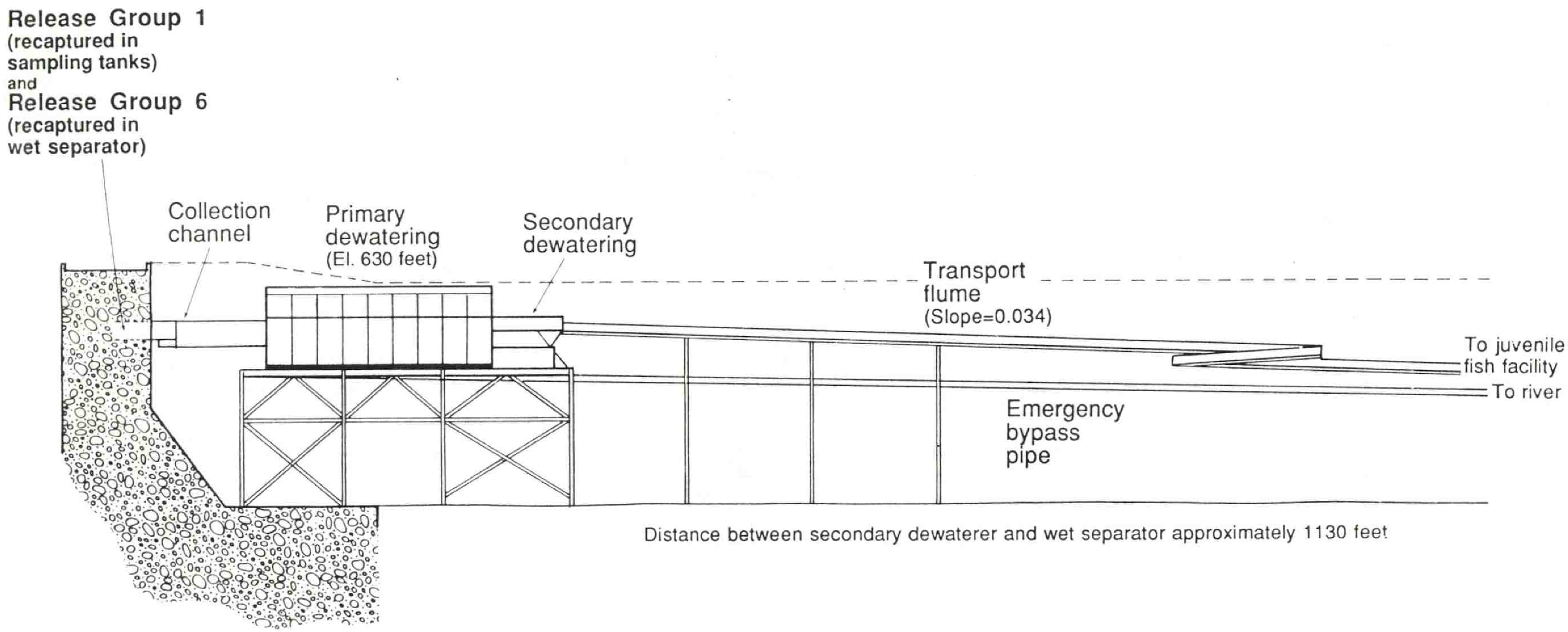

Figure 1.--Plan and elevations of the upper section of the juvenile fish collection facilities at Little Goose Dam, showing release sites for for test groups of juvenile and adult salmonids.

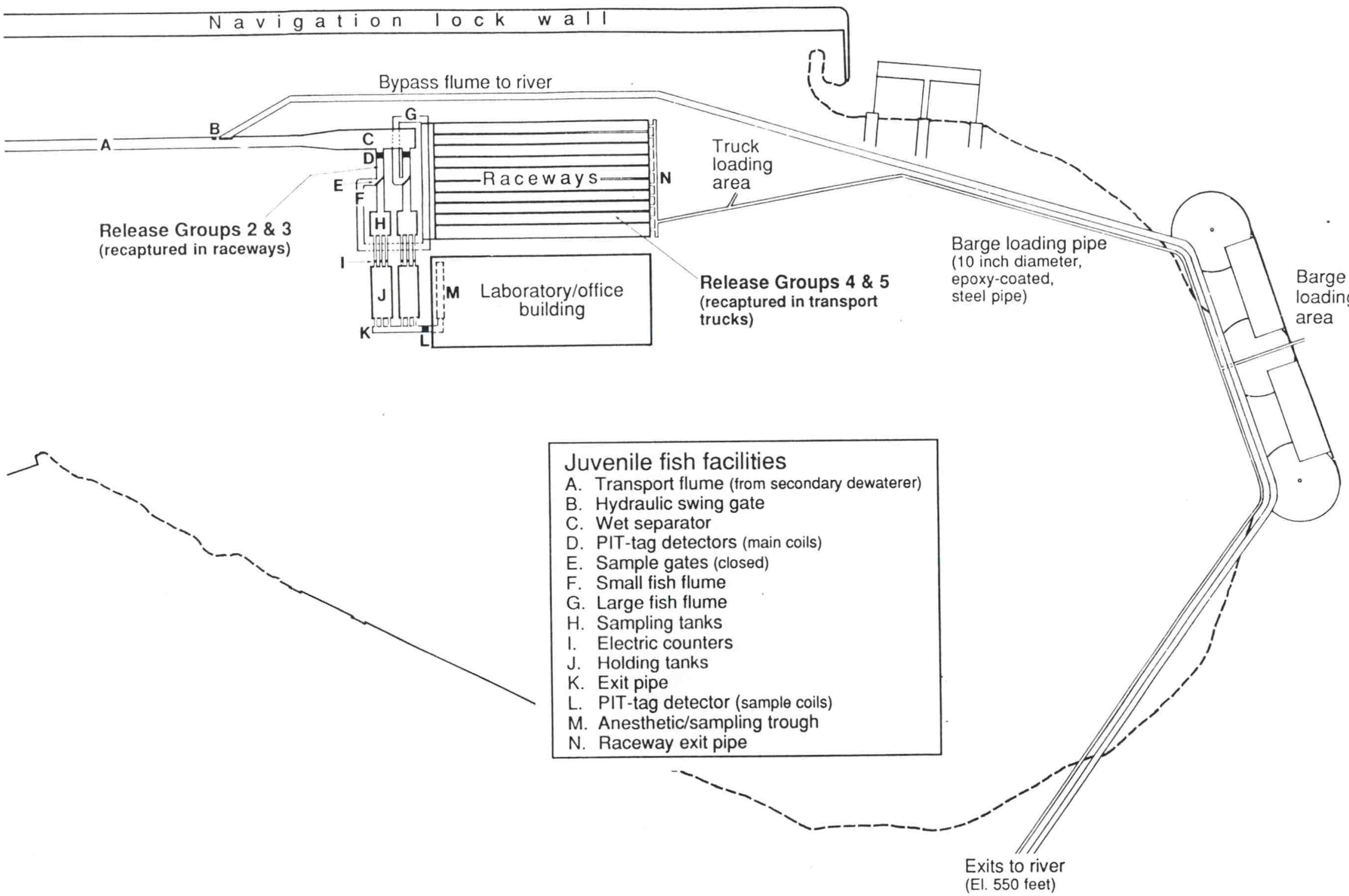

Figure 2.--Overhead view of lower section of juvenile fish facilities at Little Goose Dam, showing release and recapture sites for test groups of juvenile and adult salmonids.

necessary to use these fish so that changes or modifications to the facility could be made prior to the principal spring outmigration.

Releases were made 1) into the bypass gallery (at Unit 1) and recaptured in the sample holding tank (Test Group 1); 2) into the collection flumes (which go directly to the raceways just downstream from the wet separator and bypass the sample flumes) and recaptured in the raceways (Test Groups 2 and 3); and 3) from the raceways, into the raceway exit pipe and recaptured in the transport trucks (Test Groups 4 and 5) (Table 1 and Figs. 1-2). Test Group 1 consisted of two replications for each species, which were identified by an upper or lower caudal fin clip.

Test Group 1 evaluated potential injury during fish travel from the bypass gallery, through the dewatering section, transport flume, wet separator, and sample holding facilities. These fish were released from the forebay deck (El. 651 ft.) into the south end of the collection gallery (Unit 1-A) at the water surface. The release was through a 4-in, 12 ft long hose into a 10-in PVC pipe that exited at the surface of the collection channel (El. 630 ft). To recapture all of the fish from Test Group 1, the facility sampler was set at 100%, and all fish exiting the wet separator were collected in the sample holding tanks. A large percentage of both the yearling chinook salmon (70%) and steelhead (85%) remained in the wet separator after the initial release, taking from 1 to 12 days to pass into the sample holding tanks. Therefore, fish were crowded from the holding tanks into the sampling trough (located in the laboratory-office building), enumerated, and checked for descaling and injuries every 24 hours. Because many of these fish remained in the wet separator for several days, no delayed mortality tests were conducted after the fish were recaptured.

The Test Group 2 and 3 releases were made to evaluate both the small-fish and large-fish flumes ("F" and "G" in Fig. 2) that transport fish from the wet separator to the

Table 1.--Groups of hatchery and migrating salmonids, released at various locations and times, recaptured and examined for descaling and eye/head injuries. Delayed mortality tests (48-hour) were conducted on Test Groups 4 and 5.

Test Group	Date	Purpose	Release location	Recapture location	Species	Source	N	Replicates
1	3/22 to 3/26	Evaluation of primary dewater, transport flume, wet separator, and sample holding facilities.	Bypass gallery	Lab/office building	Yr chinook	Hatchery	201, 199	2
					Steelhead	Hatchery	197, 192	2
2	3/26	Evaluation of flumes from wet separator to raceways.	Large-fish exit from wet separator	Raceway 4	Yr chinook	Hatchery	86	1
					Steelhead	Hatchery	44	1
3	3/26	Evaluation of flumes from wet separator to raceways.	Small-fish exit from wet separator	Raceway 5	Yr chinook	Hatchery	106	1
					Steelhead	Hatchery	20	1
4	3/29	Evaluation of raceway exit pipe and truck loading flume (before modifications).	Raceway 1	Transport truck	Yr chinook	Hatchery	288	1
					Yr chinook	In-river[a]	314	1
					Steelhead	Hatchery	124	1
					Steelhead	In-river[a]	47	1
					Sockeye	In-river[a]	46	1
5	4/13	Evaluation of raceway exit pipe and truck loading flumes (after modifications)	Raceway 2	Transport truck	Steelhead	Hatchery	1,139	1
6	3/28	Evaluation of effects of primary dewater, and wet separator on adults	Bypass gallery	Wet separator	Adult steelhead	Hatchery	11	1

[a] All in-river fish were collected from daily samples and only fish with no descaling and/or injuries were used.

raceways. Hatchery yearling chinook salmon and steelhead were released into these flumes just downstream from the wet separator, recaptured in the raceways, anesthetized with tricaine methane sulfonate (MS-222), and examined for descaling and eye/head injuries. Areas of concern in these two flumes were the two abrupt corners that are formed when the sample gates are closed (during normal, nonsampling operation), and the six 90° corners (three on each flume) through which fish pass traveling from the wet separator to the raceways. Because of the high velocity of fish and water at these corners, fish are forced up on the walls of the flume creating the potential for descaling or other physical injury.

Test Group 4 evaluated potential problems with the raceway exit pipe and the truck loading flume. This group was a combination of hatchery fish and in-river yearling chinook salmon, steelhead, and sockeye salmon, O. nerka (90-120 mm) that were collected at the facility and checked for descaling and injuries. It was necessary to add the in-river fish to increase the number of fish in the raceway, so that immediately after the raceway valve was opened, the test fish exited the raceway under velocities and densities similar to an actual release. Test Group 5 was a repeat of Test Group 4, (after modifications had been made to the facility), but consisted entirely of hatchery steelhead from Dworshak NFH. All of the fish from both test groups were held for 48-hour delayed mortality tests. In addition to these test releases, on 21 and 26 April and 4 and 9 May, in-river yearling chinook salmon and steelhead were sampled from a transport barge (immediately after normal loading operations) and examined for descaling and injuries.

Both the hatchery and in-river fish of all the test groups were examined prior to release; descaled or injured fish were not used. Descaling was determined by examining five equal parts per side on each fish; if any two areas on the same side were estimated to be 40% or more descaled, the fish was classified as descaled (Ceballos et al. 1991).

We also released 11 marked adult steelhead (Test Group 6) into the bypass gallery to assure that adults could pass through the primary and secondary dewatering systems and transport flumes without being injured. These prespawning adults from Lyon's Ferry Hatchery (average length 570 mm) were tagged with Floy[1] spaghetti tags and held for 48 hours before release. They were then recaptured on the wet separator and examined for descaling or physical injury.

Stress Evaluation

To measure levels of stress and fatigue caused by the new facility, groups of migrant yearling chinook salmon and steelhead (20 of each species) were sampled from five locations (with three replications). The five locations in the facility were as follows: 1) gatewell Slots 4A and 4B (for baseline levels); 2) the start of the transport flume (just downstream from the secondary dewatering section and designated as upper flume in Results and Discussion section); 3) between the end of the transport flume and the wet separator (designated as lower flume in Results and Discussion section); 4) the raceways, including a pre-barge sample; and 5) after loading into the transport barges (Fig. 2). To determine if the fish recovered from stress and fatigue while held in the raceways, blood samples were taken from fish in the raceway at 0, 2, 4, 6, and 9 hours from the time that fish density reached 0.5 lb fish per gal of water, and immediately before (pre-barge) and after being loaded into transport barges (approximately 17 to 21 hours in the raceways). Blood samples were analyzed for plasma cortisol, glucose, and lactic acid.

Because juvenile chinook salmon and steelhead tend to move through Columbia River hydroelectric projects in the evening (Sims et al. 1981, Gessel et al. 1986), fish were sampled in the first three locations between 1800 and 1900 h. This was done to maximize

---

[1] Reference to trade names does not imply endorsement by National Marine Fisheries Service, NOAA.

the possibility that fish sampled in these locations were from a single population moving through the facility and to ensure that we were not sampling fish that had remained overnight or longer in the system.

