PROGRESS REPORT
EVALUATION OF FISH PROTECTIVE FACILITIES AT LITTLE GOOSE DAM AND REVIEW OF OTHER STUDIES RELATING TO PROTECTION OF JUVENILE SALMONIDS IN COLUMBIA AND SNAKE RIVERS, 1972

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Research Performed Under Contract No. DACW68-71-0093 Between the Corps of Engineers, Department of the Army and the National Marine Fisheries Service, U.S. Department of Commerce

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February 1973

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INTRODUCTION

During the spring of 1972, the National Marine Fisheries Service (NMFS) under contract of the U.S. Army Corps of Engineers continued, for the second year, an evaluation of fish protective facilities for juvenile salmonids at Little Goose Dam on the Snake River. As in 1971, emphasis was placed on the diverting, collecting, marking and transporting young salmonids for release below Bonneville Dam with appropriate control releases for evaluation of the operations. A magnetic tag detector with fish diverter and trap were installed in the fishway at Little Goose to obtain returning adult fish for data on effect of transport on fish survival and ability to home. Further examination was made on rates, timing and survival of young migrants and on levels of dissolved gases in the Columbia and Snake Rivers. This report summarizes progress on these actions in 1972.

TRAVELING SCREEN AND ORIFICE BYPASS STUDIES

The three traveling screens operated during 1971 were modified extensively and tested again in 1972 before and during the spring outmigration of juvenile salmonids. Permanent inserts were installed in gatewell orifice openings, and fish passage from the bypass system was monitored with electronic counters. Methods of improving passage of fish through orifices were explored and studies continued on source and extent of descaling of fish in the gatewells.

Traveling screen

During the major period of downstream migration, the three traveling screens collectively were in operation 60 percent of the time; at least one screen was in operation throughout the season. This improvement over the operation in 1971 was largely accomplished by changing the drive mechanism from a single to a dual system. The best combination of components to date couples Vickers hydraulic motors (Model 35 M) to Grizzley gear boxes (Model 674) utilizing a double-strand roller drive chain. Tests of four different types of bearing material--Ryertex, MC901 Nylon, Roulon, and Graphalloy--indicated that Graphalloy was the most durable and caused less wear or scoring of the stainless steel shafts.

Fish passage through gatewell orifices

Permanent type inserts were developed and installed to replace clear plastic types used previously to convert orifices from a bell-mouth to a non-tapered design. These inserts were made of $\frac{1}{4}$-inch aluminum plate with a 6-inch opening illuminated from the downstream side by a 75-watt mercury vapor lamp. A 4-inch grating over the opening prevented large

diameter debris from entering the bypass pipe. Nevertheless, it was necessary periodically to inspect the orifices and remove debris that was preventing or obstructing fish passage.

Automatic fish counters were installed at the entrance to the raceways of the fish holding facility, and hourly counts were obtained of fish entering the facility. Comparison of numbers of fish counted indicated that the automatic counter was accurate within 5 percent of manual counts. Under normal turbine operation, peak daily emigration from the gatewells occurred between 7 and 12 p.m. Accumulations of fish were again noted in the gatewells as in the previous year. These accumulation presumably result from delays in fish passage through the submerged ports and are due, in part at least, to excessive turbulence in the gatewells.

We noted that sudden increases in the count of fish at the collection facility were correlated with the shutdown of one or more turbines. Shutting down a turbine, of course, results in complete cessation of turbulence in the gatewells of that unit.

We then designed and instituted a series of tests to reproduce this phenomena. During a 21-day period from April 14 through May 3, we were able to record six 24-hour periods when all three turbines were in continuous operation. These constitute control days. Also interspersed in this 21-day period, were 6 test days in which one of the three turbines was deliberately shut down for a period of 2 to 3 hours between 12 noon to 3 p.m.

Figure 1 graphically portrays the averaged data for the control and test days. Clearly apparent in the comparison is the marked increase in the proportion of fish arriving at the collection facility in conjunction with the shutdown of only one of three turbines. The pattern of fish movement during the balance of the 24-hour period on test days (when all turbines were again operating) conformed fairly well with that on the control days. Declines in hourly movement on test days (primarily in the hours immediately following the turbine shutdown period) can be ascribed to a reduction in numbers of fish available for passage due to the accelerated movement of fish from the gatewells in the preceding period of turbine shutdown. Overall, approximately 50,000 migrants passed from the gatewells during the control days and 93,500 on the test days.

We then considered methods for reducing gatewell turbulence without shutting down the turbine. In two series of tests, we modified the porosity of the vertical barrier screen in gatewell 1B to change the flow pattern in the gatewell. In one set of tests, plywood sheets were attached to the upper 32 feet of screen and to the lower 16 feet of screen, leaving about 36 feet of screen uncovered between the panels (Figure 2). For a second set of tests, only the upper 32 feet of screen was covered with plywood.

In the tests where both upper and lower portions of the screen were covered, water entering the gatewell was reduced by about one-half. Turbulence in the gatewells was reduced, but the reduction of water inflow apparently resulted in an inferior fish entrance condition.

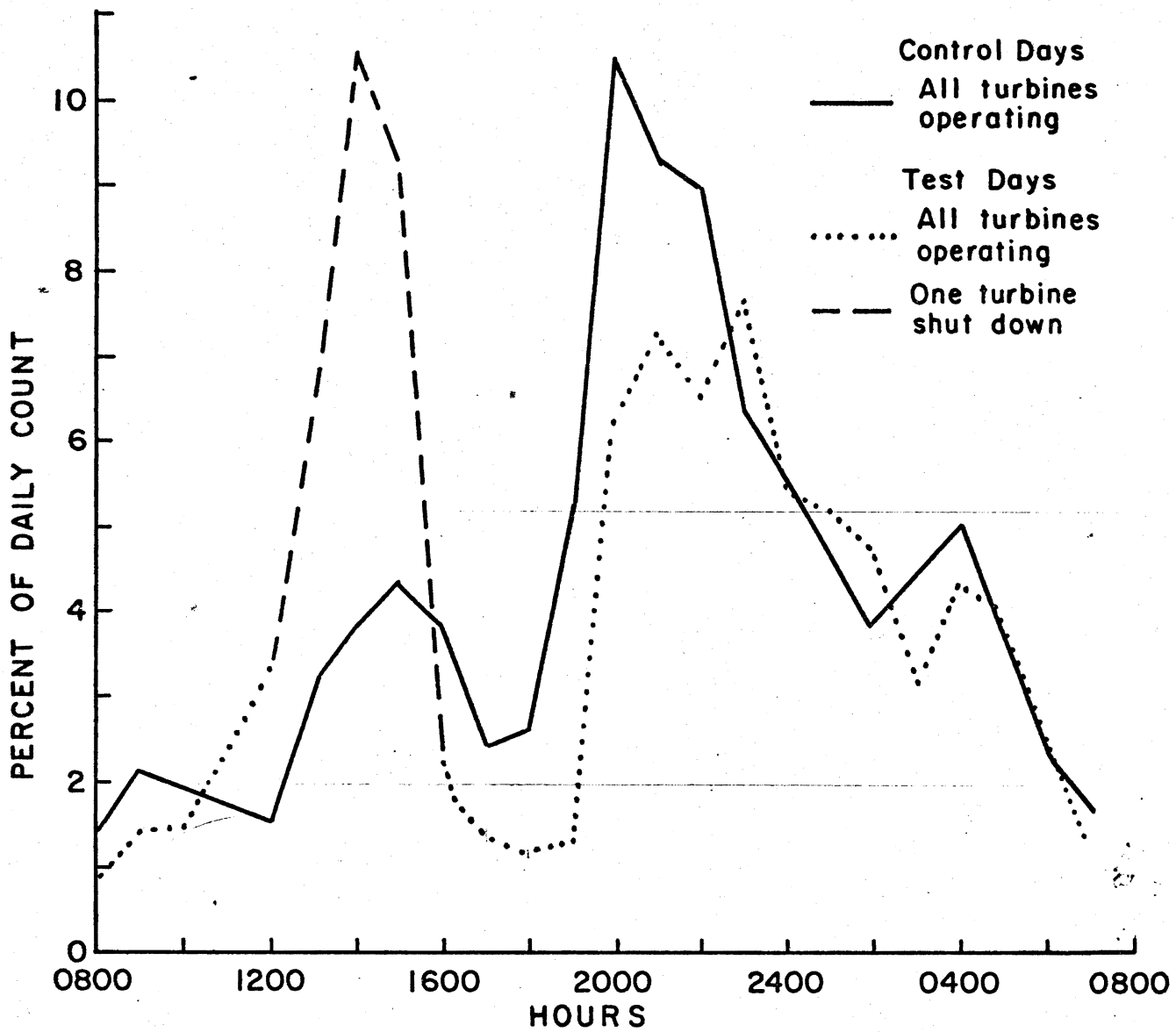

Figure 1.--Hourly distribution of juvenile salmon entering fish collection facility at Little Goose Dam in relation to turbine operation; control period--April 14-30, test period--April 24-May 3.

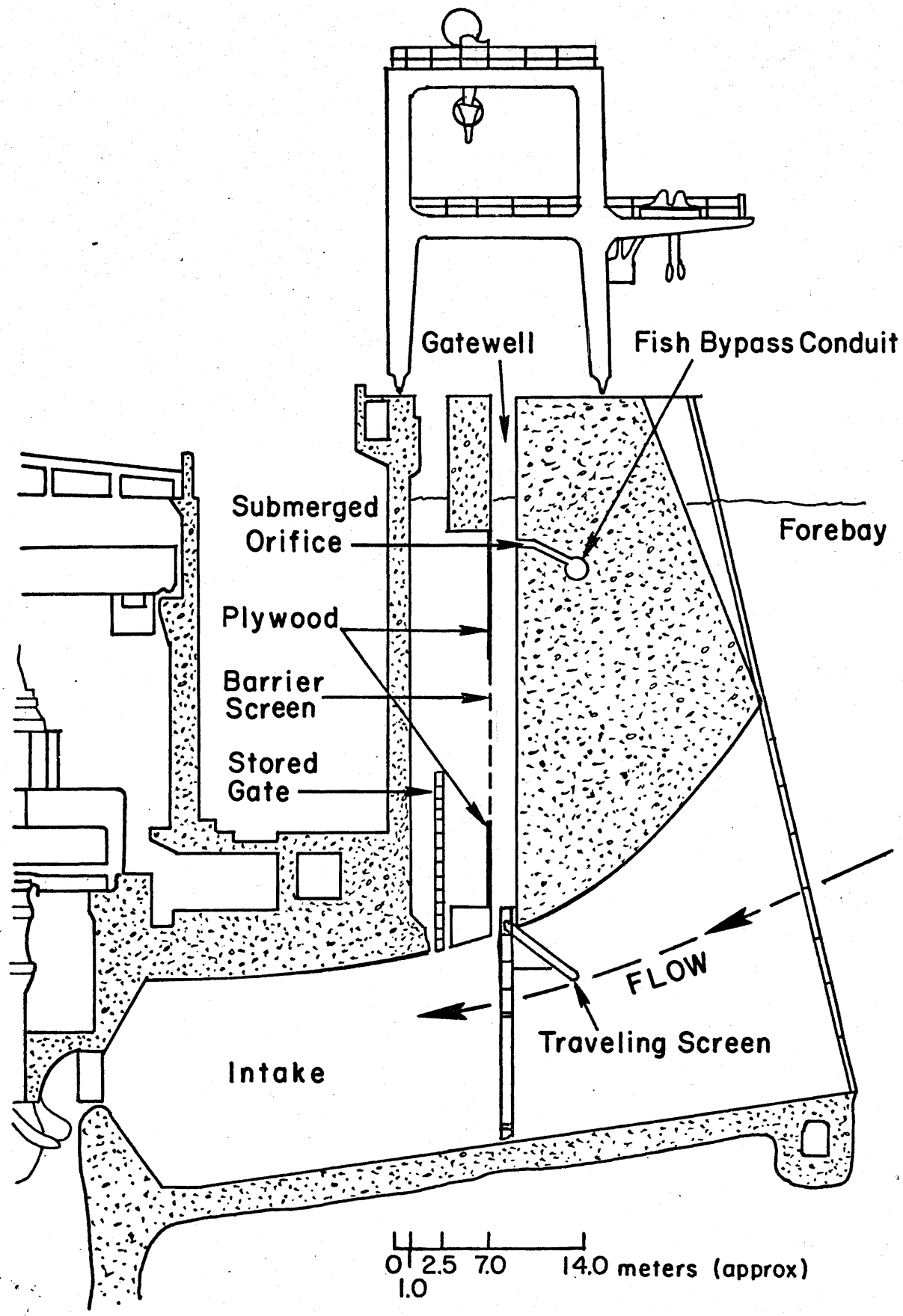

Figure 2.--Turbine intake gatewell showing placement of plywood sheets on barrier screen to reduce surface turbulence in gatewell.

In the tests where only the upper portion of screen was covered, flow entering the gatewell was not reduced significantly. Although the tests were conducted near the end of the juvenile migration when few fish were available, encouraging results were obtained. Turbulence at the surface of the gatewell was essentially eliminated. The fish were well distributed and swimming with much less effort than in adjacent, control gatewells. In addition, passage of fish through the orifice was enhanced. In view of these results, we recommend that the upper levels of all vertical barrier screens at Little Goose Dam be equipped similarly with a suitable non-flow-through material.

Descaling

The degree of descaling appears to be related to length of time fish spend in a gatewell. During periods when fish were dipnetted each day from the wells, the number of descaled fish ranged from 2.4 to 8.0 percent of the total removed. When longer intervals of time existed between dipnetting operations, the percentage of descaled fish ranged from 4.2 to 13.7 percent.

In the event that impingement on the traveling screen might also be contributing to the descaling of fish, a small mesh screen was tested late in the season. There was no evidence that the smaller mesh had an effect on the incidence of descaling but the reduction in mesh size resulted in the deflection of larger volumes of water into the gatewell, thus increasing turbulence on the surface. This turbulence may have counteracted any benefits derived from use of the smaller mesh by increasing the delay of fish in the gatewell. Further discussion on descaling in other areas of the bypass and collection system is given in a subsequent section of this report.

TRANSPORTATION AND HOMING

Progress in the transportation studies at Little Goose Dam during 1972 are summarized in this section of the report.

Objectives of the transportation research were: (1) continue evaluation of the transportation system by marking and releasing 50,000 chinook as controls at Little Goose Dam and 50,000 as test (transported) fish below Bonneville Dam, (2) mark and release 50,000 steelhead at Little Goose (controls) and 50,000 below Bonneville (test) to evaluate the effect of transporting steelhead, (3) on request of the Columbia Basin Fishery Technical Committee (CBFTC) transport all juvenile chinook salmon and steelhead trout collected at Little Goose Dam to release locations below Bonneville Dam, (4) test and evaluate fish facilities used at Little Goose Dam for diverting, collecting, marking, and transferring fish to transport trucks, (5) determine if large numbers of naturally migrating wild and hatchery stocks of juvenile salmon and steelhead can be transported without excessive mortality, and (6) determine levels of stress at various stages of handling and transporting.

General experimental design

Juvenile steelhead and chinook used for the transportation experiment in 1972, were divided into 5 groups--3 control and 2 test or transported groups. One control group was marked, transported one hour, and released about 21 km upstream from Little Goose Dam at Central Ferry; a second control was marked and transported 6 hours and released at the same location; and a third control group was marked and released directly into the tailrace about 1 km downstream from the power house.

The test groups were hauled in tank trucks to two release sites downstream from Bonneville Dam; one was at Dalton Pt., 17 km from Bonneville on the Oregon shore and the other was at the Washington State boat launching site about 2 km from Bonneville Dam on the Washington shore. In 1972, 1-3 ppm quinaldine was used in the transport truck to partially anesthetize fish destined for release at Dalton Pt.; fish released on the Washington shore were not anesthetized. The two conditions provided a basis for comparing mortalities occurring during and after transport. Separate magnetic tag codes and brands were designated for each experimental group. Codes on the tags were changed twice during the marking periods; the brands were changed weekly.

Evaluation of the survival and homing ability of these groups will be based on adult returns to the commercial and sport fishery, Little Goose Dam, and the spawning grounds. A magnetic tag detector and fish separator, similar to that used at Ice Harbor Dam, was installed at Little Goose Dam for evaluation of adults returning to the dam. Limited recovery efforts precluded an evaluation on survival of juveniles to the estuary during the transport experiment.

Evidence in 1971 suggested that cumulative stress may have occurred in fish during passage through the collection and bypass system and in transportation. To provide some information on the degree of stress occurring sequentially in the bypass and transportation process, three groups of juvenile chinook were marked and released subsequent to capture at the following points in the system: (1) from a gatewell

without a traveling screen, (2) from a gatewell with a traveling screen, and (3) after passage through the bypass pipe, upwell, sorter, and marking operation. These fish were then released upstream from Little Goose Dam at Central Ferry. The experiment was evaluated by comparing the number of fish from the various groups recaptured at Little Goose and Ice Harbor Dams.

In addition to evaluating stress by comparing recaptures of fish in relation to their exposure in the system, blood glucose and urea levels were analyzed from six groups of juvenile chinook salmon twice during the migration period. Fish were obtained from the following locations: (1) gatewell with traveling screen, (2) gatewell without traveling screen, (3) counter tunnels (after passage through sorter), (4) holding box after passage through pump, (5) exit of marking building (before entering transport truck), and (6) release site. The percentage descaling was also compared among groups 1, 2, and 3 as an additional stress indicator.

A further experiment was also conducted to determine whether the duration of time spent in the transport truck reduced survival after release. In this experiment comparisons of recoveries of marked fish transported either 1 or 6 hours were again made from collections at Little Goose and Ice Harbor Dams.

Mortality during transport and delayed mortality measurements were compared among all groups transported downstream. These comparisons included high vs low density loads, anesthetized vs loads not anesthetized, and marked vs unmarked. In these comparisons, a high density load was 1.0 pound or more fish/gallon of water; low density was usually $\frac{1}{2}$-pound fish or less/gallon of water.

Collection, marking, and transport procedures

Juvenile salmon entering the gatewells were collected either at the end of the orifice bypass system or on occasion in the gatewells by use of a specially designed dip net. Fish obtained with the gatewell net were used only in the release and recapture experiment for determining stress levels. Fish entering the orifices from gatewells continued on through the bypass pipe (Figure 3) to the holding area downstream from the tailrace deck. Before entering the holding area, the fish passed through a grader and were sorted by size. We adjusted the grades so that most of the juvenile chinook would be separated from the steelhead before entering the holding ponds.