During normal fish holding operations at COE juvenile fish facilities, the maximum fish loading density is 0.5 lb of fish per gal of water. To conduct valid tests, we attempted to expose the fish held in the raceways to densities approaching this level; however, we needed to shorten the time during which fish were collected in the raceway (prior to the start of sampling). Therefore, the raceway crowder was moved up--before any fish were introduced--to reduce the size of the raceway by 1/2 or 3/4. Fish were then collected for 4 hours; thus, when the raceway sampling was started (denoted as 0-hour), individual fish in the sample population had actually been in the raceway from 0 to 4 hours and raceway densities ranged from 0.2 to 0.3 lb of fish per gal of water for the three replicates for both species. The density of fish in the sample raceway was estimated using the hourly sample count (from COE), and the species composition and average weight by species (from the daily index sample measured by Oregon Department of Fish and Wildlife, ODFW).

A standard dip-net was used to collect the fish as quickly as possible, and raceway samples were taken at night to minimize fright responses on the remaining fish. Sampled fish were immediately placed in 200 mg/L MS-222, a concentration that is not known to significantly alter plasma cortisol, glucose, or lactic acid values (Black and Conner 1964, Strange and Schreck 1978). Immediately after fish were completely immobilized, the caudal peduncle was severed and blood was obtained from the caudal vasculature with a 0.25-ml ammonium-heparinized Natelson capillary tube. Blood samples were centrifuged, and the plasma was separated and frozen immediately on dry ice. Plasma cortisol, glucose, and lactic acid were assayed at Oregon State University. Thawed plasma was assayed for cortisol using a radioimmunoassay, for glucose using the o-toluidine method, and for lactic acid using a fluorimetric enzyme reaction (Barton et al. 1986, Barton and Schreck 1987).

Standard errors (S.E.) and comparisons between means for all three parameters at the various locations and raceway times were calculated using Analyses of Variance (ANOVA) (Sokal and Rohlf 1981) with $t = 10$ treatments (locations/raceway times) and $n = 3$ replications (days) throughout the bypass season ($n = 2$ for pre-barge and barge groups). Subsamples of 20 fish from each replicate (day) were averaged before analyses (replicates were not pooled). Significance was established for $P \leq 0.05$. Fisher's Protected Least Significant Difference (FPLSD) method (Petersen 1985) was used to compare locations and/or raceway times. Results that differed by more than the FPLSD were judged to be significantly different.

Results and Discussion

Mortality and Injury Evaluation

Dewatering sections and transport flume--The marked yearling chinook salmon and steelhead groups passed quickly through the primary and secondary dewatering sections and transport flume into the wet separator, but remained in the wet separator for 1 to 12 days. Appendix Table 1 provides the daily collection numbers and descaling, injury, and mortality rates.

Averaged descaling, eye/head injuries, and mortality rates for the two releases of marked yearling chinook salmon were 0.3, 1.0, and 4.7%, respectively (Table 2). Sixty-eight percent of this mortality (13 of 19 fish) was caused by initial operational problems which were easily identified (Appendix Table 1). When fish were flushed from the holding tanks into the sampling trough, some became stranded in the exit pipe (K in Fig. 2) after the initial surge of water dissipated, and others swam against the flow into a

Table 2.--Percent mortality, descaling, and eye/head injuries of yearling chinook salmon and steelhead released into the bypass gallery and recaptured in the holding tanks (Test Group 1, Table 1), Little Goose Dam, 1990.

Species	Number released	Number recovered	Mortality[a]		Number examined	Descaling		Eye/head injuries	
			N	%		N	%	N	%
Chinook	400	401[b]	19	4.7	382	1	0.3	4	1.0
Steelhead	389	379[c]	23	6.1	356	1	0.3	1	0.3

[a] Moribund fish collected from the system, not delayed mortality.
[b] Total recovery for each release varied because a few fish were mutilated by anesthetic line pump, making it difficult to distinguish between upper and lower caudal fin marks.
[c] Total recovery less than release number because some fish were stranded in anesthetic line and not recaptured.

1.5-in diameter pipe used for flushing the system with anesthetic. These problems were alleviated by screening the entrance to the 1.5-in pipe and by releasing fish from the holding tanks, beginning with the pipes closest to the sampling building. The water remaining in the tank lines farthest from the building could then be used to flush fish into the laboratory-office building. As a permanent solution, a molded fiberglass pipe, without any joints and with more slope, was to be installed from the holding tank to the sampling trough prior to the 1991 outmigration.

The cause of the remaining six mortalities is not known. However, on 23 or 24 March, one of the flat metal straps holding the trash sweep brushes broke and was submerged in the primary dewaterer directly in front of the exit, where velocities approach 5 ft per second. This condition existed for 2 to 3 days before being noticed and remedied on 25 March. All of the eye/head injuries were on yearling chinook salmon examined from 23 to 26 March and all of the mortality was noted on 26 March; therefore, this could have been caused by the broken trash sweep--because the fish could have taken from 1 to several days to pass through the system. None of these six mortalities had obvious injuries, but all had been dead for 2 to 3 days before recovery.

Descaling and eye/head injury rates for the two marked steelhead releases were less than 1% (Table 2). The averaged mortality rate was 6.1% (for both release groups); however, most of this mortality seemed to result from the initial stress of transportation, marking, and release. During the 48-hour holding periods before the 25 and 26 March releases, mortality rates were 1.5 and 2.7% respectively; and the first day after each release, 32 and 35% of the fish collected were dead (Appendix Table 1). None of these fish showed any signs of descaling or other physical injury. The subsequent daily mortalities were much lower for each release, even after the fish had been in the system for 9 days, suggesting that the fish that endured the initial stresses of marking and release were not impaired or injured by the facility. Other than the first day mortalities and mortalities due to the obvious stranding problems mentioned above, there was only one other steelhead mortality in the release group.

Flumes exiting from small-fish and large-fish sides of wet separator--There was concern that, because of high velocities and abrupt corners in these flumes, fish would be descaled or injured; however, this did not seem to occur. Out of the 192 yearling chinook salmon and 64 yearling steelhead examined, there were no mortalities, descaling, or other obvious physical injuries.

Raceway exit flume (before and after modifications)--Descaling, eye/head injuries, and subsequent delayed mortality rates were high for the first group of fish loaded into a transport truck from raceways (29 March; Table 3). A large percentage of the injuries were contusions on the head, nasal area, and just anterior of the dorsal fin. There were also some cases where the skin in the head region had been cut and peeled away. It is not known why the injury rates and delayed mortality were substantially higher for the in-river fish. However, the lower descaling rate for the hatchery fish is probably because these fish were not smolted and therefore less susceptible to descaling.

From these results, we identified two areas that needed modification before the facility could be used for transportation operations. The first was the exit pipe from the raceway (N in Fig. 2) where upstream edges existed between each "Y" connection (from the raceway drain) and the adjoining coupling. On further examination, it was noted that upstream edges also existed at the entrance to each raceway drain where a nipple from the "Y" connected to the drain. All of these edges were approximately 3/8-in thick at the widest part and came to a blunt point because the edge had been beveled from the outside.

Table 3.--Percent descaling and eye/head injuries of marked hatchery and in-river juvenile salmonids loaded from raceways into a truck at Little Goose Dam, 1990 (Test Groups 4 and 5, Table 1).

Species	Number released	Descaling N	Descaling %	Eye/head injuries N	Eye/head injuries %	Delayed mortality N	Delayed mortality %
In-river fish, 29 March							
Chinook	314	46	14.6	25	8.0	15	4.8
Steelhead	47	6	12.8	1	2.1	3	6.4
Sockeye	46	12	26.1	1	2.2	3	6.5
Totals, averages	407	64	15.7	27	6.6	21	5.2
Marked hatchery fish, 29 March							
Chinook	288	1	0.3	7	2.4	1	0.3
Steelhead	124	1	0.8	1	0.8	1	0.8
Totals, averages	412	2	0.5	8	1.9	2	0.5
Marked hatchery fish, 13 April							
Steelhead	1,139	0	0.0	1	0.1	5	0.4

The second area requiring modification was the dewatering section located in the transition flume (10 ft upstream from the truck loading area, Fig. 2). This was designed to remove excess water from the 10-in diameter raceway exit pipe before fish and water entered the 10-in barge-loading pipe or were shunted into the truck-loading flume by a swing gate located approximately 5 ft downstream from the transition flume. Because the dewatering section worked insufficiently, water volume and velocity remained high. Because of the high water-velocity, fish were forced against the swing gate as they were shunted into the truck-loading flume. The lack of sufficient dewatering occurred for two reasons: 1) inadequate capacity of the porosity plate, and 2) inadequate capacity of the drain system to handle simultaneous discharge from the dewatering section and raceways operating at full capacity.

To fix the raceway exit pipe, the dewatering section of the transition flume, and problems in the laboratory-office building, the entire facility was dewatered from 2 to 12 April. During this time, the edges in the raceway pipe and in the barge loading pipe were smoothed. A 90° bend at the end of the raceway exit pipe was replaced with four 22.5° elbows to make a more gradual sweeping curve. To alleviate the problem in the transition flume, the porosity of the dewatering section was improved by drilling more holes in the porosity plate. Also, a piece of aluminum sheet metal was bent and placed in front of the swing gate in a sweeping curve, making the transition to the truck flume more gradual and keeping fish away from the flume wall.

These modifications were tested with hatchery steelhead from Dworshak NFH on 13 April (Test Group 5). The descaling and eye/head injuries on these fish were 0 and 0.1% respectively (Table 3). The types of injuries that appeared in the 29 March release--contusions and abrasions on the head and body--did not appear in the 13 April release.

The only injury was a torn operculum on one fish. This decrease in injuries indicated that the major problems caused by the edges in the raceway exit pipe had been alleviated.

On four separate dates, yearling chinook salmon and steelhead that were sampled for blood analyses after being loaded from the raceways onto the transport barge were also examined for descaling and eye/head injuries (Table 4). The descaling rates for these fish ranged from 4.5 to 10.7%, which was comparable to descaling rates measured on sample fish (prior to the raceways) on the same dates (pers. commun., William Knox, ODFW). The eye/head injuries ranged from 0.0 to 1.8% with a weighted mean of 0.4%

Although the modifications to the raceway pipe and the truck-loading flume solved the main injury and descaling problems, they were considered temporary. Permanent solutions are scheduled as part of the clean-up contract and include a one-piece molded fiberglass pipe to replace the raceway exit pipe, a bar screen in the dewatering section of the transition flume to replace the porosity plate, and a separate drain line to handle the increased discharge.

<u>Adult travel through primary and secondary dewatering section and transport flume</u>--No descaling, eye/head injuries, or mortalities were observed on any of the 10 adult steelhead released into the bypass gallery and recaptured on the wet separator. However, the median time for passage through the system was almost 13 hours (Fig. 3). The tagged fish were observed along the sides of the primary dewatering section and on the bottom of the flume under a hydraulic jump section, just upstream from the wet separator. On 2 April, when the system was dewatered, one of these fish still remained in the primary dewaterer (after 118 hours) and had to be removed, along with 10 other non-marked adult steelhead.

Table 4.--Percent descaling and eye/head injuries of marked hatchery and in-river juvenile salmonids sampled from the transport barge immediately after loading at Little Goose Dam, 1990.

Species	Number released	Descaling N	Descaling %	Eye/head injuries N	Eye/head injuries %
In-river fish, 21 April					
Chinook	150	16	10.7	0	0.0
In-river fish, 26 April					
Chinook	160	17	10.6	1	0.6
In-river fish, 4 May					
Chinook	161	15	9.3	0	0.0
In-river fish, 9 May					
Chinoook	112	10	8.9	2	1.8
Steelhead	110	5	4.5	0	0.0

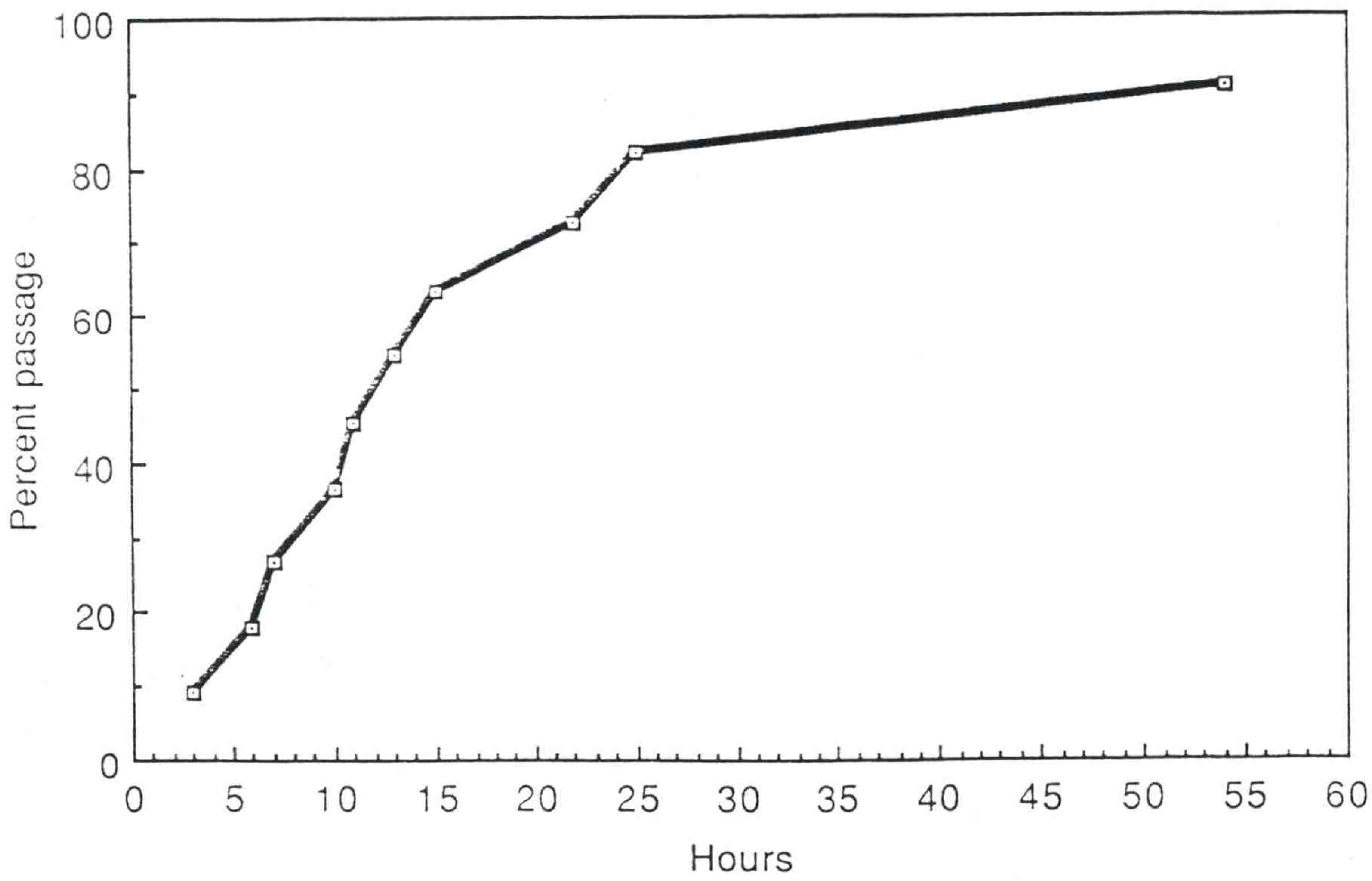

Figure 3.--Percent passage of 11 adult steelhead released into the bypass gallery (Unit 1) and recaptured on the wet separator at Little Goose Dam, 28 March 1990. (One fish remained in primary dewaterer.)