Fingerling chinook salmon and steelhead trout were pumped with a 5-inch Paco model fish pump into a tank in the marking building. Here they were dipped from the tank, anesthetized and sorted. Previously marked or injured and descaled fish were returned to the river in the tailrace of the turbine discharge. Each of the remaining fish was cold-branded with liquid nitrogen (Mighell, 1969), the adipose fin was excised, and a magnetic wire tag (Jefferts, et al., 1963) was inserted in the snout. Before discharge into the transport truck, the fish passed through a magnetic field and detection coil. Improperly tagged fish were automatically rejected and returned to the marker for retagging. When steelhead and chinook were hauled simultaneously, they were kept in separate compartments in the tank truck whenever possible. Load densities were governed by the size of the daily catch and ranged as high as 1.5 pounds fish per gallon. All fish were transported in a 5,000-gal capacity truck with aeration, refrigeration, and filtration.

Figure 3.--Fingerling bypass transport pipe (arrow) and raceways for holding juvenile salmon and steelhead at Little Goose Dam.

Water chemistry measurements were made at the time of release for each load of fish transported. Concentrations of ammonia, nitrogen, dissolved oxygen, carbon dioxide, pH, and total alkalinity were recorded. Most releases were made at dusk. Records of mortality were kept during marking and at time of release. Delayed mortality of transported groups was also determined by holding samples of fish from each load in cages for 48 or more hours at Bonneville hatchery in the Tanner Creek bypass.

Fish obtained with the gatewell net were marked in the same manner as those marked for the transportation experiment--i.e., a wire tag, brand, and adipose clip were used. Blood samples were obtained from fish taken in gatewells (with and without traveling screens) and in the holding area; blood glucose and urea values were determined by Scientia Labs using a technicon SMA 1260 AutoAnalyzer.

Percentage descaling of fish obtained at the three locations was determined during the marking process. Any fish with over 10% visible descaling was recorded as a descaled fish. No further refinement of descaling categories was made.

Results

Marking and transport

Results of the transportation experiment at Little Goose Dam in 1972 are limited primarily to enumeration of the marked experimental groups (Table 1) and the unmarked groups (Table 2) that were released at the control and test sites. Evaluation of the effect of transportation on survival and homing ability will be made upon return of the adults in 1973 and 1974. Results of experiments designed to determine levels of stress at various stages of handling and transport were based on data

Table 1 Summary of marked juvenile chinook and steelhead by release group, Little Goose Dam--Spring 1972.

Marking Period	Release Site	Brand Position[1] and Symbol	Chinook	Steelhead
March 4-April 6	Central Ferry[2]	LA-1S	4401	333
April 10-14	"	LA-$\overline{S}$	2162	936
April 11	"	LA-X	1748	669
April 17-23	"	LA-S1	4465	533
April 24	"	LA-$\underline{S}$	2309	3796
April 27-May 7	"	LA-1Δ	5397	2812
May 8-15	"	LA-$\overline{D}$	4665	6955
May 16-21	"	LA-∇1	5780	7332
May 28-30	"	LA-$\underline{\triangleleft}$	5720	9450
		Subtotal	36,626	32,811
April 4-9	Central Ferry[3]	LA-1C	3396	0
April 10-14	"	LA-$\overline{C}$	5200	796
April 15-23	"	LA-C1	4465	740
April 24	"	LA-$\underline{C}$	913	3359
April 28-May 5	"	LA-1⊔	8703	2872
May 9-15	"	LA-$\overline{\sqsubset}$	3277	2636
May 17	"	LA-⊓1	1252	3322
		Subtotal	27,206	13,725

[1] LA, RA indicate brand positions; i.e. left anterior, right anterior.

[2] Fish transported 1 hour in tank truck before releasing.

[3] Fish transported 6 hours in tank truck before releasing.

Table 1 continued.

Marking Period	Release Site	Brand Position[1/] and Symbol	Chinook	Steelhead
March 31-April 6	Tailrace Little Goose	LA-π	1665	128
April 10-23	" " "	LA-ω	5072	582
April 24-30	" " "	LA-ξ	527	3228
May 1-7	" " "	LA-9	5954	4230
May 8-15	" " "	LA-ω	2013	7717
May 16-21	" " "	LA-6	1611	4001
		Subtotals	16,842	19,886
March 30-April 6	Dalton Pt.	RA-1J	5,137	16
April 10-14	" "	RA-Ξ4	8,128	581
April 17-23	" "	RA-f1	16,677	2,221
April 24-30	" "	RA-ΞΞ	9,934	7,078
May 1-7	" "	RA-1N	6,142	6,832
May 8-15	" "	RA-Ξ	7,140	860
May 16-21	" "	RA-N1	4,319	5,474
		Subtotals	57,477	23,062
March 28-April 6	Bonneville	RA-1V	4984	235
April 10-14	"	RA-Ξ	9028	952
April 17-23	"	RA-Λ1	15,589	1770
April 24-30	"	RA->	10,483	8,449
May 1-7	"	RA-1T	2,892	5,174
May 8-15	"	RA-Ξ1	11,179	2,129
May 16-21	"	RA-⊥1	1,126	2,488
May 22-30	"	RA-ΞΞ	5,998	6,405
		Subtotals	61,279	27,602
		Grand Total	199,430	117,086

Table 2 Numbers of unmarked juvenile chinook and steelhead collected at Little Goose Dam and transported to release location downstream from Bonneville Dam--Spring 1972.

Date	Release Site	Chinook	Steelhead
April 18	Bonneville Boat Launch	2,000	--
April 24-30	" " "	14,850	5,983
May 1-7	" " "	45,600	25,861
May 8-15	" " "	107,411	86,700
May 16-21	" " "	7,000	8,500
May 22-31	" " "	5,278	4,693
June 1-8	" " "	3,506	3,100
	Subtotal	185,645	134,837
April 19	Dalton Point	1,980	--
April 24-30	" "	--	2,493
May 1-7	" "	9,950	6,590
May 8-15	" "	48,581	25,626
May 16-21	" "	--	--
May 22-31	" "	--	--
June 1-8	" "	7,895	6,977
	Subtotal	68,406	41,686
	Grand Total	254,051	176,523

obtained from juveniles; these are discussed along with preliminary data obtained from returns of jack chinook and steelhead from the 1971 experiment.

A total of 199,430 chinook (80,674 controls, 118,756 test) and 117,086 steelhead (66,422 controls, 50,644 test) were marked for the Little Goose experimental groups (Table 1). Approximately 254,000 chinook and 176,000 steelhead were transported unmarked (Table 2). Additional transport of fish from Ice Harbor Dam was omitted this year because of high delayed mortality experienced with fish taken from that site in 1971. The grand total of fish handled at Little Goose in 1972 was about 900,000; about 150,000 of these involved fish that were returned directly to the river at Little Goose Dam and were not included in the evaluation of the transport operation.

More unmarked fish were transported downstream than originally planned due to evidence that perforated bulkhead gates in the skeleton bays were causing substantial mortalities of juvenile migrants. On May 12, after a meeting of the Columbia Basin Fishery Technical Committee, the Corps of Engineers removed the bulkheads and NMFS was requested to transport all steelhead and chinook that were available in the collection facility of Little Goose Dam. Additional unmarked fish were also transported to determine effects of load density on survival. As a result, approximately 600,000 marked and unmarked steelhead and chinook were transported and released downstream from Bonneville Dam. The predetermined number of fish marked per experimental group also was exceeded in all cases.

Return of jacks from the 1971 experiment

Although final evaluation of the effect of transporting juvenile chinook and steelhead cannot be made until all adults have returned from the ocean

following 1 to 3 years residence, returns of jack chinook and 1-ocean steelhead from the 1971 experiment provide an indication of the possible success of that operation. To date (November 5, 1972), 21 spring chinook and 316 steelhead have returned to Little Goose Dam from those released in 1971. A comparison of returns from test and control groups indicates that survival of the transported groups was increased more than 50 percent. If these data follow the pattern indicated in earlier experiments at Ice Harbor, final returns from the 1971 experiment at Little Goose (to be based on returns of adults in 1972, 73 and 74) should result in an overall improvement of 100 percent or more in the survival of transported groups. This is predicated on evidence that transport/control ratios are higher for 2- and 3-ocean fish than for jacks. At any rate, the recent jack returns indicate substantial numbers of adult chinook and steelhead should be returning in 1973 from the 1971 transportation experiment.

Transport and delayed mortality

Since a successful transportation system would require handling and transporting large numbers of steelhead and chinook without excessive mortality, particular attention was centered on determining where injuries and stresses may occur in the handling and transporting system. We were especially concerned with the delayed mortality that occurs after release of the fish since it probably reflects the sum of all the stresses occurring in the system.

Mortality observed at the time of release of the transported groups indicated an overall average of 0.57% for chinook and 0.47% for steelhead. This loss is lower than shown last year for chinook (0.87) but higher than that shown for steelhead (0.16). Samples of fish from each load were held for 48-72 hours at the Bonneville hatchery to determine delayed mortality. A comparison of delayed mortality of fish treated differently in the system was possible this year and included (1) marked and unmarked chinook, (2) marked and unmarked steelhead, (3) high density vs low density loads, and (4) partially anesthetized and unanesthetized chinook.

Delayed mortality of marked steelhead ranged from 0 to 4.0% with an overall average of 1.4%; delayed losses in marked chinook ranged from 0 to 26.0% with an overall average of 10%. Average delayed mortality of unmarked steelhead was 0.85%, slightly lower than delayed mortality of marked steelhead. Average delayed mortality of unmarked chinook was 12.2%, slightly higher than that of marked chinook. The higher loss among unmarked chinook may be explained by the fact that descaled or injured fish were removed from the marked groups but not from the unmarked loads as these fish were pumped directly into the truck. Thus it appears that the higher than expected delayed mortality of the unmarked chinook resulted from injured or descaled fish that had not been removed during the loading process and subsequently died in the holding cages after transport. Steelhead, on the other hand, can apparently withstand injuries and descaling far better than chinook. This species was handled in the same manner as chinook (i.e., no removal of injured and descaled fish in the unmarked loads), yet delayed losses from loads containing injured and

descaled fish (unmarked groups) were essentially comparable to those among groups of marked steelhead from which injured fish had been removed.

A comparison between high and low density loads of chinook indicated that average delayed mortality in nine high-density loads was 7.4%, lower than that for low density loads of either marked or unmarked chinook. Average transport mortality of these high density loads was 1.3%, slightly higher than the overall average of the low density loads (0.57%). The lower delayed mortality among the high density loads of chinook is unexplained at this time. No significant difference was shown between delayed mortality of high and low density loads of steelhead trout.

Average delayed mortality of 16 loads of marked chinook not anesthetized was 13.7%; mortality in 13 loads of partially anesthetized fish was 7.0%, indicating a potential benefit from use of anesthetic. Variability in the results was high, however, and further studies are needed for verification.

It should be noted that delayed mortality among chinook was reduced from an average of about 23% in 1971 to 10% in 1972. We feel that this reduction was obtained by removing all injured and descaled fish from the experimental groups before marking in 1972. Thus, it appears that if injuries and other stresses to the fish can be eliminated in the collection and transport system, the delayed mortality can no doubt be even further reduced. This conclusion is substantiated by subsequently described stress experiments wherein rate of recapture and blood chemistry of the fish are compared in relation to various stresses encountered in the system.

Descaling and stress

Daily records of the percentage of descaling indicated that about 16% of all chinook salmon entering the marking facility at Little Goose Dam bore some measure of descaling. Of this total, about 4% of the chinook apparently were descaled before entering the turbine intakes, an additional 4% was associated with the traveling screens or hydraulics in the gatewells, and about 8.8% occurred as the fish passed from the gatewells through the orifice, bypass pipe, collection area, and pump into the marking building.

Recovery of marked fish and blood chemistry are discussed below in relation to the degree of stress encountered by fish in various areas of the bypass, collection, and transportation system.

Recovery rates at Little Goose Dam of juvenile chinook salmon released at Central Ferry following different exposures in the bypass system are presented in Table 3. (Comparable recovery rates were also observed at Ice Harbor Dam). These recoveries indicate no substantial difference in survival among the three groups.

Blood glucose and urea levels measured from the aforementioned fish and additional groups in the handling sequence (Figure 4) indicate an increase in stress after marking (Group 4), but no significant difference in stress among groups taken from the gatewells (Groups 1 and 2) and after passage through the bypass (Group 3). An additional increase in stress was noted in fish following transport (Group 5).

A further experiment to determine whether the duration of transport significantly affected survival of fish after release again indicated that the increased stress noted in blood chemistry was not

TABLE 3.--Comparison of recoveries of three groups of juvenile chinook salmon released at Central Ferry and recaptured at Little Goose Dam, April-June 1972. Group I was dipped from gatewell with traveling screen; Group II, dipped from gatewell without a traveling screen; Group III from facility after passing through collection system and marking procedure.

Date released	Number released	Number recaptured	Percentage recapture	Dates of recaptures
Group I				
3/30-4/5	1,966	181	9.2	4/4-5/9
4/10-4/14	1,834	139	7.5	4/12-6/1
4/17-4/21	2,000	264	13.2	4/17-5/17
4/25-4/28	1,583	341	21.5	4/27-5/30
5/3-5/5	1,000	36	3.6	5/8-6/6
5/8-5/12	2,257	51	2.2	5/12-6/8
5/16-5/19	408	13	3.1	5/18-6/8
Totals	11,048	1,025	--	--
Cumulative average			9.2	
Group II				
3/30-4/5	741	75	10.1	4/3-5/3
4/10-4/14	1,705	202	11.8	4/17-5/12
4/17-4/21	3,000	355	11.8	4/17-5/25
4/25-4/28	2,000	137	6.8	4/27-5/30
5/3-5/5	1,830	75	4.6	5/8-6/6
5/8-5/12	2,000	50	2.5	5/11-6/6
5/16-5/19	1,100	50	4.5	5/22-6/6
Totals	12,376	944	--	--
Cumulative average			7.6	
Group III				
3/30-4/7	4,401	280	6.4	4/3-5/1
4/10-4/14	2,369	238	16.3	4/26-5/16
4/17-4/21	4,465	523	11.7	4/20-6/8
4/25-4/29	2,162	274	12.7	4/13-5/19
5/1-5/6	5,376	275	5.1	5/1-6/6
5/8-5/13	4,465	216	4.6	5/10-6/8
5/15-5/20	4,786	314	5.4	5/22-6/8
Totals	29,024	2,120	--	--
Cumulative average			7.3	

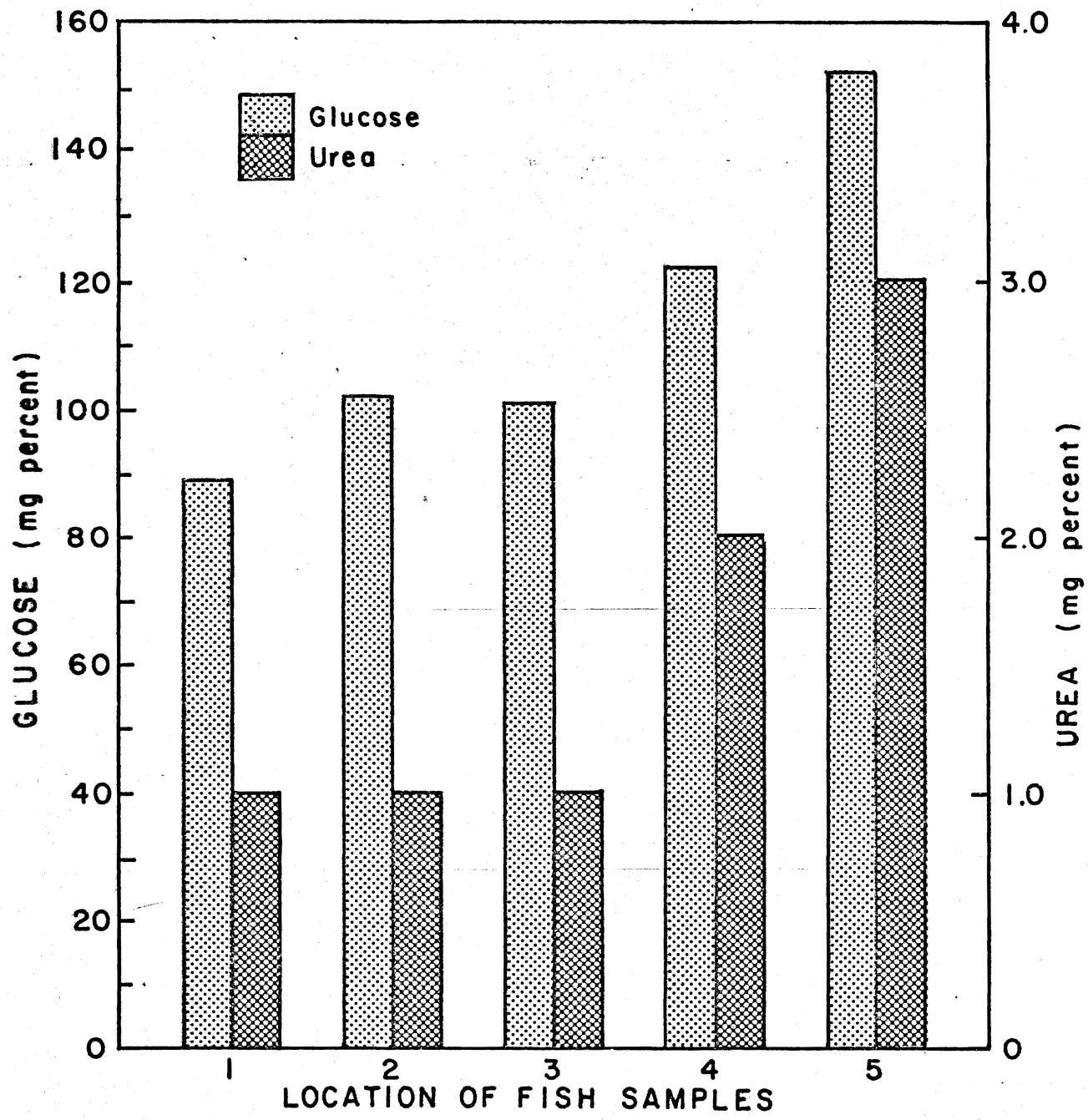

Figure 4.--Urea and glucose concentrations in juvenile chinook taken sequentially at five locations in the diversion, bypass, and transportation operation of Little Goose Dam, April, 1972. Location: (1) gatewell with traveling screen, (2) gatewell without screen, (3) separator counter tunnels (4) after exit from marking building, (5) release site after transporting.

reflected in the recovery rate (survival). Comparisons of recovery rate (Table 4) of juvenile chinook and steelhead trout marked at Little Goose Dam and transported either 1 or 6 hours and released at Central Ferry, indicated a slight difference in recovery rate among collections at Little Goose but no difference in recovery rate at Ice Harbor. Thus, we feel that the stresses indicated by increases in blood glucose and urea were not serious enough to cause changes in the rate of survival. The data, however, seem to indicate that the factors such as injury and descaling are of primary importance and if these are eliminated, the major cause of mortality will be eliminated.