Stress Evaluation

Cortisol, lactic acid, and glucose levels all increased significantly for yearling chinook salmon as they passed from the bypass gallery into the raceways. Cortisol levels in yearling chinook salmon increased moderately as fish moved through the transport flume and again from the wet separator to the raceway, with a significant overall increase from the gatewell and upper flume (primary and secondary dewaterers) to the raceway (Fig. 4). As seen by Maule et al. (1988) at McNary Dam, these cortisol levels indicated that the stresses caused by fish passage through a collection system are cumulative and that cortisol will continue to increase even after fish have been in the raceways for 2 to 3 hours. In our studies, cortisol levels did not significantly decrease until the fish had been in the raceways for 6 hours, then remained low until the fish were loaded onto a barge (approximately 17 hours later). This pattern of increase and later decrease was also similar to that of migrating juvenile fall chinook and spring chinook salmon at McNary Dam (Maule et al. 1988) and hatchery acclimated chinook salmon subjected to handling stresses (Strange et al. 1977).

Changes in plasma glucose levels for yearling chinook salmon were similar to those of cortisol; concentrations increased somewhat as fish entered the raceway (0-hour), but not significantly, then increased sharply and significantly between the 0-hour and 2-hour periods (Fig. 4). Glucose levels then remained nearly constant in the raceway through the 9-hour period, but then significantly decreased during the pre-barge loading period. Levels again increased significantly after loading the fish onto the barge.

Lactic acid levels also showed a stress pattern in yearling chinook salmon that was similar to those suggested by plasma cortisol and glucose levels, except that the significant increase in lactic acid (from 55 to 75 mg/dl) occurred from the gatewell to the upper flume (Fig. 4). After the fish had been in the raceways for 4-hours, lactic acid

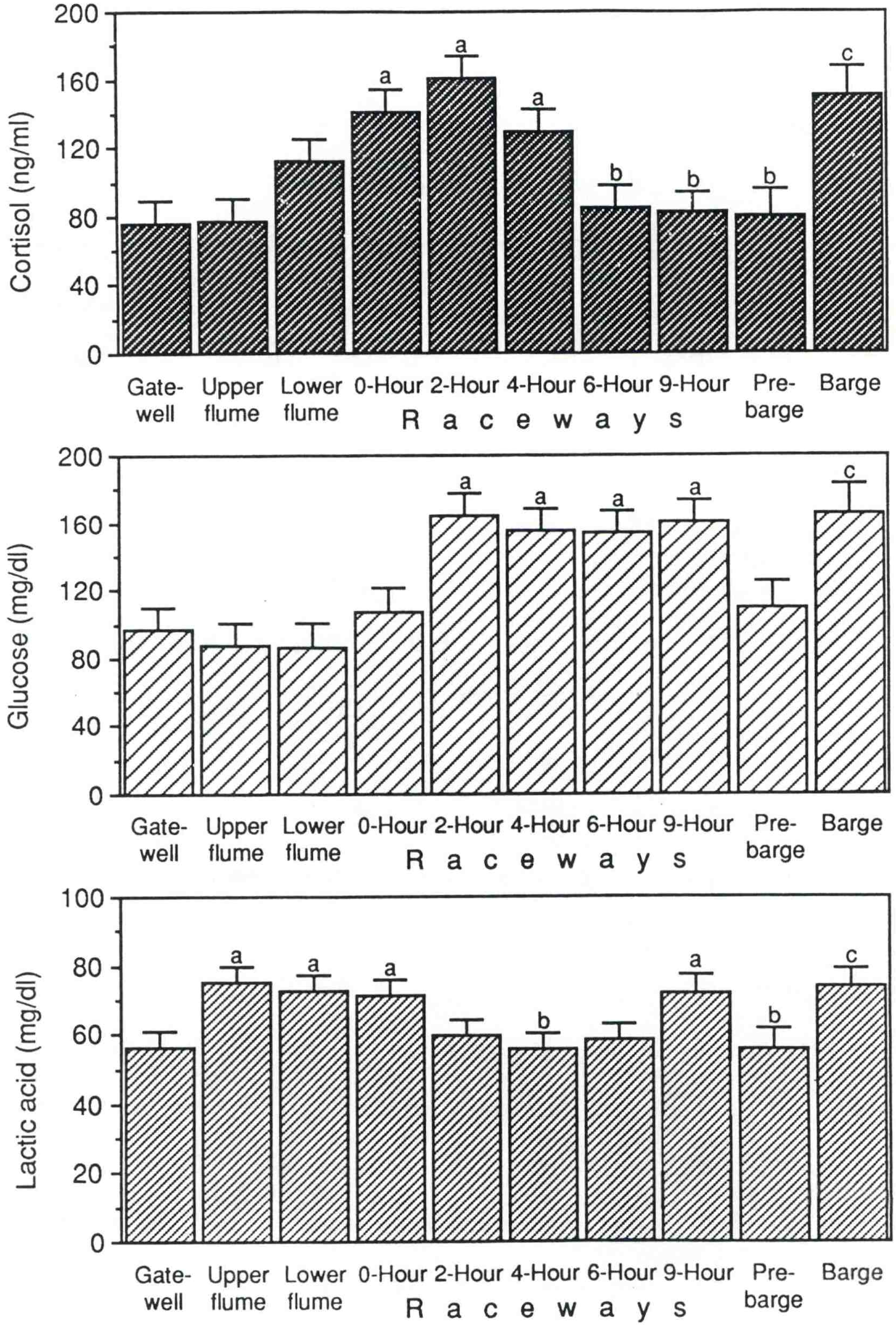

Figure 4.--Mean concentrations (+ S.E., n = 3) of plasma cortisol, glucose, and lactic acid for yearling chinook salmon sampled at five locations (fish in raceway sampled at six different times) in the collection and transportation facility at Little Goose Dam, 1990. Bars marked (a) are significantly higher than gatewell levels, bars marked (b) are significantly lower than 0-hour raceway levels, and bars marked (c) are significantly higher than pre-barge levels.

levels had decreased significantly to approximate gatewell levels. The increase from the 6-hour to the 9-hour raceway period was marginally significant, but the increase apparently was not sustained, as concentrations measured the following day (prior to barge loading) decreased to previous levels.

For steelhead, cortisol levels increased significantly as the fish traveled from the gatewell to the upper flume, increased slightly between the upper and lower flume, and then dropped steadily until reaching near-gatewell levels by the 4-hour raceway period (Fig. 5). The total decrease between the lower flume and 4-hour raceway period was significant. Cortisol levels then increased significantly between 6-hour and 9-hour raceway periods. Since the 9-hour raceway sample was taken at daybreak (0600 h), this could have been a response to the increase in light intensity and/or a measure of a diel variation in cortisol levels (Congleton et al. 1988, Congleton and Wagner 1988).

Glucose levels for steelhead remained nearly constant throughout the system; however, passage through the system produced a nonsignificant increase from about 120 mg/dl at the lower flume to about 150 mg/dl by the 2-hour raceway period (Fig. 5).

Lactic acid levels in steelhead increased significantly from the gatewell to the upper flume, stayed fairly constant through the lower flume, the wet separator, and into the raceway, then dropped significantly from the 0-hour to 2-hour raceway period (Fig. 5). Levels then remained constant until the 9-hour raceway period, at which time the levels increased slightly, but not significantly.

In summary, levels of plasma cortisol, glucose, and lactic acid generally showed significant increases as yearling chinook salmon and steelhead passed through the primary dewaterer and flume and into the raceways; however, they returned to nearly gatewell levels within several hours in the raceways. These increases appeared within the normal range of responses for both species. The highest average cortisol value

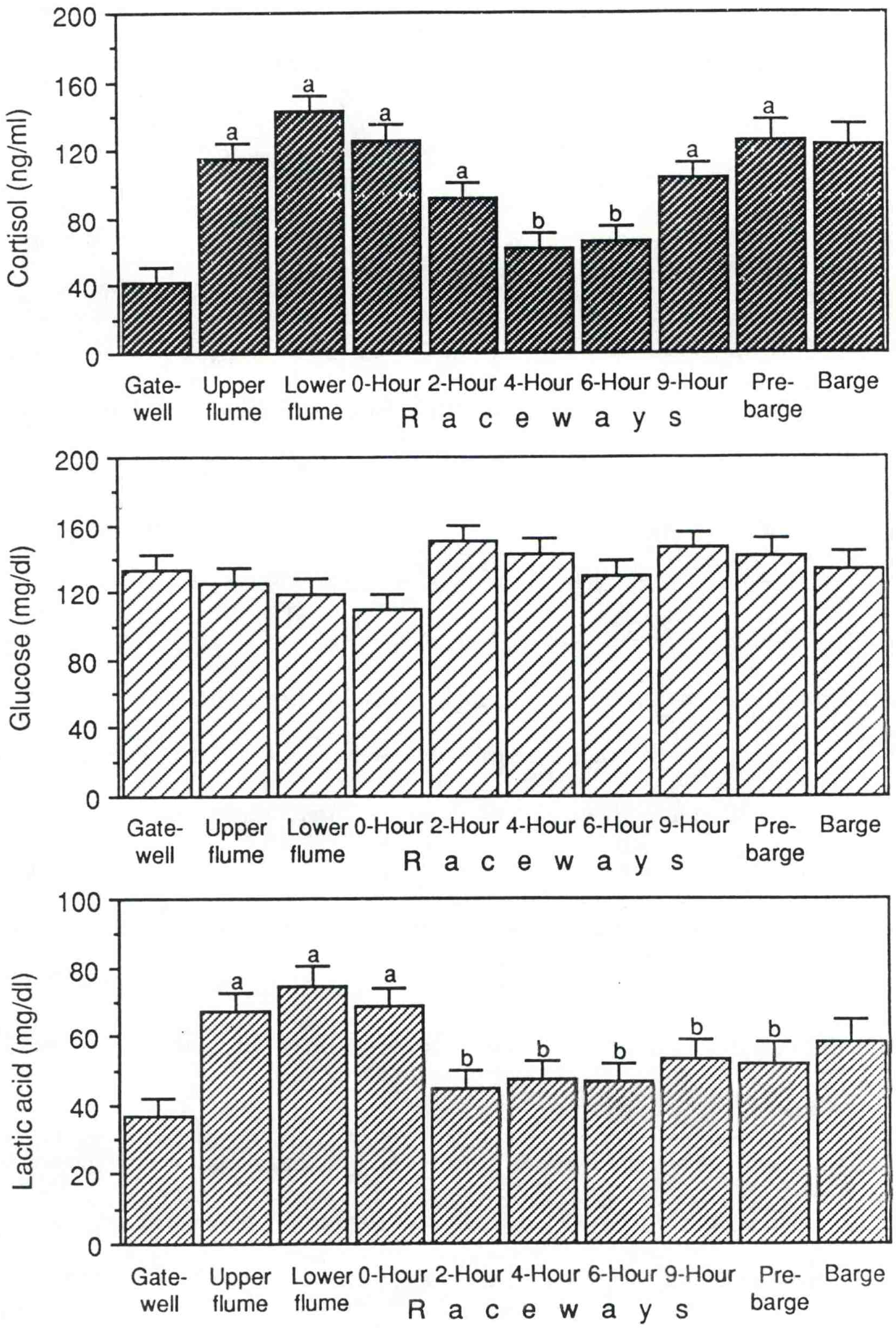

Figure 5.--Mean concentrations (+ S.E., n = 3) of plasma cortisol, glucose, and lactic acid for steelhead sampled at five locations (fish in raceway sampled at six different times) in the collection and transportation facility at Little Goose Dam, 1990. Bars marked (a) are significantly higher than gatewell levels and bars marked (b) are significantly lower than 0-hour raceway levels.

observed for yearling chinook salmon--160.5 ng/ml at the 2-hour raceway period--was at the low end of the range as measured by Congleton et al. (1984) for this species above and below the wet separator at Lower Granite Dam (160-210 ng/ml). These values were also well below those measured by Matthews et al. (1987) for yearling chinook salmon after they were marked at Lower Granite Dam.

The pooled-plasma glucose levels for yearling chinook salmon were slightly higher than measurements obtained by other researchers (Matthews et al. 1987, Maule et al. 1988), but the trends and the persistently high levels were similar. Because changes in glucose are a secondary metabolic response brought about by changes in endocrine levels (both corticosteroids and catececholamines), the response time is longer and stresses of short duration show increased blood glucose levels of rather long duration (Mazeaud et al. 1977).

Plasma lactic acid in salmonids is also a secondary (or metabolic) response to stress, physical activity, or both. The significant increases in plasma lactic acid between the gatewell and the upper flume for both yearling chinook salmon and steelhead were similar to increases measured by other researchers following handling or confinement stresses (Barton et al. 1986, Barton and Schreck 1987). These increases suggest that fish were holding in the primary dewaterer (also supported by observations) and experiencing some level of swimming fatigue. However, these concentrations do not indicate levels of extreme exhaustion, and both species recovered after 2 to 4 hours in the raceways, similar to recovery rates found by Barton et al. (1986) and Barton and Schreck (1987). Compared to the values obtained at the upper flume, the lactic acid levels obtained at the lower flume were only slightly higher for steelhead and only slightly lower for yearling chinook salmon, suggesting that the fish were not holding in the transport flume and, therefore, not experiencing any additional levels of fatigue or stress.

The means, standard errors, and ANOVA tables for all three plasma indices are given for both species in Appendix Tables 2, 3, and 4. The actual values and the corresponding fork lengths for yearling chinook salmon and steelhead are given in Appendix Tables 5 and 6.