General observations of fish diversion and collection system

In general, the holding and handling facility at Little Goose Dam functioned satisfactorily. The fish grader was modified this year to eliminate a portion of the debris problem, but further modifications will be needed. Improvements made in the electronic counting system increased the accuracy and no further modification of this portion of the system is contemplated. We anticipate that some changes will be made in the design of the collection and bypass system to alleviate descaling and injury to fish. For example, we determined that debris does lodge at the juncture of the orifice pipe and the main conduit where a 90-degree turn exists. Long sticks apparently jam at these points and cause descaling and injury when fish pass this area of the bypass. The debris must be removed before next spring and a method of preventing the longer debris from entering the orifices must be devised. We also noted that the longer sticks tend

parison of recoveries of juvenile chinook salmon and steelhead trout marked at Little Goose Dam and transported either
6 hours and released.

RECOVERY LOCATION

ed:	Little Goose						Ice Harbor			
	Chinook			Steelhead			Chinook		Steelhead	
Numbers Marked	Numbers Recaptured	Percentage Recaptured	Numbers Marked	Numbers Recaptured	Percentage Recaptured	Numbers Recaptured	Percentage Recaptured	Numbers Recaptured	Percentage Recaptured
4,401	280	6.4	333	41	12.3	37	.8	8	2.4
2,162	274	12.7	936	237	25.3	70	3.2	52	5.5
4,465	523	11.7	533	144	27.0	151	3.3	31	5.8
2,309	238	16.3	3,796	759	20.0	45	1.9	71	1.8
1,748	273	15.6	664	190	28.6	50	2.8	43	6.4
5,376	275	5.1	2,812	301	10.7	59	1.0	37	1.3
4,665	216	4.6	6,955	462	6.6	22	.4	104	1.4
5,780	314	5.4	7,332	450	6.1	43	.7	144	1.9
5,720	230	4.0	9,450	1,132	12.0	41	.7	277	2.9
36,635	2,623	--	32,811	2,584	--	518	--	767	--
. . . . .	. . . . .	7.1	. . . . .	. . . . .	7.9	. . . . .	1.4	. . . . .	2.3
ed:									
3,396	433	12.8	0	0	0.0	62	1.8	0	0.0
5,200	718	13.8	796	244	28.0	187	3.5	39	4.8
4,465	625	14.0	740	153	20.7	119	2.6	37	5.0
913	120	13.0	3,359	533	15.9	12	1.3	58	1.7
8,703	397	4.6	2,872	418	14.6	118	1.3	44	1.5
3,277	168	3.3	2,636	132	5.0	10	.3	28	1.0
1,252	41	3.3	3,322	224	6.8	11	.8	75	2.2
27,206	2,502	--	13,725	1,704	--	519	--	281	--
. . . . .	. . . . .	9.2	. . . . .	. . . . .	12.4	. . . . .	1.9	. . . . .	2.0

to lodge in the intake of the fish transfer pump. This problem has been solved by installing a plexiglas section with a quick coupling in the intake. Now any debris can be quickly detected and removed.

Although bypass systems incorporated in the recently constructed Little Goose, Lower Monumental, and John Day Dams utilized the most advanced knowledge available at the time of construction, it is apparent from our observations at Little Goose Dam that the enclosed conduit system can create several problems where fish and debris must travel through relatively inaccessible orifices and pipes. Removal of debris from entrances to the orifices can be accomplished by hand, but once the material passes into the closed system, blockages must be removed by other means. In these instances, virtually the only access to the debris is through the 6-inch orifice where the blockages are nearly impossible to remove without a major shutdown of either a turbine or the whole bypass system. We believe the open system recommended for Lower Granite Dam will eliminate the majority of debris problems at that site, but solution of the descaling and injury problems due to debris in the closed system at Little Goose (and quite possibly at Lower Monumental and John Day Dams) obviously must be achieved by other means. Action should be taken before next spring's migration to assure that existing debris is removed and that subsequent periodic checks are made to maintain a debris-free system during the downstream migration. Effort also should be expended on devising methods of preventing debris from entering these systems.

DISSOLVED NITROGEN IN THE COLUMBIA AND SNAKE RIVERS WITH OBSERVATIONS OF EFFECTS ON STEELHEAD AND CHINOOK

Monitoring of the dissolved nitrogen levels in the Columbia and Snake Rivers was continued in 1972 to determine (1) effects on nitrogen levels of changes in flow distribution that would result from additional perforated bulkhead gates at dams in the Snake River, (2) relation of flow and load control to nitrogen levels, (3) effect of the prototype spillway deflectors, and (4) effect of prevailing saturation levels on survival of juvenile and adult steelhead and chinook migrants. The following summarizes data collected and analyzed to date.

Methods

Methods used for collection and analysis of the nitrogen samples in 1971 were similar to those reported by NMFS in 1971 except that five additional stations (Appendix Table 1) in the Snake River drainage were sampled. Nitrogen data listed in the tables and figures contain the argon fraction in air.

The saturometer developed by Weiss was also tested. Data obtained with this instrument were compared with values obtained by use of sampling and analysis techniques described by NMFS in previous years.

Effects of nitrogen saturation levels on fish were based on techniques similar to those used in 1971. Fish holding tests conducted in previous years were not repeated, however, in 1972. Daily observations of gas bubble disease symptoms in juvenile steelhead and chinook arriving at Ice Harbor Dam were recorded from March 30-May 1, then periodically

thereafter. Population estimates based on recapture of marked groups from upstream locations were continued. These are given in another section of this report.

Information on the condition of mature adults will be based on data from Rapid River hatchery and spawning ground surveys made by Idaho Fish and Game and the National Marine Fisheries Service. These data are incomplete at this time, but preliminary observations indicate that prespawning mortalities were much lower than last year.

Results

Nitrogen concentrations and effect of perforated bulkheads and flow control

Forebay (10 m depth) and tailrace (surface) concentrations of dissolved nitrogen for 1971 and 1972 on the Columbia and Snake Rivers are compared in Figure 5. Appendix Table 1 gives the oxygen and nitrogen concentration, location, temperature, depth, and flow at the time the individual samples were taken in 1972.

Nitrogen concentrations in the Snake River were considerably lower in April and early May of 1972 than in 1971 even though flows were nearly as high as those measured in 1971. Later in the season flows were higher than in 1971. The lower dissolved gas levels in 1972 were due to the operation of the perforated bulkheads. In 1971, flows at Little Goose Dam during the April 6 to May 4 surveys ranged from 99,700 to 199,000 cfs; concentrations of nitrogen and argon exceeded 130 percent saturation. During the same period in 1972, flows ranged from 78,000 to 133,000 cfs

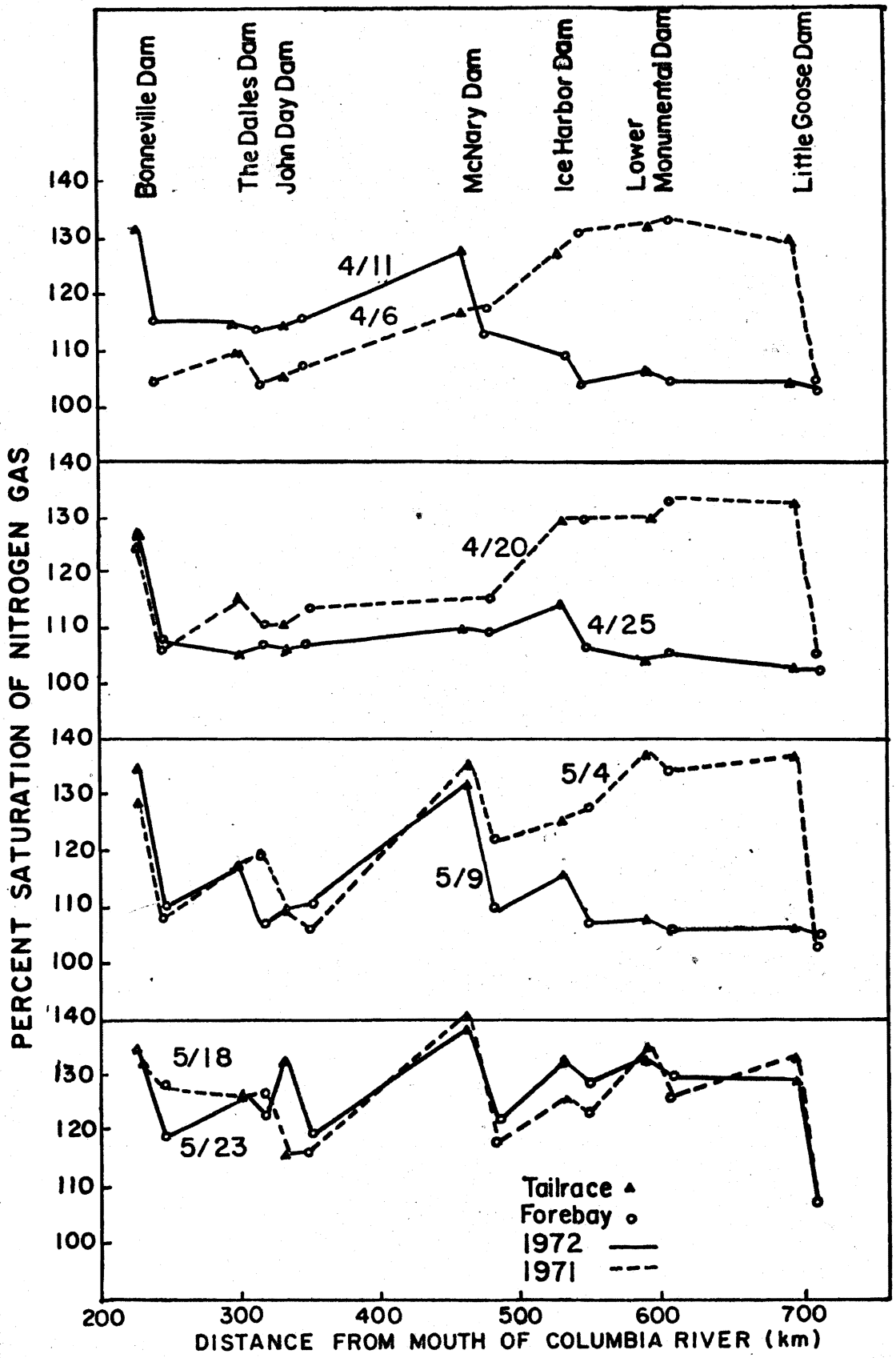

Figure 5.--Forebay (10m) and tailrace (surface) concentrations of dissolved nitrogen and argon in samples from Little Goose Dam to Bonneville Dam, April-August, 1971 and 72.

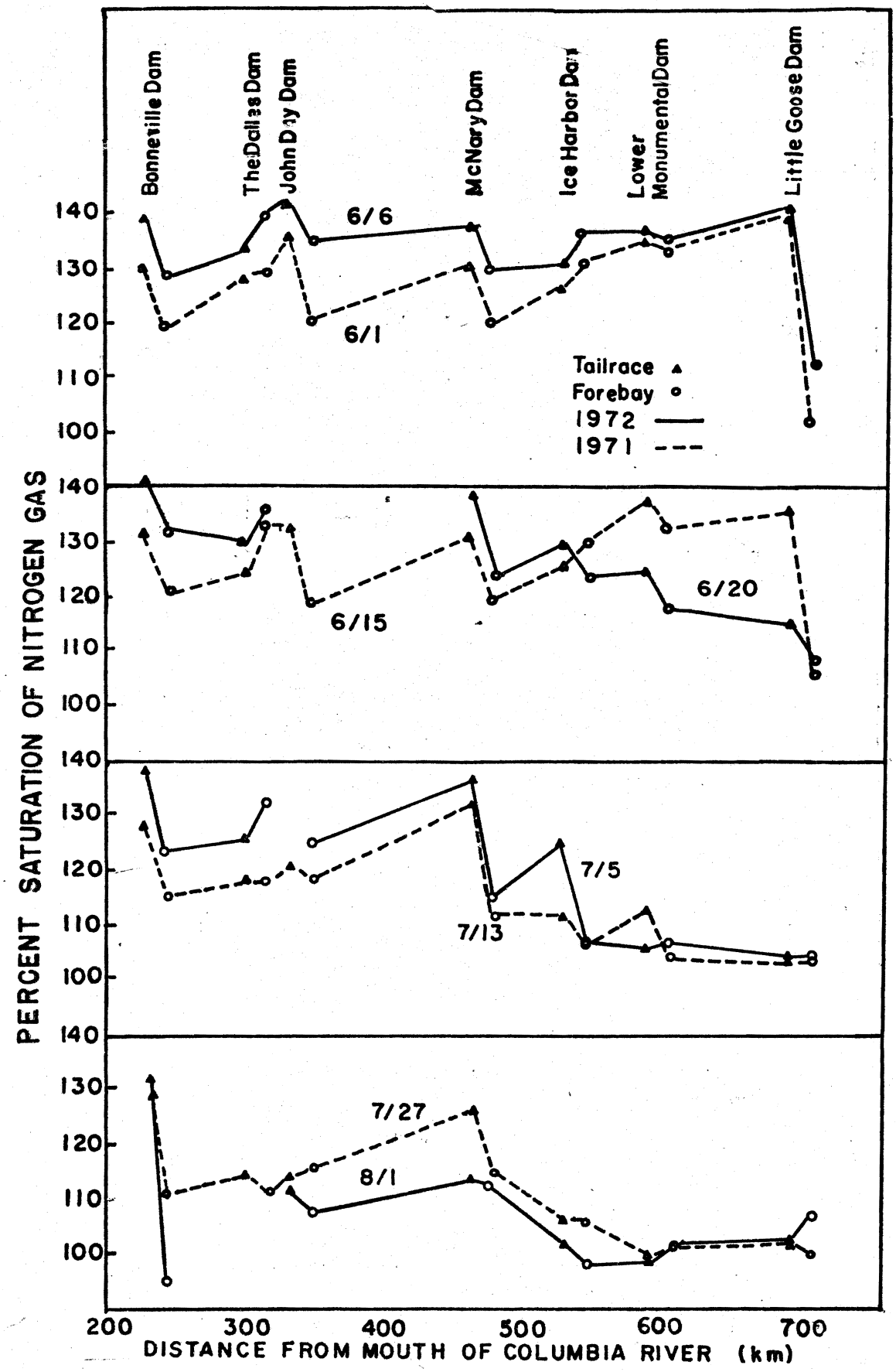

Figure 5.--continued

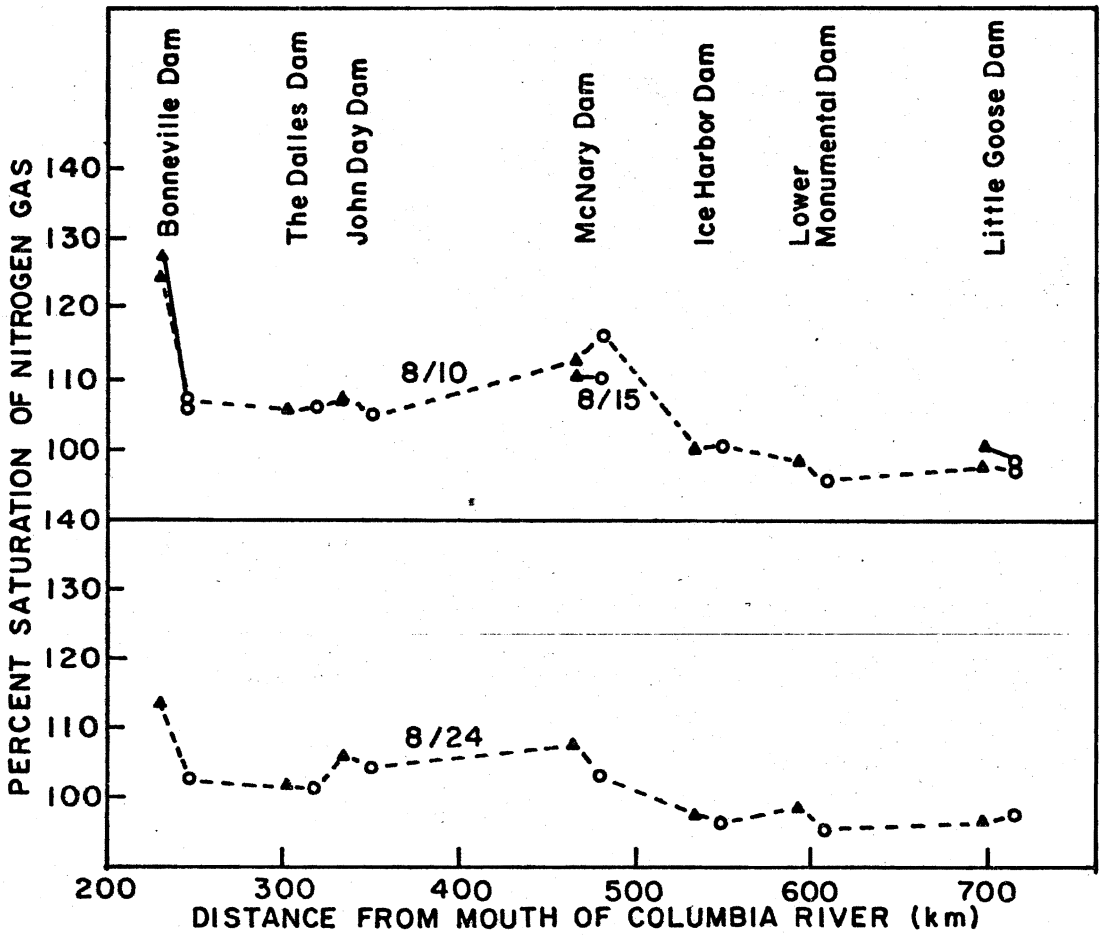

Figure 5.--continued

and nitrogen concentrations remained below 110 percent saturation.

On about May 9, 1972, a substantial number of dead juvenile chinook and steelhead were observed below Little Goose Dam, and an emergency meeting was held by personnel from fisheries agencies and the Corps of Engineers to examine the available data. On the basis of information available at that time, a decision was made to close some of the gates pending further study concerning the magnitude of these losses. By May 23, sufficient information was available to indicate that the losses were caused by the perforated bulkheads, and that mortality probably exceeded that which would occur from gas bubble disease. The Corps was then requested to remove from operation all perforated bulkheads. Nitrogen concentrations on the Snake River immediately increased to a range of 125 to 132 percent because water that formerly passed through the bulkheads was diverted to the spillways. Concentrations returned to comparatively low levels after re-installation of the gates in early June. Levels between Little Goose and Ice Harbor Dams remained below 125 percent even though mean daily flows in the Snake were near 150,000 cfs. By August 1, concentration in both the Columbia and Snake Rivers were no higher than 114% saturation except in the Bonneville tailrace which was 132 percent.

Concentrations on the Columbia River were also comparatively low until the May 23 survey. By that time, flows on the Columbia had increased to nearly 500,000 cfs which resulted spills of over 300,000 cfs. Prolonged spilling continued throughout June and July, and nitrogen concentrations from 125 to 135 percent were common in the Columbia until August 1 even though the bulkheads were re-installed in Snake River Dams by June 10.