OBJECTIVE 2 - EVALUATE RELIABILITY AND EFFICIENCY OF THE SAMPLING SYSTEM AT THE COLLECTION FACILITY

Approach

The new sampling system at Little Goose Dam's collection and bypass facility was designed to estimate numbers of fish and to monitor their condition and species composition (Fig. 2). The sample gates on both flumes (one for small fish and one for large fish) exiting the wet separator are designed so that the sample time can be set from 0 to 100%. The sample time is increased or decreased by COE personnel, depending on the daily numbers of fish entering the facility, so that an approximate sample size of 500 fish can be maintained. The hourly counts (from counters located on lines between the sample and holding tanks) and the sample rate are then used to calculate the numbers of fish entering the facility on an hourly basis. During normal operations, timers are set so that a sample is taken four times per hour (every 15 minutes).

The accuracy of the sample rate is important because raceway loading is determined by the sample count. In the new facility, two PIT-tag detectors are located on both the large-fish and small-fish exits from the wet separator (main coils) and on the holding tank exit pipe (sample coils), so that PIT-tagged fish can be detected both upstream and downstream from the sample gates (Fig. 2). Therefore it was possible to use the number of in-river PIT-tagged fish (from various upriver timing and survival studies) detected by the main coils and sample coils to provide an estimate of the actual sample rate. This estimate was the number of PIT-tagged fish detected by the sample coils divided by the number of PIT-tagged fish detected by the main coils.

To compare the sample rate setting (COE sample rate) and the estimate of the actual sample rate, the following notations were used:

AR_i = actual sample rate during period i (i = 1,..., p)

SR_i = COE sample rate setting during period i

ER_i = estimated sample rate during period i

= proportion of PIT tags recorded on main coils in period i that were also recorded on sample coils in period i

RD_i = relative difference of SR_i and ER_i during period i

$= (SR_i - ER_i)/SR_i$

$= 1 - (ER_i/SR_i)$

n = number of PIT tags recorded on main coils in period i

The ER_i can be assumed to follow binomial distributions with mean AR_i and variance $AR_i(1 - AR_i)/n$. Therefore the observed ER_i is the best unbiased estimate of AR_i. A test of Ho: $\mu(ER_i) = \mu(SR_i)$ (or equivalently Ho: $\mu(RD_i) = 0$) is therefore a surrogate test for Ho: $\mu(SR_i) = AR_i$ (i.e., whether SR_i is also an unbiased estimate of AR_i). The test could be carried out for each of the actual sample rates; however, it was of interest to answer the more general question of whether the COE sample rate setting was an accurate (i.e., unbiased) estimate of the actual sample rate over all possible sample rates. The actual sample rate (AR_i) was considered a representative sample of all sample rates and therefore a t-test comparing the mean of the relative difference (RD_i) to 0 was used to test the hypothesis that the COE sample rate setting was accurate, in general.

Due to high variability both in the numbers of operation hours and in the numbers of fish detected by the main coils, some observed sample rate periods were not included in the analyses. Periods where no fish were observed were obviously excluded, as were periods where the COE sample rate setting multiplied by the PIT-tag number detected on the main coils gave an expected PIT-tag number on the sample coils of less than 1.

The numbers of PIT-tagged yearling chinook salmon and steelhead detected by both the main coils and the sample coils, at the various rate settings throughout the entire sampling season (12 April to 18 July), are given in Appendix Table 7.

Results and Discussion

A t-test analysis showed no significant difference between the COE sample rate settings and the estimated actual PIT-tag sample rate for fish entering either the small-fish flume ($t = -1.35$, $P = 0.20$) or large-fish flume ($t = -0.68$, $P = 0.51$) (Tables 5 and 6).

The results of the previous analyses should be viewed with caution and used only to make rough comparisons about the accuracy of the COE sample rate. The data used in these analyses were observational and not experimental, and therefore had some complicating factors. The observed sample rate settings were not equally represented in either run hours or in PIT-tag numbers on the main coils. Because the settings used were not randomly distributed over time or the fish (and PIT tag) outmigration, some settings had a large number of run hours and PIT tags while others had only a few run hours or PIT tags or both. It appears that the use of PIT tags to estimate the sample rate will not be very accurate when few PIT tags pass through the sample tank. However, in all cases where the number of PIT-tagged fish detected by the sample coils was greater than 10, the relative difference between the estimate and the COE sample rate setting was less than 25%, suggesting that keeping a constant sample rate setting until 15-20 fish have been detected by the sample detector will give a relative estimate of the sample rate.

Table 5.--The numbers and percentages of small fish sorted by the wet separator and detected by the PIT-tag main and sample coils at all sample rates used throughout the collection season at Little Goose Dam, 1990.

COE sample rate (%)	Run (hours)	Main coils	Sample coils	Estimated sample rate (%)	Relative difference (%)
0.50	2	7	0	0.00	[a]
0.67	78	402	8	1.99	-197
1.00	65	286	7	2.45	-145
1.11	33	162	1	0.62	44
1.33	229	784	8	1.02	23
1.67	53	169	2	1.18	29
2.00	218	722	16	2.22	-11
2.11	1	2	0	0.00	[a]
2.67	184	484	12	2.48	7
3.06	94	112	5	4.46	-46
3.33	27	99	0	0.00	100
4.00	28	20	4	20.00	[a]
4.67	19	25	3	12.00	-157
5.00	1	1	0	0.00	[a]
5.33	195	295	13	4.41	17
6.00	25	26	2	7.69	-28
7.33	26	4	1	25.00	[a]
9.72	23	11	2	18.18	-87
10.00	949	131	16	12.21	-22
12.80	43	0	0	[b]	[a]
19.72	66	2	1	50.00	[a]
20.00	2	0	0	[b]	[a]
31.60	8	0	0	[b]	[a]

[a] Data not used in analysis; sample rate times the number of PIT tags detected on the main coils was less than 1.

[b] Tests in which no PIT tags were detected by the main coils.

Table 6.--The numbers and percentages of large fish sorted by the wet separator and detected by the PIT-tag main and sample coils at all sample rates used throughout the collection season at Little Goose Dam, 1990.

COE sample rate (%)	Run (hours)	Main coils	Sample coils	Estimated sample rate (%)	Relative difference (%)
0.50	1	9	0	0.00	[a]
0.67	122	187	9	4.81	-618
1.16	1	0	0	[b]	[a]
1.33	204	265	1	0.38	71
1.67	99	143	1	0.70	58
2.00	270	337	2	0.59	71
2.50	1	1	0	0.00	[a]
2.67	112	134	2	1.49	44
3.33	52	58	3	5.17	-55
4.00	47	23	0	0.00	[a]
4.67	42	14	0	0.00	[a]
5.33	59	27	2	7.41	-34
6.00	96	140	7	5.00	17
6.67	282	57	2	3.51	47
7.33	19	8	0	0.00	[a]
10.00	851	41	6	14.63	-46
13.30	43	0	0	[b]	[a]
20.00	68	2	2	100.00	[a]

[a] Data not used for analysis; sample rate times the number of PIT tags detected on the main coils was less than 1.

[b] Tests in which no PIT tags were detected by the main coils.

CONCLUSIONS

1) The new collection and transportation facility at Little Goose Dam caused minimal descaling, injury, and mortality to juvenile salmonids. There were some problems with both the holding tank exit pipe and the raceway exit pipe as originally installed, but relatively minor modifications alleviated these problems for the first year, and more extensive modifications are planned for subsequent years.

2) Adult steelhead can pass through the primary and secondary dewatering sections and the transport flume without injury or mortality. Although there are areas in the primary dewaterer and the transport flume where adults can hold (median passage time was 13 hours), this did not seem to be detrimental to general fish condition.

3) Levels of plasma cortisol, glucose, and lactic acid showed significant increases as yearling chinook salmon and steelhead (with the exception of glucose) passed through the first part of the collection and transportation facility, but decreased to baseline levels within 2 to 6 hours in the raceways. These increases appeared to be normal responses for both species.

4) The t-test analyses detected no significant differences between the COE sample rate setting and the estimated actual PIT-tag sample rate for fish exiting from either the small-fish or large-fish side of the wet separator; nonetheless, the number of PIT-tagged fish counted by the main coils compared to the sample coils did not provide a reasonably accurate estimate of the sample rate (set by COE).

RECOMMENDATIONS

1) To avoid any descaling, injuries, or mortalities to juvenile salmonids during the 1990 outmigration, temporary remedies were made to both the sample holding tank exit pipe and the raceway exit pipe. As a permanent solution, we recommend replacement of these pipes with one-piece molded fiberglass pipes to avoid any edges at joints. To avoid stranding fish between the sample holding tank and the handling /marking facility, the slope on the holding tank pipe should be increased.
2) To determine if PIT tags can be used to reliably estimate the sample rate settings, we recommend an experimental design that holds constant at each sample setting either the number of run hours or numbers of fish detected.

ACKNOWLEDGMENTS

We express our appreciation to COE personnel for their assistance and cooperation in conducting these studies, with special thanks to Ray Eakin, Project Superintendent, and Ken Weeks, Mechanical Foreman, for helping to coordinate research activities. Their respective crews were also very helpful in setting up the equipment and facilities needed to carry out the work.

For ideas and assistance in conducting the research, we also thank COE fishery biologists Sarah Wik, Tim Wik, and Rex Baxter; and ODFW fishery biologists William Knox and Mark Kirsch. Finally, we thank Carl Schreck and his staff at Oregon State University for analyzing the blood samples.

LITERATURE CITED

Barton, B. A., and C. B. Schreck.
1987. Metabolic costs of acute physical stress on juvenile steelhead. Trans. Am. Fish. Soc. 116:257-263.

Barton, B. A., C. B. Schreck, and L. A. Sigismondi.
1986. Multiple acute disturbances evoke cumulative physiological stress responses in juvenile chinook salmon. Trans. Am. Fish. Soc. 115:245-251.

Black, E. C., and A. R. Conner.
1964. Effects of MS222 on glycogen and lactate levels in rainbow trout. J. Fish. Res. Board Can. 21:1539-1542.

Ceballos, J. R., S. W. Pettit, and J. L. McKern.
1991. Fish Transportation Oversight Team Annual Report - FY 1990. Transport Operations on the Snake and Columbia Rivers. U.S. Dep. Commer., NOAA Tech. Mem. NMFS F/NWR-29, 63 p. + Appendix. (Available from Environmental and Technical Services Division, 911 N.E. 11th Avenue, Suite 620, Portland, OR 97232.)

Congleton, J. L., T. C. Bjornn C. A. Robertson, J. L. Irving, and R. R. Ringe.
1984. Evaluating the effects of stress on the viability of chinook salmon smolts transported from the Snake River to the Columbia River Estuary. Report to U.S. Army Corps of Engineers, Contract DACW68-83-C-0029, 67 p. (Available from Idaho Cooperative Fishery Research Unit, Department of Fish and Wildlife Resources, College of Forestry, University of Idaho, Moscow, ID 83843.)

Congleton, J. L., and E. J. Wagner.
1988. Effects of light intensity on plasma cortisol concentrations in migrating smolts of chinook salmon and steelhead held in tanks or raceways and after passage through experimental flumes. Trans. Am. Fish. Soc. 117:385-393.

Congleton, J. L., E. J. Wagner, and R. R. Ringe.
1988. Evaluation of fishway designs for downstream passage of spring chinook salmon and steelhead trout smolts. Report to U.S. Department of Energy, Bonneville Power Administration, Portland, OR, Contract DE-AI79-86BP64234, 30 p. plus Appendices (Available from Idaho Cooperative Fishery Research Unit, Department of Fish and Wildlife Resources, College of Forestry, University of Idaho, Moscow, ID 83843.)

Gessel, M. H., L. G. Gilbreath, W. D. Muir, and R. F. Krcma.
1986. Evaluation of the juvenile collection and bypass systems at Bonneville Dam--1985. Report to U.S. Army Corps of Engineers, Contract DACW75-85-H-0001, 63 p. + Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Matthews, G. M., D. L. Park, J. R. Harmon, C. S. McCutcheon, and A. J. Novotny.
1987. Evaluation of transportation of juvenile salmonids and related research on the Columbia and Snake Rivers--1986. Report to U.S. Army Corps of Engineers, Contract DACW68-84-H-0034, 34 p. + Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Maule, A. G., C. B. Schreck, C. S. Bradford, and B. A. Barton.
1988. Physiological effects of collecting and transporting emigrating juvenile chinook salmon past dams on the Columbia River. Trans. Am. Fish. Soc. 117:245-261.

Mazeaud, M. M., F. Mazeaud, and E. M. Donaldson.
1977. Primary and secondary effects of stress in fish: some new data with a general review. Trans. Am. Fish. Soc. 106:201-212.

Petersen, R. G.
1985. Design and analyses of experiments. Marcel Dekker, New York. 429 p.

Sims, C. W., J. G. Williams, D. A. Faurot, R. C. Johnsen, and D. A. Brege.
1981. Migrational characteristics of juvenile salmon and steelhead trout in the Columbia River Basin and related passage research at John Day Dam, Volume I. Report to U.S. Army Corps of Engineers, Contract DACW57-80-F-0394, 61 p. + Appendices. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Sokal, R. R., and F. J. Rohlf.
1981. Biometry, 2nd Edition. W. H. Freeman. San Francisco. 859 p.

Strange, R. J., and C. B. Schreck.
1978. Anesthetic and handling stress on survival and cortisol concentration in yearling chinook salmon (Oncorhynchus tshawytscha). J. Fish. Res. Board Can. 35:345-349.

Strange, R. J., C. B. Schreck, and J. T. Golden.
1977. Corticoid stress response to handling and temperature in salmonids. Trans. Amer. Fish. Soc. 106:213-218.

Trefethan, P. S., and W. J. Ebel.
1973. Collection and transportation system of juvenile salmonids evaluated at Little Goose Dam. U.S. Natl. Mar. Fish. Serv., Mar. Fish. Rev. 35:33-36.

Appendix Table 1.--Recoveries, descaling, injuries, and mortality of hatchery yearling chinook salmon and steelhead released in the juvenile collection facility at Little Goose Dam, 1990 (Test Group 1).

Date	Number recovered	Mortality N	Mortality %	Descaling N	Descaling %	Eye/head inj. N	Eye/head inj. %
Yearling chinook salmon: release date 22 March, N = 201							
23 March	61	3[a]	4.9	0	0.0	1	1.6
24 March	38	0	0.0	0	0.0	1	2.6
25 March	14	0	0.0	0	0.0	1	7.1
26 March	12	5	41.7	0	0.0	1	8.3
27 March	11	0	0.0	0	0.0	0	0.0
28 March	13	5[b]	38.5	0	0.0	0	0.0
29 March	16	1[b]	6.3	0	0.0	0	0.0
30 March	20	0	0.0	0	0.0	0	0.0
31 March	5	0	0.0	0	0.0	0	0.0
01 April	6	0	0.0	0	0.0	0	0.0
02 April	1	0	0.0	0	0.0	0	0.0
02 April	9	0	0.0	0	0.0	0	0.0
Totals	206[c]	14	6.8	0	0.0	4	1.9
Yearling chinook salmon: release date 23 March, N = 199							
24 March	66	0	0.0	0	0.0	0	0.0
25 March	21	0	0.0	0	0.0	0	0.0
26 March	16	1	6.3	0	0.0	0	0.0
27 March	10	0	0.0	0	0.0	0	0.0
28 March	10	4[b]	40.0	0	0.0	0	0.0
29 March	28	0	0.0	0	0.0	0	0.0
30 March	20	0	0.0	0	0.0	0	0.0
31 March	4	0	0.0	0	0.0	0	0.0
01 April	5	0	0.0	1	20.0	0	0.0
02 April	4	0	0.0	0	0.0	0	0.0
02 April	11	0	0.0	0	0.0	0	0.0
Totals	195	5	2.6	1	0.5	0	0.0

Appendix Table 1.--Continued.

Date	Number recovered	Mortality N	Mortality %	Descaling N	Descaling %	Eye/head inj. N	Eye/head inj. %
Steelhead: release date 25 March, N = 197							
26 March	28	9	32.1	0	0.0	0	0.0
27 March	15	0	0.0	0	0.0	0	0.0
28 March	14	1[b]	6.7	0	0.0	0	0.0
29 March	23	0	0.0	0	0.0	0	0.0
30 March	12	0	0.0	0	0.0	1	8.3
31 March	15	0	0.0	0	0.0	0	0.0
01 April	17	0	0.0	0	0.0	0	0.0
02 April	19	0	0.0	0	0.0	0	0.0
02 April	40	0	0.0	0	0.0	0	0.0
Totals	183	10	5.4	0	0.0	1	0.5
Steelhead: release date 26 March, N = 192							
27 March	26	9	34.6	0	0.0	0	0.0
28 March	17	2[b]	11.8	1	5.9	0	0.0
29 March	15	1	6.7	0	0.0	0	0.0
30 March	15	0	0.0	0	0.0	0	0.0
31 March	6	0	0.0	0	0.0	0	0.0
01 April	18	1	5.6	0	0.0	0	0.0
02 April	16	0	0.0	0	0.0	0	0.0
02 April	83	0	0.0	0	0.0	0	0.0
Totals	196	13	6.6	1	0.5	0	0.0

[a] Fish were stranded in exit pipe from sample holding tank.
[b] Fish flushed from anesthetic line (dead for 2-3 days).
[c] Total recovery may vary, because some fish from anesthetic line were mutilated by pump, making it difficult to distinguish upper caudal from lower caudal mark.

Appendix Table 2.--Means of plasma cortisol values (ng/ml), standard errors, ANOVAs, and Fisher's Protected Least Significant Difference (FPLSD) for yearling chinook salmon and steelhead sampled at various locations and times at Little Goose Dam, 1990.

		Yearling chinook		Steelhead	
No.	Location/time	Mean	S.E.	Mean	S.E
1	Gatewell	75.7	13.0	42.2	9.3
2	Upper flume	77.3	13.0	114.5	9.3
3	Lower flume	112.0	13.0	142.3	9.3
4	Raceway (0-hour)	140.7	13.0	125.1	9.3
5	Raceway (2-hour)	160.5	13.0	91.2	9.3
6	Raceway (4-hour)	129.4	13.0	61.0	9.3
7	Raceway (6-hour)	85.5	13.0	65.3	9.3
8	Raceway (9-hour)	81.7	13.0	103.5	9.3
9	Pre-barge	79.4	16.0	125.4	11.4
10	Barge	150.9	16.0	123.3	11.4

FPLSD No. 1 through 8 comparisons for yearling chinook = 38.8
FPLSD No. 9 through 10 comparisons for yearling chinook = 47.5
FPLSD No. 1 through 8 comparisons for steelhead = 29.4
FPLSD No. 9 through 10 comparisons for steelhead = 33.8

Yearling Chinook Salmon ANOVA

Source	df	Sum of squares	Mean square	F	P
Location	9	560358.75	62262.08	6.10	0.0006
Error	18	183766.13	10209.23		
Total	27	744124.88			

Steelhead ANOVA

Source	df	Sum of squares	Mean square	F	P
Location	9	550057.51	61117.50	11.80	<0.0001
Error	18	93261.67	5181.20		
Total	27	643319.18			

Appendix Table 3.--Means of plasma glucose values (mg/dl), standard errors, ANOVAs, and Fisher's Protected Least Significant Difference (FPLSD) for yearling chinook salmon and steelhead sampled at various locations and times at Little Goose Dam, 1990.

		Yearling chinook		Steelhead	
No.	Location/time	Mean	S.E.	Mean	S.E.
1	Gatewell	96.5	13.3	133.0	8.9
2	Upper flume	87.5	13.3	126.0	8.9
3	Lower flume	86.7	13.3	119.5	8.9
4	Raceway (0-hour)	107.8	13.3	109.9	8.9
5	Raceway (2-hour)	164.9	13.3	150.1	8.9
6	Raceway (4-hour)	155.6	13.3	142.1	8.9
7	Raceway (6-hour)	154.2	13.3	129.3	8.9
8	Raceway (9-hour)	160.4	13.3	147.0	8.9
9	Pre- barge	109.2	16.3	140.8	10.8
10	Barge	166.5	16.3	133.4	10.8

FPLSD No. 1 through 8 comparisons for yearling chinook = 39.6
FPLSD No. 9 through 10 comparisons for yearling chinook = 48.6
No FPLSD for steelhead as ANOVA F test was not significant.

Yearling Chinook Salmon ANOVA

Source	df	Sum of squares	Mean square	F	P
Location	9	29480.32	3275.59	6.13	0.0006
Error	18	9611.44	533.97		
Total	27	39091.76			

Steelhead ANOVA

Source	df	Sum of squares	Mean square	F	P
Location	9	4168.21	463.13	1.97	0.1056
Error	18	4231.86	235.10		
Total	27	8400.07			

Appendix Table 4.--Means of plasma lactic acid values (mg/dl), standard errors, ANOVAs, and Fisher's Protected Least Significant Difference (FPLSD) for yearling chinook salmon and steelhead sampled at various locations and times at Little Goose Dam, 1990.

No.	Location/time	Yearling chinook Mean	Yearling chinook S.E.	Steelhead Mean	Steelhead S.E
1	Gatewell	56.4	4.7	36.6	5.3
2	Upper flume	75.1	4.7	67.4	5.3
3	Lower flume	72.6	4.7	74.8	5.3
4	Raceway (0-hour)	71.0	4.7	68.7	5.3
5	Raceway (2-hour)	59.5	4.7	44.7	5.3
6	Raceway (4-hour)	55.7	4.7	46.8	5.3
7	Raceway (6-hour)	58.2	4.7	46.3	5.3
8	Raceway (9-hour)	72.2	4.7	53.2	5.3
9	Pre-barge	55.6	5.8	51.4	6.5
10	Barge	73.6	5.8	58.1	6.5

FPLSD No. 1 through 8 comparisons for yearling chinook = 14.1
FPLSD No. 9 through 10 comparisons for yearling chinook = 17.3
FPLSD No. 1 through 8 comparisons for steelhead = 15.7
FPLSD No. 9 through 10 comparisons for steelhead = 19.2

Yearling Chinook Salmon ANOVA

Source	df	Sum of squares	Mean square	F	P
Location	9	1792.53	199.17	2.96	0.0241
Error	18	1213.26	67.40		
Total	27	3005.79			

Steelhead ANOVA

Source	df	Sum of squares	Mean square	F	P
Location	9	4012.14	445.79	5.35	0.0012
Error	18	1498.95	83.27		
Total	27	5511.09			

Appendix Table 5.--Fork lengths, plasma cortisol, glucose, and lactic acid values for migrating yearling chinook salmon collected at various locations and times at Little Goose Dam's collection facility, 1990.

FORK LENGTH mm[a]	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl	FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl	FORK LENGTH mm	CORTISOL ng/ml	LACTATE mg/dl	GLUCOSE mg/dl
Gatewell 4A 4B, 19-April-1990				Gatewell 4A 4B, 23-April-1990				Gatewell 4A 4B, 25-April-1990			
125 120	20.6	83.5	59.8	126 121 115	59.8	67.7	84.3	142	128.5	37.6	37.6
138	81.1	43.2	65.5	142	23.6	29.4	117.7	127	65.8	74.5	127.7
132	207.6	55.1	182.8	142	135.5	25.0	89.8	134	81.1	62.3	75.8
140	44.0	28.2	60.2	130	51.7	57.6	107.9	131	67.4	79.9	61.1
131	62.9	47.2	84.7	135	85.0	59.8	96.9	140	83.7	66.1	114.0
134	89.0	54.5	82.6	129	64.9	54.9	91.4	133	54.4	71.3	117.3
129	66.0	40.9	71.9	139	35.1	49.6	86.0	135	72.3	49.2	77.5
141	52.4	109.9	68.7	135	95.2	49.6	87.6	134	72.9	86.8	69.8
123	88.4	72.5	220.2	146	16.4	39.4	93.1	142	126.4	33.0	67.6
148	2.3	63.9	60.2	137	46.4	48.5	89.2	138	161.9	56.2	113.5
139	25.9	79.3	****	160	23.7	34.1	58.6	146	70.4	39.2	54.0
142	8.3	75.2	65.5	161	14.1	53.8	206.5	129	55.7	37.6	84.6
166	28.2	56.3	71.9	124 131	370.7	93.5	258.0	140	143.8	67.4	93.8
138	6.1	64.5	50.6	141	135.1	49.0	100.7	133	127.5	43.6	66.5
147	12.0	48.4	74.1	133	151.2	43.9	121.6	139	57.4	79.9	72.0
131 111	26.6	67.2	98.6	137	94.7	29.0	99.6	142	84.6	52.1	81.8
142	35.8	71.8	81.5	133	24.0	72.9	87.6	136	75.4	67.4	283.1
170	5.2	69.8	56.0	142	104.1	42.4	102.4	143	172.9	42.5	130.6
128	44.8	45.5	67.9	132	88.5	49.6	95.8	134	82.7	50.9	80.7
133	23.8	71.1	94.3	130	99.9	40.9	74.4	140	105.8	45.2	129.3
Primary Dewaterer, 19-April-1990				Primary Dewaterer, 23-April-1990				Primary Dewaterer, 25-April-1990			
133	81.7	111.2	58.1	127 100	90.0	101.8	43.6	139	5.6	54.4	87.6
127 140	115.1	80.6	66.0	125 113	100.4	95.2	****	140	9.2	72.3	53.7
133 114	58.2	95.6	68.7	128 120	30.0	100.3	46.3	130	149.2	78.8	261.9
140	71.9	58.4	58.1	121 109 112	78.5	73.2	101.5	110 115	71.1	67.1	86.6
124	105.3	61.8	81.5	132	124.5	48.6	68.2	121	202.8	61.5	94.5
127	86.5	50.8	78.3	138	7.5	80.6	69.3	135	39.4	67.2	69.1
124	155.8	49.7	53.8	145	74.4	71.3	227.1	126	76.3	64.9	107.2
114 133	111.4	54.6	97.5	130	56.8	84.7	41.4	140	18.4	55.4	64.3
140	41.0	95.6	69.8	131	126.4	72.6	95.5	125 100	113.2	50.1	158.6
133	32.1	66.4	85.8	131	60.3	80.6	****	119 114	25.7	77.6	102.5
124 140	48.9	89.9	61.3	160	96.1	74.5	67.6	129 110	94.3	72.3	87.6
140	50.6	54.6	77.3	130 122	60.2	82.6	42.0	139 122	45.7	78.2	55.8
117 130	94.6	86.1	71.9	132	9.7	33.5	126.6	131	106.2	96.0	74.9
133	24.4	54.6	71.9	139	114.1	61.1	185.6	128 127	157.8	86.6	71.2
133	80.8	82.4	94.3	128 110	100.5	81.2	80.2	126	122.7	60.9	142.2
137	101.5	81.2	46.4	135 126	32.2	89.6	48.0	140	110.2	78.2	76.5
117 146	41.9	96.8	62.3	130 128	82.2	92.4	102.0	137	31.9	56.1	54.3
127	61.3	87.4	46.4	155	59.9	88.2	182.9	125	122.4	66.0	86.6
140	9.7	71.0	79.0	131	78.4	58.6	78.5	124 101	208.3	102.3	87.1
143	70.3	84.3	****	145	52.0	91.0	44.7	132 129	48.0	83.0	194.1

Appendix Table 5.--Continued.