Flow and load control measures were undertaken by the Corps of Engineers again in 1972 to reduce dissolved gas concentrations during the time when major releases of fish were planned from the lower Columbia River hatcheries. Flow control began on April 24 and continued through April 28. Flow on April 24 was reduced at Bonneville from 268,100 to 174, 900 cfs. Average nitrogen concentration measured at Prescott, Oregon, (Table 5) was reduced about 5.6 percent during the flow control period. The most dramatic reduction in nitrogen concentration occurred below McNary Dam; concentrations before flow control (Figure 5, see 4/11 and 4/25) exceeded 125 percent saturation, but during flow control levels did not exceed 110 percent. In addition to reducing the overall nitrogen level, a marked increase in adult passage at Bonneville Dam occurred during the period of flow control. Five days prior to flow control, passage ranged between 5 and 9,000 chinook salmon a day. During flow control, passage ranged from 7 to 19,000, more than a 100% increase over the previous period. Whether this increase was the result of flow control or merely the natural peaking of the run (normally occurring in late April) is unknown at this time.

Effect of prototype flow deflector on nitrogen concentrations

Several tests to determine the effect of prototype flow deflectors at Lower Monumental and Bonneville Dams on nitrogen concentrations were conducted this year. Analysis of the Bonneville data will be included in a detailed report by Mr. Tervooren of the Portland district of Corps of Engineers; our analysis of the data obtained at Lower Monumental follows.

TABLE 5.--Average concentrations of dissolved nitrogen before, during and after flow control in the Columbia River at Prescott, Oregon.

DATE	NITROGEN Percent Saturation	Mean Daily Flow at Bonneville (KCFS)
	BEFORE FLOW CONTROL	
April 17	114.4	312.3
April 18	113.4	312.5
April 19	116.0	290.8
April 20	115.7	263.2
April 21	111.8	268.1
Average	114.2	
	DURING FLOW CONTROL	
April 24	111.5	174.9
April 25	106.7	189.6
April 26	105.4	196.8
April 27	108.3	190.7
April 28	110.0	193.8
Average	108.6	
	AFTER FLOW CONTROL	
May 1	109.8	275.8
May 2	113.0	262.6
May 3	115.4	282.2
May 4	114.5	270.8
May 5	117.3	260.2
Average	114.0	

Data on concentration of dissolved gasses were obtained on four occasions at Lower Monumental Dam from April 3 to June 21 when tailwater levels ranged from elevation 442.3 to 444.5 and forebay gas concentrations ranged from 103 to 112% saturation. Analyses were made of water samples taken (Appendix Table 2) below spillway bay 2 (equipped with flow deflector with dentates), and spillway bay 3 (without flow deflector). Data obtained on May 10 were omitted in the final analysis because the sampling procedure was altered and mixing occurred between the test spill bay with deflector and the control spill bay without deflector.

Figure 6, constructed from data obtained on April 3, illustrates the effectiveness of the spillway deflector at three flow volumes from 4,600 to 14,900 cfs. The most dramatic reduction occurred at the 4,600 cfs discharge. The highest concentration recorded in samples taken below bay 2 with spillway deflector was 16.9 ml/l nitrogen (109.7% saturation); in samples taken below bay 3, the control bay, concentrations reached 20.3 nitrogen (131.8% saturation). Data collected on the other dates show similar results, indicating the deflector will substantially reduce nitrogen concentrations regardless of tailwater depth or nitrogen concentration in the forebay.

A pictoral representation of the effect of the deflector on tailwater flow is shown in Figure 7. This photo was taken at Lower Monumental during the time when the tests were conducted. The highly aerated flow is obviously spread out over a wide area, thus reducing the plunging to depths where high hydraulic pressures produce the high nitrogen concentrations by forcing the entrained air into solution.

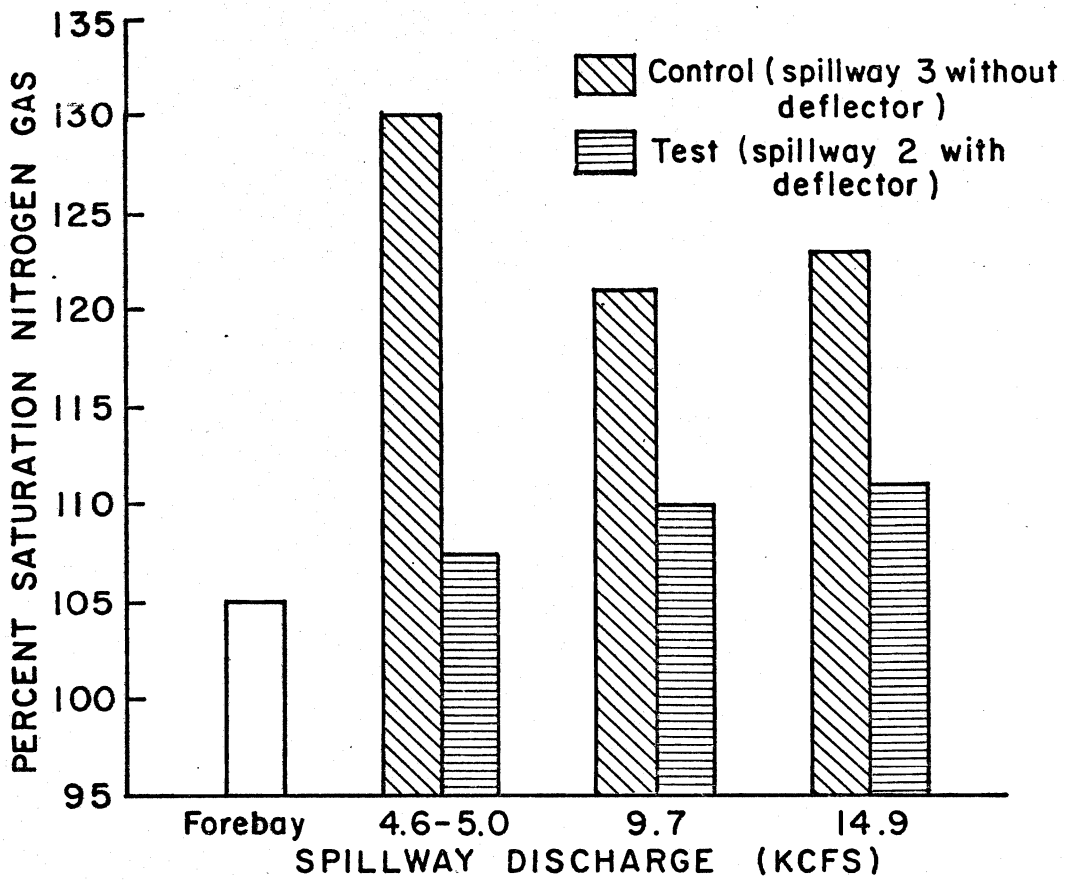

Figure 6.--Average nitrogen concentration measured at Lower Monumental Dam in forebay, below spillway deflector, and control spillway bay at three flows; April 4, 1972.

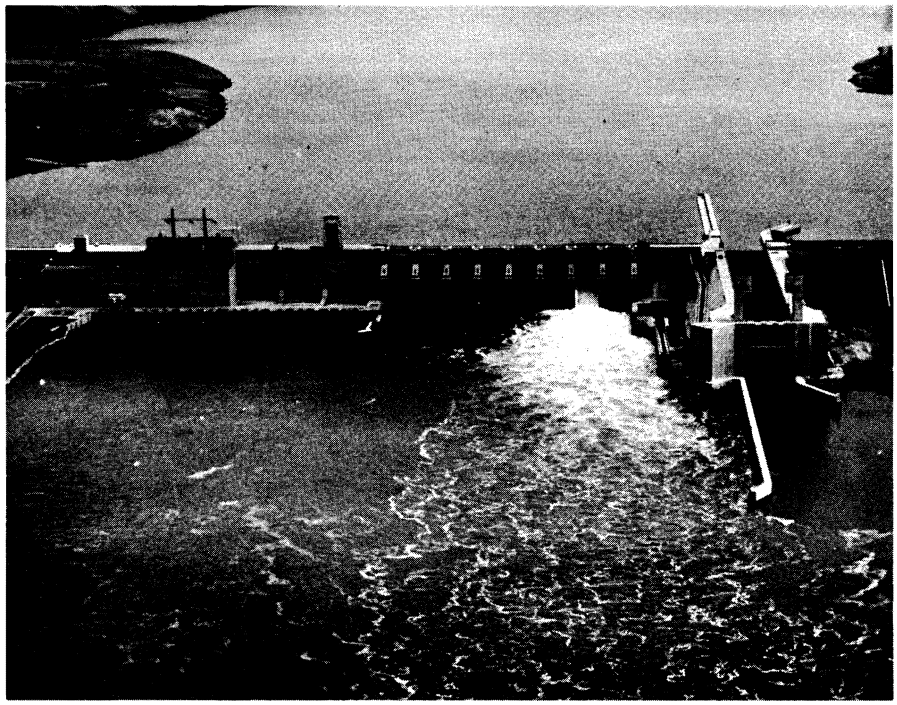

Figure 7.--Spillway discharge at Lower Monumental Dam showing surface spreading of water passing over the spillway deflector.

Comparison of saturometer with gas chromatograph

On 77 separate occasions from April 3 to July 18, 1972, the saturometer value in percentage saturation of total gas was compared with the value obtained from the same location and at the same time by use of the chromatograph as the analytical instrument.

The average overall difference in percentage saturation total gas of these 77 comparisons was -0.88%; i.e., on the average the saturometer read 0.88% lower than the chromatograph. The maximum difference noted was 8.50 percent. The mean difference in total gas pressure in terms of mm mercury was 9.20.