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
Separator, 19-April-1990			
120	99.4	101.6	****
132	145.2	76.5	64.6
110	8.6	****	****
131	75.6	72.5	81.8
114 109	103.0	68.5	72.4
132	51.6	56.3	58.0
125	141.2	54.5	96.2
132	173.1	65.8	136.1
117	86.6	55.1	110.1
141	147.7	71.8	97.9
122	215.7	53.8	73.5
133	64.7	55.7	73.5
116	123.4	87.7	64.1
140	83.5	72.5	90.1
120	95.5	49.6	83.5
150	33.9	33.3	68.5
130	128.6	80.7	56.3
124	139.1	49.0	104.0
120 108	109.5	42.6	70.2
143	65.4	69.8	80.2
Raceway # 6 - 0 hour, 19-April-1990			
139	32.4	68.5	72.3
125 126	228.1	67.8	96.6
143	92.3	39.8	92.0
131 116	187.7	95.7	107.0
138	56.8	66.5	107.6
135	51.2	87.7	****
140	214.7	31.8	99.5
139	66.0	50.2	59.5
136	417.7	65.2	****
140	90.4	47.8	129.6
146	65.0	17.5	74.0
134	92.5	55.1	118.6
140	248.5	66.5	109.9
142	60.5	42.1	75.7
132 130	263.8	59.4	193.4
139	45.7	41.5	103.0
133	111.0	68.5	58.3
143	208.9	19.7	121.0
139	259.9	62.6	174.8
141	131.6	61.3	54.9

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
Separator, 23-April-1990			
134 132	42.8	96.4	62.3
156	66.6	67.8	82.6
144	88.0	67.2	74.1
135	84.0	55.1	97.5
131	128.9	93.5	38.9
129 130	56.3	88.4	94.3
135	14.3	94.9	80.5
142	66.8	82.8	58.1
140	86.5	87.0	81.5
129	116.5	87.7	139.1
163	295.7	73.1	114.6
143	63.6	75.8	44.2
150	101.3	66.5	80.5
142	12.8	103.1	****
138 130	66.8	84.2	78.3
150	126.3	59.4	58.1
131 123	183.5	66.5	61.3
135	129.4	82.8	45.3
135 135 135	46.7	125.6	40.6
146	98.7	73.8	79.0
Raceway # 6 - 0 hour, 23-April-1990			
148	143.4	42.2	128.5
147	120.4	58.7	126.7
133 125	106.0	94.9	106.5
145	141.3	87.5	82.7
146	146.6	92.6	85.0
139	68.8	70.6	165.0
140	193.5	67.4	140.1
137	240.1	62.2	177.7
132 124	142.6	60.2	108.8
137	127.4	52.7	76.3
124 118 108	194.0	88.1	****
135	246.1	81.4	123.8
149	133.6	92.6	127.9
129	120.4	70.6	125.6
133 123	243.0	78.7	56.6
131	174.8	91.5	114.6
140	124.6	56.2	76.3
132 124	146.4	90.3	49.7
146	91.3	71.7	101.8
132 129	147.3	70.6	78.6

FORK LENGTH mm	CORTISOL ng/ml	LACTATE mg/dl	GLUCOSE mg/dl
Separator, 25-April-1990			
131	172.8	48.3	90.2
150	144.9	51.2	99.1
123 118	120.7	94.3	85.7
146	122.6	53.2	106.4
139	125.8	94.9	209.5
138	108.2	65.3	68.3
134	158.4	86.4	71.7
144	224.1	76.0	118.7
137	146.0	93.1	72.9
131	117.1	26.0	76.7
135 129	224.3	88.7	94.1
139	196.5	65.9	155.7
132	60.6	76.5	77.3
135	81.6	95.5	52.1
135	188.4	78.7	152.3
128	129.3	75.4	159.1
132 123	140.9	78.7	90.1
132 116	42.7	79.8	129.4
159	221.6	51.2	107.5
129	26.0	77.0	65.0
Raceway #7 - 0 hour, 25-April-1990			
124 121	165.4	104.5	98.7
145	122.7	56.4	68.7
142	175.4	58.9	157.6
133	207.1	70.0	84.8
136	124.0	91.1	91.8
132	173.3	113.0	52.7
124	98.6	47.8	202.1
135	186.2	67.3	96.0
122	279.6	96.2	292.1
126	132.0	85.3	83.2
122	114.4	56.4	75.7
135	194.3	89.6	73.0
145	109.3	75.5	56.9
125	178.6	81.7	****
125	90.9	97.7	59.1
126	170.4	75.5	69.3
116 116	195.3	97.0	244.4
123 117	215.1	76.8	232.1
136	177.3	96.2	55.9
125 120	105.5	128.2	48.9

Appendix Table 5.--Continued.

Raceway #6 - 2 hour, 19-April-1990

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
132 124	195.7	71.8	####
120 135	92.3	97.7	146.7
124 127	257.4	67.2	####
132 114	208.7	80.0	####
130	37.9	62.6	71.8
124 115	194.3	83.5	63.5
125 120	326.2	65.8	193.2
137	195.5	49.6	185.5
133	174.3	106.9	44.7
125	317.6	62.0	####
146	228.3	36.5	204.3
138	54.3	37.6	99.6
137	141.4	66.5	178.3
142	106.3	31.3	102.3
137	124.9	73.1	239.2
145	71.3	82.1	107.9
123 121 125	183.0	86.3	83.5
138	68.6	22.9	137.3
141	48.9	44.3	85.2
146	202.2	42.1	223.7

Raceway #6 - 4 hour, 20-April-1990

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
126 120	84.4	97.5	####
127 122	123.0	78.8	####
132	163.3	35.5	240.9
143	25.1	25.3	136.6
135	261.6	65.8	160.4
154	251.9	56.8	49.7
124	136.5	49.7	85.0
133	116.4	45.0	####
145	103.5	13.9	66.5
153	10.3	49.2	104.7
137 128	103.1	84.9	108.8
147	64.5	62.9	100.1
136	27.8	20.6	82.7
132 129	168.9	68.7	102.4
140	112.2	57.9	136.6
120 120	187.7	86.1	####
132 130	44.0	55.1	####
142	67.9	55.1	####
135	18.5	42.4	90.2
115 126	180.3	90.5	####

Raceway #7 - 2 hour, 23-April-1990

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
136 128	157.6	79.9	168.8
136	196.0	66.0	245.0
135	145.4	90.8	209.1
139	121.6	74.6	172.6
125	60.9	72.9	105.7
137	138.4	54.0	97.0
131	123.4	47.3	150.9
160	278.9	93.9	272.9
141	296.8	63.2	246.3
142	251.1	56.7	137.9
135	109.0	27.9	144.7
144	159.0	38.9	121.2
129	248.4	99.6	85.2
139	107.1	85.3	407.3
141	92.2	40.8	136.6
147	58.3	31.9	154.0
140 134	148.3	74.0	129.2
155	202.7	36.0	238.8
133	143.4	46.3	182.5
150	103.8	67.7	273.5

Raceway #7 - 4 hour, 24-april-1990

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
125 131	306.4	77.6	309.1
142	123.4	30.8	214.8
130 115 120	142.7	65.4	172.2
132 129	101.0	51.2	129.5
129 126	171.4	66.6	279.9
127 124 112	111.1	84.8	105.1
144	82.6	43.4	228.6
115 108 121	306.9	83.0	221.7
132	52.1	54.9	121.5
128 124	81.7	71.2	123.1
133 120	267.5	47.0	247.1
100 125 124	59.5	79.4	82.9
139	27.3	38.9	102.5
128 137	268.0	62.6	148.6
122 116	88.8	76.4	125.8
131 128	68.5	62.6	161.3
135 122	178.0	41.4	203.1
138	82.9	53.3	190.9
135	234.7	53.8	300.6
142	278.2	71.7	274.6

Raceway #6 - 2 hour, 25-April-1990

FORK LENGTH mm	CORTISOL ng/ml	LACTATE mg/dl	GLUCOSE mg/dl
155	263.2	55.7	321.5
143	85.0	38.5	133.6
142	315.9	49.6	222.9
159	114.7	32.6	124.8
136	96.9	23.5	143.5
148	94.8	32.0	84.3
132	267.0	61.4	252.5
135	179.6	58.2	151.1
134 133	233.2	29.4	186.7
143	77.5	16.7	126.5
122 115	241.0	94.0	235.5
135	23.4	60.8	99.6
136	135.0	66.7	181.3
####	100.9	55.1	166.5
132	139.8	63.4	239.3
135 139	279.4	76.8	151.7
128 116	215.0	25.9	123.2
126 125	184.2	103.0	271.1
139	144.0	60.8	136.9
143	70.8	68.0	151.1

Raceway #6 - 4 hour, 26-April-1990

FORK LENGTH mm	CORTISOL ng/ml	LACTATE mg/dl	GLUCOSE mg/dl
158	70.0	24.8	99.8
132 133	60.7	69.6	149.6
119 115	177.9	70.7	260.5
132 117	52.4	51.3	129.8
123	31.5	29.6	83.7
130 127	221.6	61.6	244.9
127	248.4	47.8	134.6
135	124.7	63.2	260.5
133	224.8	53.3	317.2
141	24.3	34.0	133.0
133 131	241.9	99.7	250.8
129	31.5	38.2	149.1
122 96	136.8	45.3	104.1
140	46.7	34.9	100.3
129	258.0	55.4	214.9
149	53.9	34.5	156.0
130 124	42.0	17.9	89.1
135 124	35.7	74.0	74.1
132	238.8	40.1	217.6
145	155.6	30.0	170.0

Appendix Table 5.--Continued.

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
Raceway #6 - 6 hour, 20-April-1990			
131	128.3	27.5	107.5
120 115	120.3	55.1	219.0
113 118	140.8	****	7.3
130 126 125	42.5	82.4	115.4
115 115 115	97.6	75.2	94.1
132 129 118	229.1	107.3	194.3
120 110	185.4	102.7	****
139	22.9	66.4	107.5
130	98.5	79.4	****
133	9.6	68.1	107.5
125 104	104.6	66.9	174.2
138	44.7	69.3	104.2
110 122	91.4	39.4	178.7
144	18.2	76.4	****
126 118	200.8	111.2	****
134	5.7	****	7.3
147	29.9	34.5	113.1
131	90.6	65.2	250.4
128 123	273.6	81.2	****
169	8.9	35.5	87.4
Raceway #6 - 9 hour, 20-april-1990			
139 120	32.3	86.5	94.9
115 122 123	92.3	84.1	72.3
130 125 133	153.8	93.3	113.4
115 128 125	81.9	106.0	****
132	13.1	83.5	130.2
125 115	160.3	95.1	167.9
140 115	24.9	82.3	85.0
132	37.3	78.7	****
142	80.1	51.9	136.6
136	54.5	79.9	158.6
137 118	234.6	79.9	311.1
125	86.2	54.5	****
127 139	86.3	82.9	138.3
130 104	185.3	63.8	****
146	129.2	52.4	166.7
140	55.4	78.7	308.2
126 123	45.5	93.3	144.7
145	130.6	36.5	87.9
142	70.7	61.0	103.6
149	238.3	84.1	351.6

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
Raceway #7 - 6 hour, 24-April-1990			
135 120	66.0	29.4	184.1
142	192.3	42.6	391.7
142	87.9	32.2	110.7
141 125	61.0	64.8	275.7
144	82.9	42.1	169.0
135	22.5	19.7	88.1
138 115	42.6	53.0	151.2
146	56.5	62.4	286.5
127 125	181.0	67.9	191.6
122 124	189.6	79.5	315.6
145	19.4	19.3	118.3
120 124 98	130.5	78.8	245.0
122 110	173.5	83.5	231.0
122 120 126	160.6	55.9	150.1
140 115	50.5	57.0	123.1
106 151	113.3	27.6	324.2
140	91.5	27.6	139.3
130 111	29.5	29.4	97.8
141	19.7	34.1	141.5
120 107 110	107.9	89.0	190.0
Raceway #7 - 9 hour, 24-April-1990			
141	139.7	36.5	165.8
144	55.2	38.9	255.3
141	32.6	40.4	244.7
143	56.2	24.9	76.2
143	32.7	49.7	****
137 120	53.9	100.1	133.8
134 121	64.5	71.0	90.1
128	34.9	91.1	****
130	62.0	65.8	107.1
139 127	64.7	71.6	110.3
132 126	24.6	49.2	175.4
121 130 128	28.5	72.2	99.7
129 111	14.4	88.0	128.5
133	16.2	56.8	142.3
130 128	10.6	73.4	125.3
128 121	62.4	43.4	142.8
133 120	46.8	40.4	109.3
131 125	21.8	98.1	289.0
133 130 131	27.7	97.5	118.9
141	27.6	45.5	114.6

FORK LENGTH mm	CORTISOL ng/ml	LACTATE mg/dl	GLUCOSE mg/dl
Raceway #6 - 6 hour, 26-April-1990			
130	79.6	22.4	71.3
151	84.2	31.4	106.2
146	56.1	36.0	224.3
135	35.3	22.4	150.6
141	22.5	45.8	137.8
173	43.6	43.3	126.2
142	101.5	72.9	199.9
147	52.5	37.4	139.5
143	206.5	70.6	****
151	43.2	48.8	170.0
126 124	28.6	64.3	58.0
139	68.2	54.5	161.6
130 126	24.5	73.4	79.6
135	23.6	68.3	188.2
140	73.9	44.7	137.8
135	48.8	75.2	173.8
123	21.7	64.3	121.2
136	130.4	104.7	36.9
143	51.0	43.7	198.8
130 130	114.6	87.7	214.9
Raceway #6 - 9 hour, 26-April-1990			
126	22.7	98.6	147.4
133 131	36.9	103.4	145.2
131 125	70.1	67.4	140.2
122 125	72.5	96.8	123.7
141	84.3	72.3	167.9
131 116	62.9	89.8	99.4
134	186.7	80.6	342.0
142 129	147.5	91.5	181.9
155	267.6	94.5	387.3
147	26.1	44.0	110.7
116 126	49.5	105.2	90.8
135	10.5	76.7	107.5
147	180.7	42.1	196.5
141	148.3	71.2	269.8
135 134	106.9	68.5	111.8
135	73.2	61.0	86.5
156	236.8	77.8	194.8
135 128	25.4	73.4	341.5
132 130	45.6	93.9	149.0
146	181.0	43.0	93.5

Appendix Table 5.--Continued.

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
Pre barge load (Raceway #7), 21-April-1990			
171	95.5	****	****
130 119	83.1	58.2	80.1
118 105	97.1	96.0	****
111 130 125	90.6	77.0	91.8
126 126	52.7	83.0	81.2
139 129	55.3	72.3	106.4
144 133	52.5	68.3	87.9
142	69.8	49.0	113.1
143	65.2	64.9	118.7
132 117	104.2	58.2	139.5
153	16.0	33.6	67.2
129	139.5	48.5	114.2
124 115	39.0	87.9	66.1
139	21.3	82.4	79.0
132 137	42.2	68.3	83.4
138	143.4	25.4	110.3
141	44.2	38.4	91.8
144	51.1	66.0	103.6
132 128	25.4	84.2	66.6
149	31.6	17.9	80.1
Barge, 21-April-1990			
139 118	229.2	67.8	237.6
135 129	169.1	67.2	158.3
145	105.6	65.8	228.7
176	81.8	92.0	68.7
138	65.7	42.1	113.5
135	144.7	59.4	132.7
135	181.7	94.2	239.3
158	144.0	55.1	186.0
130 130	109.9	85.6	273.5
139	109.8	73.1	117.8
118 136 121	46.0	87.0	99.7
141	85.2	65.2	99.7
133 130	125.8	66.5	109.3
131 122	195.8	89.9	195.6
129 121	63.4	88.4	****
125 118	95.8	73.1	121.0
111 119 103 113	213.5	93.5	****
128 120 125	62.9	94.9	158.3
138	113.3	71.1	137.0
108 108 128 116	201.5	80.0	83.7

FORK LENGTH mm	CORTISOL ng/ml	LACT. mg/dl	GLUC. mg/dl
Pre barge load (Raceway #7), 26-April-1990			
147 130	68.3	37.0	109.0
133 125	111.7	74.0	112.3
139	48.1	27.9	276.9
131 115	91.6	57.2	107.3
173	112.5	38.4	134.5
140	132.2	19.6	109.0
145	35.7	40.3	136.1
126 116	99.2	68.3	134.5
142	139.8	53.5	146.7
136	104.3	36.5	109.5
137 127	104.7	62.1	127.3
124 119 105	122.9	76.4	107.3
160	124.8	17.3	90.7
131	96.3	49.3	82.9
150	129.7	45.2	109.0
111 123	74.9	66.6	137.8
131 119	76.5	65.5	92.4
143	55.7	45.8	136.7
149	63.8	37.0	116.7
121 122	71.5	62.7	121.7
Barge, 26-April-1990			
149	94.0	47.4	145.3
124	138.7	35.8	129.8
158	281.8	64.3	271.0
132	130.0	53.2	150.9
133	120.0	61.2	163.9
132	125.2	61.7	274.1
131	124.6	80.9	167.0
130	134.0	36.7	147.8
131 125	233.8	94.9	178.1
127	151.1	54.7	137.3
127 118	255.3	103.6	238.2
123 123	197.2	90.3	227.7
144	197.1	93.8	357.7
122 118	139.4	87.0	185.6
135 129	261.0	85.8	147.8
121 117	144.2	93.8	100.1
129	224.3	32.7	110.0
125 127	181.2	100.7	202.3
141	199.9	85.8	123.6
122 116 111	158.5	66.9	135.4

a/ Where there is more than one length, the samples were pooled with 2-4 fish.

Appendix Table 6.--Fork lengths, plasma cortisol, glucose, and lactic acid values for migrating steelhead collected at various locations and times at Little Goose Dam's collection facility, 1990.

Gatewell 4A 4B, 3-May-1990

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
183	15.00	44.75	93.62
219	41.73	13.48	179.08
235	31.23	20.08	106.22
197	100.70	24.58	102.93
201	16.00	18.91	108.41
193	33.63	21.68	111.15
204	64.12	19.30	84.31
215	110.60	31.26	225.64
192	111.60	27.18	81.57
214	53.63	33.62	103.48
198	49.49	47.45	91.43
192	56.28	22.91	81.02
205	52.52	33.15	95.27
202	46.50	20.87	69.52
201	39.34	54.72	221.26
195	142.10	36.05	84.31
183	80.43	53.01	107.86
200	26.36	36.05	151.69
195	27.90	52.44	70.07
210	110.60	24.16	115.53

Primary Dewaterer, 3-May-1990

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
166	88.37	62.10	77.83
188	74.79	70.97	97.78
220	87.97	43.94	307.00
189	118.50	58.09	147.39
247	133.20	84.62	116.12
197	181.30	65.61	108.03
178	172.00	32.97	119.35
228	112.90	66.79	136.07
176	96.60	53.06	393.27
185	61.37	66.79	105.33
189	113.00	65.02	95.92
166	60.34	65.61	110.18
185	124.30	37.34	100.73
230	103.80	20.51	77.83
213	109.30	82.08	57.88
226	122.10	47.10	102.93
165	33.02	45.51	97.78
195	36.03	9999.00	104.79
201	200.50	48.70	96.70
189	89.22	83.35	127.98

Gatewell 4A 4B, 8-May-1990

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
206	28.54	47.35	112.53
194	12.66	32.42	87.63
212	29.85	23.10	42.60
154	9.69	46.86	78.09
210	11.85	43.96	67.50
204	5.67	33.31	63.26
244	24.05	32.42	50.54
205	15.69	36.47	97.16
185	38.15	46.86	128.95
228	8.14	31.77	78.62
196	12.15	23.10	148.55
207	147.90	58.97	357.82
179	34.36	21.51	110.94
241	32.00	28.24	132.13
200	25.36	25.56	76.50
199	56.10	30.88	71.20
162	71.82	19.93	137.96
180	14.57	29.37	74.91
215	59.24	29.11	89.22
206	67.81	34.03	239.71

Primary Dewaterer, 8-May-1990

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
200	163.20	108.86	127.63
217	183.70	68.48	110.78
206	161.20	54.33	116.96
185	44.06	81.76	98.42
236	218.50	55.35	146.74
215	129.50	82.33	110.21
211	206.40	126.32	98.42
214	173.10	63.67	73.69
190	63.07	82.89	116.40
201	214.30	61.04	127.07
173	20.12	67.41	113.59
184	150.00	62.09	120.89
230	294.90	94.46	337.77
210	70.76	56.89	81.00
190	52.35	83.46	75.94
247	90.98	76.15	72.01
185	103.30	33.76	82.12
190	55.11	89.21	94.48
210	42.83	73.39	85.49
221	187.10	123.78	154.60

Gatewell 4A 4B, 10-May 1990

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
214	4.83	47.62	54.45
206	16.01	37.62	164.60
201	34.42	48.13	133.53
224	24.71	22.26	98.19
205	50.14	42.54	175.31
211	10.27	40.55	166.20
182	19.57	64.33	321.52
222	9.23	39.10	167.81
189	30.82	44.04	318.30
215	12.12	44.55	84.37
176	71.70	23.95	193.52
243	46.42	56.61	169.95
226	27.92	21.85	158.17
194	14.83	54.46	109.97
200	9.64	33.34	100.33
200	84.15	51.27	195.12
202	20.31	53.39	186.55
201	18.29	47.62	164.06
190	96.90	49.17	343.47
169	12.35	65.02	131.39

Primary Dewaterer, 10-May-1990

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
191	136.90	85.68	95.15
205	100.20	66.82	117.85
220	43.92	77.68	114.53
201	112.10	92.21	130.60
174	70.15	59.81	116.19
185	66.01	65.30	121.73
215	155.90	69.37	393.36
210	83.29	61.79	113.42
200	46.79	70.91	124.51
209	69.46	76.11	156.65
216	128.30	59.31	89.59
209	138.00	74.54	101.78
178	53.51	69.37	85.15
200	60.85	37.32	95.15
191	99.01	51.55	80.16
200	44.33	50.13	86.81
241	290.70	96.63	334.58
234	129.30	63.79	121.19
185	121.00	49.66	91.82
214	176.80	63.79	113.97

Appendix Table 6.--Continued.

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Separator, 3-May-1990			
232	104.30	28.06	86.05
194	30.67	59.05	91.67
171	267.10	70.31	42.79
223	251.00	86.50	39.96
221	102.50	68.75	99.54
192	185.30	85.94	46.35
219	141.90	52.66	119.77
227	125.80	101.82	86.05
209	75.47	68.75	137.75
222	43.12	71.36	123.14
185	85.13	73.47	79.87
233	113.50	94.92	123.14
216	57.83	68.22	113.02
235	119.40	33.06	84.37
233	167.90	39.16	115.27
235	90.42	60.05	70.32
171	273.70	105.90	226.52
217	111.20	62.07	117.52
236	138.50	40.06	118.64
265	99.29	120.22	160.78
Raceway #2 - 0 hour, 3-May-1990			
224	132.30	66.68	90.55
247	212.20	72.04	106.84
222	37.55	23.51	91.67
230	96.64	25.45	134.94
182	74.01	61.45	70.32
194	98.63	23.51	132.69
198	128.30	92.55	148.98
165	18.22	56.35	60.21
227	192.80	32.04	101.79
119	102.30	29.45	75.38
181	86.76	75.46	92.80
203	94.64	118.55	83.25
198	29.51	72.04	132.69
215	175.30	89.63	98.42
217	113.50	44.83	48.49
227	153.40	107.60	106.84
193	67.28	97.74	87.74
238	89.21	88.90	118.64
208	65.16	76.15	77.07
223	184.90	86.73	98.30

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Separator, 8-May-1990			
269	168.90	39.59	106.84
248	141.60	37.25	125.39
239	336.40	81.20	77.07
226	160.20	64.76	65.83
183	84.53	54.85	90.55
186	115.40	86.30	258.55
206	182.10	56.38	47.85
220	207.30	64.23	70.88
194	38.84	37.25	111.90
236	35.18	61.06	133.25
202	29.00	49.29	84.37
199	103.80	47.81	137.75
177	216.80	102.64	140.56
205	73.22	67.98	102.35
195	157.50	59.49	97.29
213	219.30	104.43	92.24
246	163.90	52.81	111.34
222	131.90	54.85	92.80
190	279.60	117.18	282.71
219	325.20	103.83	253.49
Raceway #5 - 0 hour, 8-May-1990			
246	133.10	51.80	102.93
215	72.69	47.63	85.95
217	190.80	59.34	173.60
220	94.48	80.20	167.03
211	120.00	42.39	88.14
214	72.60	79.57	79.93
257	194.80	52.51	162.10
247	113.10	51.41	96.36
232	112.50	67.38	129.23
204	56.44	38.83	88.69
260	104.60	31.08	126.49
229	146.10	43.42	101.29
202	152.80	70.37	82.12
252	142.70	83.57	139.64
205	171.20	58.24	42.68
241	130.70	26.96	217.42
190	136.70	59.80	119.37
209	187.10	63.27	116.63
196	81.56	43.94	102.93
203	26.47	16.91	113.89

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Separator, 10-May-1990			
221	119.20	109.86	99.67
185	136.70	97.03	102.58
215	108.00	116.44	93.29
215	87.21	86.51	371.37
218	309.50	95.15	166.99
224	258.00	73.44	195.48
206	145.40	95.77	125.50
218	163.30	35.08	85.86
188	40.46	99.56	136.64
176	107.50	58.84	77.81
250	62.20	19.98	85.24
200	147.20	97.66	166.37
216	87.85	76.94	100.10
211	119.10	102.74	85.24
190	170.20	74.02	144.70
188	186.20	93.28	169.47
199	36.77	105.31	90.20
215	269.50	124.49	134.17
210	165.50	85.29	57.99
222	66.22	104.67	113.53
Raceway #3 - 0 hour, 10-May-1990			
196	119.10	92.42	194.49
200	231.20	119.79	139.99
230	497.20	105.90	196.00
185	132.80	46.32	129.32
241	149.50	90.55	107.97
233	169.90	67.89	78.75
182	202.60	27.24	44.48
234	168.80	89.93	127.63
218	116.10	91.18	98.98
238	146.40	80.46	88.86
213	22.43	105.84	142.24
194	61.26	110.43	89.99
195	151.30	94.92	91.11
213	97.88	103.89	260.79
219	269.10	84.40	78.75
213	95.99	94.94	92.80
185	26.21	85.01	146.74
208	92.10	78.98	89.43
231	32.18	73.66	46.15
196	128.70	66.19	66.95

Appendix Table 6.--Continued.

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Raceway #2 - 2 hour, 3-May-1990			
196	26.02	65.36	78.91
186	133.00	74.78	48.71
198	45.06	68.68	187.83
240	52.44	21.63	200.77
267	54.32	33.10	161.41
238	157.00	78.23	182.44
224	91.68	49.05	150.09
219	94.26	51.40	163.57
227	101.20	36.45	154.94
225	62.57	57.07	204.55
224	109.50	52.01	113.96
208	128.70	48.00	172.73
214	55.38	20.25	86.46
210	53.21	50.18	185.67
222	55.09	60.16	127.98
196	26.62	51.15	132.29
196	95.03	81.04	172.73
193	142.60	73.93	111.26
240	94.31	37.42	252.00
225	47.53	46.96	147.39
Raceway #2 - 4 hour, 4-May-1990			
215	22.86	30.11	153.85
195	47.56	59.55	112.00
243	62.97	21.76	116.24
206	88.41	13.54	97.69
216	64.54	36.95	73.85
249	48.02	25.64	130.54
209	85.11	38.72	75.44
235	46.18	41.86	91.34
211	64.01	42.32	117.83
180	98.78	37.83	86.04
210	18.31	54.12	122.06
212	137.90	57.06	312.79
212	141.70	35.20	161.27
201	73.20	48.83	118.89
201	73.06	48.35	99.81
203	27.99	52.18	150.67
229	35.33	13.87	117.30
203	17.47	53.63	116.77
223	26.96	19.51	98.75
178	10.34	58.55	43.66

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Raceway #5 - 2 hour			
230	156.40	55.03	261.49
218	55.97	55.03	97.11
241	126.30	38.17	207.43
215	88.48	53.84	124.96
205	274.00	81.25	383.28
216	90.71	44.11	106.40
228	130.60	28.63	88.37
195	22.79	42.46	77.45
227	127.40	34.04	136.43
232	61.50	48.04	126.60
245	106.90	19.65	90.01
231	69.62	33.04	195.96
195	47.44	50.33	90.01
233	34.47	23.55	128.79
216	90.27	57.43	*********
233	81.59	22.22	132.61
238	114.90	18.82	140.26
215	86.65	23.10	71.99
210	154.70	50.91	216.71
217	142.80	33.54	190.50
Raceway #5 - 4 hour, 9-May-1990			
251	71.88	84.58	318.32
230	57.16	27.42	103.71
170	124.70	51.40	117.73
233	68.19	36.34	126.90
169	56.56	70.02	102.64
232	43.01	41.36	129.60
210	18.09	43.66	166.80
235	24.53	34.71	117.73
216	38.22	40.23	84.30
210	145.70	70.69	217.49
203	58.49	25.45	169.50
213	80.18	127.39	120.97
190	103.50	45.41	160.33
218	89.31	67.34	239.59
246	93.68	44.83	123.13
209	25.49	66.68	128.52
199	62.90	79.63	205.08
213	40.43	74.78	219.64
214	34.40	44.93	199.69
209	50.00	62.09	106.41

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Raceway #2 - 2 hour			
230	81.80	37.25	270.56
221	76.21	18.32	95.27
196	16.26	17.15	104.03
220	130.20	57.42	193.97
212	35.06	50.29	82.67
208	73.72	70.68	119.92
189	257.00	69.05	142.38
206	55.52	35.86	91.98
210	106.00	33.57	85.95
211	69.97	42.93	145.11
210	73.53	34.48	254.67
244	59.87	37.71	208.11
225	186.00	58.45	162.10
215	88.30	30.88	105.13
205	22.87	29.99	92.53
217	58.40	31.32	180.17
244	53.23	27.38	213.04
225	260.40	41.01	153.88
203	22.99	57.93	171.96
205	52.52	22.73	80.48
Raceway #2 - 4 hour, 11-May-1990			
236	15.05	13.68	139.41
195	36.78	48.88	66.21
242	75.14	22.41	153.50
262	114.00	46.32	112.30
220	24.50	31.44	131.81
217	96.27	26.60	159.47
235	34.50	39.38	189.29
250	138.20	24.06	93.86
201	38.68	55.26	194.41
242	88.35	29.21	75.42
210	36.65	65.06	218.57
173	72.36	37.47	74.34
227	18.61	23.23	75.97
213	135.90	39.38	260.32
205	24.79	47.85	169.77
194	44.45	27.79	144.83
195	5.85	72.50	135.07
205	27.17	48.36	97.35
198	64.66	58.97	309.66
213	90.61	68.46	189.20

Appendix Table 6.--Continued.

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Raceway #2 - 6 hour, 4-May-1990			
168	13.85	80.57	116.77
191	74.20	72.56	108.03
219	41.51	12.61	97.11
203	76.82	75.20	100.39
209	32.84	54.44	126.06
193	36.01	75.20	108.03
225	51.94	48.04	108.03
215	60.61	60.49	93.84
237	66.53	47.47	86.74
213	61.44	55.63	133.70
224	39.06	35.57	141.89
227	52.06	40.84	117.32
197	127.40	103.26	****
221	46.34	28.63	100.39
215	18.01	50.33	190.50
222	83.98	27.21	84.55
223	216.00	57.43	404.57
250	89.81	38.17	133.16
224	39.21	62.34	78.00
215	109.10	23.10	193.77
Raceway #2 - 9 hour, 4-May-1990			
210	110.80	73.88	65.44
119	177.90	20.92	92.74
193	19.84	93.10	211.80
248	87.39	69.31	335.76
250	139.90	66.75	163.74
117	195.90	33.04	213.43
224	156.00	54.44	98.20
261	61.43	24.45	61.61
210	68.44	69.31	180.12
210	206.80	50.91	129.88
203	34.30	95.24	169.20
210	119.80	43.56	126.60
228	125.20	58.65	106.40
215	62.27	49.18	109.67
226	163.80	49.18	138.62
198	132.10	50.33	150.63
200	126.30	81.25	109.13
215	164.60	69.96	87.28
242	198.30	46.34	170.29
194	63.66	107.73	143.53

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Raceway #5 - 6 hour, 9-May-1990			
208	56.58	53.32	90.51
219	102.40	54.95	112.11
208	137.40	17.93	108.90
200	101.10	49.29	83.73
170	57.15	60.01	90.51
220	12.15	35.86	81.58
210	55.21	48.80	131.39
218	38.42	50.79	124.96
222	150.10	36.32	115.86
211	75.50	65.83	309.73
221	40.10	29.55	58.02
211	100.30	38.18	123.36
216	97.86	19.90	89.62
215	22.56	29.99	106.76
236	145.30	48.80	221.90
230	34.25	26.09	104.61
233	157.30	43.89	216.01
224	81.74	44.86	233.68
220	67.69	52.30	98.72
255	109.60	31.77	173.70
Raceway #5 - 9 hour, 9-May-1990			
211	151.10	69.44	73.85
218	52.59	24.81	133.72
252	148.90	44.55	116.77
203	19.01	21.43	92.93
221	42.18	40.55	110.41
223	65.57	26.54	139.55
202	243.60	44.04	128.95
220	100.50	28.76	122.06
215	184.10	77.01	162.86
224	21.39	31.95	86.04
218	95.28	70.01	83.92
231	37.07	37.62	241.90
325	237.10	51.27	167.63
211	67.10	43.54	141.67
211	137.90	57.15	127.89
211	36.73	53.39	361.53
216	112.00	49.17	168.16
206	121.30	71.75	75.97
235	122.20	55.53	141.14
197	60.55	23.95	102.46

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Raceway #2 - 6 hour, 11-May-1990			
209	12.06	18.98	90.69
213	56.56	56.40	100.33
201	41.77	56.57	96.53
215	52.43	48.17	94.97
200	46.13	43.23	79.44
178	31.39	65.02	89.62
210	53.40	23.45	106.22
213	24.70	21.38	118.00
230	27.87	42.90	220.29
220	110.60	65.61	109.97
206	22.23	37.84	67.12
220	80.72	32.97	219.76
253	64.34	72.18	263.14
200	64.83	30.53	86.94
210	55.65	33.91	96.53
185	40.73	58.66	236.36
191	17.09	43.94	69.27
206	16.94	36.35	100.33
156	39.32	62.58	92.30
230	72.06	38.33	109.97
Raceway #2 - 9 hour, 11-May-1990			
218	84.13	53.29	388.62
231	59.47	37.42	198.26
211	52.83	49.05	168.02
213	88.43	34.06	90.16
203	109.40	48.52	166.90
221	47.84	50.62	80.08
209	124.60	57.07	115.37
221	76.18	35.97	126.01
210	135.00	77.62	183.14
221	72.52	45.42	74.48
235	167.30	71.74	391.50
218	46.30	49.57	95.20
191	54.53	*********	112.57
194	91.90	64.29	95.77
210	113.00	59.27	64.40
192	129.90	64.29	143.37
219	46.61	18.67	68.32
219	95.95	81.81	385.90
222	91.93	51.15	109.21
224	52.86	55.98	118.17

Appendix Table 6.--Continued.

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Pre barge load (Raceway #3), 4-May-1990			
227	57.77	30.74	112.01
225	127.90	42.94	95.77
245	188.00	123.00	119.29
212	35.07	66.00	229.63
213	146.30	34.52	143.93
217	125.20	34.04	123.21
193	82.23	44.99	94.64
223	79.09	25.31	197.70
205	67.29	49.71	123.21
200	97.50	85.50	93.52
227	83.31	54.02	155.70
231	128.30	62.35	185.94
246	74.89	30.74	128.81
216	16.47	43.45	96.33
203	91.06	45.51	138.33
233	213.20	44.48	173.62
254	132.60	35.48	141.69
260	98.31	27.98	193.78
177	73.72	62.92	104.17
233	122.00	46.03	76.16
Barge, 4-May-1990			
175	135.30	47.84	100.72
238	211.70	93.19	274.75
210	54.62	81.41	155.22
200	113.50	50.74	112.49
208	73.82	64.83	126.12
202	114.50	42.18	165.13
224	117.10	51.23	109.39
240	115.90	72.73	135.41
208	147.00	57.67	98.25
231	167.30	40.80	105.68

FORK LENGTH mm	CORT. ng/ml	LACT. mg/dl	GLUC. mg/dl
Pre barge load (Raceway #4), 9-May-1990			
231	245.60	112.49	158.32
236	100.30	28.00	134.79
174	43.80	52.70	161.42
240	141.40	22.78	188.05
191	133.10	122.18	102.58
210	70.19	27.65	93.91
184	100.70	53.19	147.79
160	191.00	46.41	109.37
216	205.50	57.67	159.56
175	114.20	49.77	154.61
216	105.10	37.61	131.07
191	150.60	39.88	113.73
219	171.60	23.18	116.83
211	157.80	53.68	158.94
195	175.00	70.07	200.44
201	137.70	41.72	163.29
235	120.70	83.07	189.91
195	178.50	66.91	90.20
235	317.80	33.62	210.96
184	113.80	44.99	119.30
Barge, 9-May-1990			
215	72.88	80.63	99.28
207	48.06	43.41	98.74
200	180.50	96.72	99.28
200	18.46	60.01	285.80
205	202.10	60.16	136.69
203	140.40	73.41	142.12
230	64.36	44.86	122.05
200	46.02	40.54	87.35
215	278.10	47.81	147.54
178	49.92	37.44	84.10
211	233.30	36.34	138.86
230	78.60	75.07	86.81
195	172.30	63.17	215.86
220	35.38	29.99	90.86
223	199.40	102.64	56.99
240	81.57	27.93	146.45
208	128.20	62.74	84.64
249	169.50	30.44	170.31
228	99.08	39.12	141.57
235	150.70	66.02	133.98

Appendix Table 7.--Numbers of PIT-tagged chinook salmon and steelhead detected by main coils and sample coils at various sample rates throughout the entire season at Little Goose Dam, 1990.

START DATE	TIME	RUN (HOURS)	SAMPLE RATE	MAIN COILS	SAMPLE COILS	ACTUAL RATE
4/12	1700	66	19.72	2	1	50.00
4/15	1100	23	9.72	11	2	18.18
4/16	1000	94	3.06	112	5	4.46
4/20	800	53	1.67	169	2	1.18
4/22	1300	1	1.11	140	1	0.71
4/23	1400	1	2.11	2	0	0.00
4/23	1500	2	1.11	3	0	0.00
4/23	1700	15	3.33	94	0	0.00
4/24	0800	6	1.11	19	0	0.00
4/24	1400	10	1.00	61	0	0.00
4/25	0000	1	0.50	7	0	0.00
4/25	0100	55	1.00	225	7	3.11
4/27	0800	96	1.33	333	5	1.50
5/01	0800	76	2.00	207	3	1.45
5/04	1200	48	2.67	209	5	2.39
5/06	1200	1	2.00	2	0	0.00
5/06	1300	68	1.33	264	0	0.00
5/09	0900	47	2.00	270	8	2.96
5/11	0800	24	0.67	72	8	11.11
5/12	0800	26	1.33	80	2	2.50
5/13	1000	22	2.00	48	1	2.08
5/14	0800	48	2.67	109	3	2.75
5/16	0800	27	2.00	60	1	1.67
5/17	1100	21	2.67	10	1	10.00
5/18	0800	24	4.00	16	3	18.75
5/19	0800	53	5.33	41	1	2.44
5/21	1300	17	6.00	25	2	8.00
5/22	0800	100	5.33	234	12	5.13
5/26	1200	19	4.67	25	3	12.00
5/27	0700	1	2.00	3	0	0.00
5/27	0800	63	2.67	152	3	1.97
5/29	2300	1	0.67	238	0	0.00
5/30	0000	1	0.50	0	0	-----
5/30	0100	28	0.67	0	0	-----
5/31	0500	29	1.33	94	1	1.06
6/01	1000	17	2.00	131	3	2.29
6/03	0300	2	1.33	10	0	0.00
6/03	0500	25	0.67	92	0	0.00
6/04	0600	7	1.33	3	0	0.00
6/04	1300	3	2.00	1	0	0.00
6/04	1600	4	2.67	4	0	0.00
6/04	2000	12	3.33	5	0	0.00
6/05	0800	4	4.00	4	1	25.00
6/05	1200	25	5.33	20	0	0.00
6/06	1300	1	1.33	0	0	-----
6/06	1400	17	5.33	0	0	-----
6/07	0700	6	6.00	1	0	0.00
6/07	1300	26	7.33	4	1	25.00
6/08	1500	928	10.00	132	11	8.33

Appendix Table 7.--Continued.

START DATE	START TIME	RUN (HOURS)	SAMPLE RATE	MAIN COILS	SAMPLE COILS	ACTUAL RATE
7/17	0700	8	31.60	0	0	-----
7/17	1500	22	10.00	0	0	-----
7/18	1300	2	20.00	0	0	-----
7/18	1500	43	12.80	0	0	-----
LARGE-FISH COILS						
4/12	1700	66	20.00	2	2	100.00
4/15	1100	103	10.00	11	2	18.18
4/19	0900	51	6.67	21	2	9.52
4/21	1200	24	3.33	23	3	13.04
4/22	1200	26	1.67	33	1	3.03
4/23	1400	1	2.50	1	0	0.00
4/23	1500	2	1.67	1	0	0.00
4/23	1700	16	3.33	34	0	0.00
4/24	0900	71	1.67	109	0	0.00
4/27	0800	96	2.00	131	2	1.53
5/01	0800	9	2.67	8	0	0.00
5/01	1700	67	2.00	67	0	0.00
5/04	1200	25	2.67	50	2	4.00
5/05	1300	23	2.00	20	0	0.00
5/06	1200	45	1.33	83	0	0.00
5/09	0900	28	2.00	42	0	0.00
5/10	1300	19	1.33	65	0	0.00
5/11	0800	24	0.67	53	8	15.09
5/12	0800	26	1.33	47	1	2.13
5/13	1000	22	2.00	28	0	0.00
5/14	0800	48	2.67	63	0	0.00
5/16	0800	27	2.00	37	0	0.00
5/17	1100	21	2.67	4	0	0.00
5/18	0800	24	4.00	6	0	0.00
5/19	0800	53	5.33	27	2	7.41
5/21	1300	19	7.33	8	0	0.00
5/22	0800	4	6.67	3	0	0.00
5/22	1200	96	6.00	140	7	5.00
5/26	1200	19	4.00	16	0	0.00
5/27	0700	5	2.67	9	0	0.00
5/27	1200	2	2.00	2	0	0.00
5/27	1400	24	0.67	18	0	0.00
5/28	1400	300	1.33	17	0	0.00
5/29	2000	2	2.00	9	0	0.00
5/29	2200	1	1.33	13	0	0.00
5/29	2300	1	0.67	7	0	0.00
5/30	0000	1	0.50	9	0	0.00
5/30	0100	57	0.67	104	1	0.96
6/01	1000	54	1.33	40	0	0.00
6/03	1600	16	0.67	5	0	0.00
6/04	0800	5	1.33	0	0	-----
6/04	1300	3	2.00	1	0	0.00

Appendix Table 7.--Continued.

DATE	START TIME	RUN (HOURS)	SAMPLE RATE	MAIN COILS	SAMPLE COILS	ACTUAL RATE
6/04	1600	4	2.67	0	0	----
6/04	2000	12	3.33	1	0	0.00
6/05	0800	4	4.00	1	0	0.00
6/05	1200	25	4.67	8	0	0.00
6/06	1300	1	1.16	0	0	----
6/06	1400	17	4.67	6	0	0.00
6/07	0700	5	5.33	0	0	ERR
6/07	1300	227	6.67	33	0	0.00
6/17	0000	37	10.00	30	4	13.33
7/18	1300	2	20.00	0	0	----
7/18	1500	44	13.30	0	0	----