Effect of nitrogen supersaturation on fish

Percentage of fish with symptoms of gas bubble disease was recorded from samples of steelhead trout and chinook salmon captured in gatewells at Ice Harbor Dam. These observations are used as indicators of the effect of nitrogen concentrations on the fish populations migrating downstream in the Snake River. Between March 30 and April 4, 10 to 15 percent of the chinook and 10 to 40 percent of the steelhead examined had obvious symptoms of gas bubble disease, but after that period when the perforated bulkheads were installed no symptoms were observed. On about May 30, after a portion of the bulkheads had been removed from operation, symptoms began occurring and by May 26, virtually 100 percent of the fish examined had gas bubble disease.

It was interesting to note that observers at Ice Harbor Dam indicated that the fish were in generally excellent condition during the time when the bulkheads were in operation and that very few of the individual fish

examined at Ice Harbor had injuries that might have been attributed to damage from passage through the slotted gates. This suggests that the majority of the injured or weakened fish succumbed before reaching Ice Harbor Dam.

We expected that symptoms of gas bubble disease might also begin appearing in adult salmon arriving at Little Goose after May 23. Therefore, all tag recoveries and other fish inadvertently captured in the adult trap at Little Goose Dam were examined for symptoms. Only two salmon of approximately 100 examined, however, had obvious symptoms of gas bubble disease.

Reports from Idaho Fish and Game personnel regarding the numbers of fish taken in the sport fishery and observed on the spawning grounds ranged from below average to above average. Reports of condition of fish on spawning ground and in Rapid River Hatchery[1/] indicated that fish were in better condition than noted for several years. Apparently, the lower gas levels achieved with the slotted gates, coupled with flow control measures, enabled the recent spring and summer runs to reach the spawning grounds in much better condition than those observed during the past several years. Numbers of adults arriving at Rapid River hatchery were above normal but percentage return, based on number released, was 0.44%, or about the same as last year.

1/ Verbal communication, Terry Holubetz and Evan Parish, Idaho Fish and Game.

No live cage tests were planned this year because it was expected that concentrations of dissolved gases would remain low due to the operation of the perforated bulkheads and that little mortality would be expected from supersaturation of atmospheric gases.

Although difficulties were encountered this year in attempting to solve the problem of supersaturation of atmospheric gases, we feel that considerable progress has been made through continuing cooperative efforts between the Corps of Engineers and the fisheries agencies.

TIMING, TRAVEL TIME, AND SURVIVAL OF JUVENILE CHINOOK AND STEELHEAD POPULATIONS MIGRATING IN THE SNAKE RIVER

Method

Timing and survival measurements of juvenile chinook (as in 1970 and 1971) were based on recoveries at Ice Harbor Dam of fish collected, marked, and released at Riggins, Idaho on the Salmon River. Marks were changed every 3 days to obtain a measure of timing and differences in survival throughout the outmigration. Additional data were available from releases of marked fish at hatcheries and in the forebay and tailrace of Little Goose Dam. Numbers of fish marked at individual locations and subsequently recovered at Little Goose, Ice Harbor, McNary, and The Dalles Dams are given in Table 6.

Estimates of survival of chinook salmon migrants are based on a comparison of the observed recovery of the various groups of marked fish released at Riggins with the expected recovery percentage based on independent experiments involving release and recovery of marked fish at Ice Harbor Dam. The resulting survival percentage was then compared to pre-dam (1966-68) estimates to obtain a relative measure of the difference in survival between pre- and post-dam periods. Use of the relative survival index represents a departure from the method used in previous years when absolute values of fish losses were estimated.

Assessments of steelhead migrations from the Salmon River were impractical due to the low capture efficiency of this species at Riggins. Other detail on timing of steelhead at Ice Harbor and on population estimates at Little Goose and Ice Harbor Dams was obtained from sampling and marking programs at these sites.

Table 6.--Number of fish marked and subsequently recovered at Little Goose, Ice Harbor, McNary, and The Dalles Dams.

Release area	Species	No. marked	No. recovered 1/			
			Little Goose	Ice Harbor	McNary	The Dalles
Riggins (wild)	Chinook	75,000	2,826	696	158	52
Rapid River (hatchery)	Chinook	200,000	6,909	452	5	15
Kooskia (hatchery)	Chinook	50,000	2,875	318	2	1
Hayden Creek (hatchery) 2/	Chinook	50,000	21	26	0	0
Pahsimeroi (hatchery) 2/	Chinook	50,000	3	16	0	0
Lochsa (hatchery)	Chinook	100,000	2,083	185	0	6
Hayden Creek (hatchery)	Steelhead	50,000	54	10	0	0
Pahsimeroi (hatchery)	Steelhead	50,000	168	42	0	0
Little Goose forebay	Chinook	36,000	2,623	518	211	32
Little Goose forebay	Steelhead	33,000	2,584	767	122	5
Little Goose tailrace	Chinook	17,000	---	418	171	13
Little Goose tailrace	Steelhead	20,000	---	494	130	8
Ice Harbor forebay	Chinook	31,000	---	1,047	327	63
Ice Harbor forebay	Steelhead	11,000	---	260	84	2

1/ Collection facilities at Little Goose operated spring only, Ice Harbor operated all year, and McNary and The Dalles operated spring only.
2/ Fall releases, 1971.

Chinook Salmon

Timing and Travel Time

The outmigration of chinook passing Ice Harbor Dam in 1972 started on March 30 and was mostly completed by June 15. Two peaks occurred during the outmigration, a lesser early peak between the 20th and 24th of April and the main peak on May 12. Travel time from the Salmon River to Ice Harbor Dam averaged 19 days (Table 7), ranging from 28 days for the earlier migrants to 13 days for the later fish. The bimodel timing and variation in travel time were related to river flow and temperatures during the migration period.

Water flows during the outmigration of chinook in 1972 were more comparable with those in 1970 than in 1971. Warm weather in mid-March increased water temperature which triggered an early migration of fish from the Salmon River. This was followed by cooler weather and decreased water temperature through most of April prior to the major runoff in May. Although the chinook outmigration from the Snake River started several weeks earlier than in previous years, the central portion of the run held up for periods of several days to 2 weeks before resuming migration downstream. One major difference was noted between river conditions in 1972 and 1970. Concentrations of N_2 below Little Goose through May 12 ranged between 96-110% as compared to 129-136% in 1970.

Relative Magnitude

Approximately 3,000,000 naturally-reared chinook were estimated to have passed our sampling site at Riggins on the Salmon River, the highest

Table 7.--Average travel time to Ice Harbor Dam and dates of peak migration for juvenile chinook salmon from the Salmon River, 1966-72.

Year	Travel time (days)	Peak of migration	Water flow (cfs) at peak of migration
1966	14	4/27	48,000
1967	17	5/3	42,000
1968	16	4/26	37,000
1969 1/	--	4/25	129,000
1970	25	5/13	88,000
1971	17	5/4	188,000
1972	19	5/12	125,000

1/ Trap on Salmon River not operated in 1969.

number since sampling started in 1966. These plus the 2,500,000 released at Rapid River Hatchery and recruitment from other tributaries of the Snake River resulted in an estimated 5-6 million juveniles arriving at Little Goose Dam. Population estimates at Ice Harbor Dam, however, accounted for only 1.8 million, leaving approximately 3-3.5 million fish unaccounted for between Little Goose and Ice Harbor after subtracting the 375,000 chinook transported below Bonneville Dam from Little Goose.

Survival

The estimated survival of 1.8 million chinook juveniles at Ice Harbor Dam represents only 30-36% of the original population passing Little Goose Dam. Survival estimated by comparing population estimates at Little Goose and Ice Harbor closely agrees with the estimates based on marked fish recoveries from the Salmon River. Relative survival of chinook from the Salmon River to Ice Harbor Dam in 1972 ranged from 27-36% of that in the pre-dam (1966-68) period. This compares with a relative survival of 53-70% in 1971 and 30-40% in 1970. The differences between survival in the 1970-72 period are probably the result of varying environmental conditions encountered by the juveniles passing downstream in each year.

In 1970-71, exposure of juveniles to nitrogen concentrations of 130% or more is believed to have accounted for most of the decline in survival in the Snake River from that of the pre-dam rates (70-90%). As discussed in the previous progress report, the apparent increase in survival in 1971 over that in 1970 may have been the result of a more rapid movement of fish (6 days faster than in 1970) in the Snake River, which would have reduced their exposure to high N_2. We speculated, however, that since N_2 levels in the Columbia River were much higher in 1971 than in 1970, additional stresses

downstream from Ice Harbor in 1971 may have resulted in a total survival to the estuary that would have been as low or lower than that in 1970.

By contrast, a major portion of the mortality in the Snake River in 1972 may have been related to passage of migrants through the slotted gates. Over 50% of the outmigration was present in the lower Snake River when 38-51% of the river flow was passing through slotted gates (Table 8). Evaluation of the effects of the gates at Lower Monumental Dam on fish by Long, et al, in 1972 indicated that the minimum mortality rate was 50%. Applying this rate to the proportion of the total outmigration passing through gates at both Lower Monumental and Little Goose Dams, we can estimate that approximately 50% or 1.5 to 1.7 million of the fish unaccounted for between Little Goose and Ice Harbor Dams could have been lost from passage through slotted gates.

Similar approximations can be made for losses due to passage through turbines and effects of nitrogen supersaturation. These indicate that roughly 750-850,000 fish were lost in turbine related passage (applying a 20% turbine loss) and approximately the same number due to N_2 effects (applying a 50% loss during periods of high N_2).

Survivors migrating downstreams from Ice Harbor Dam to the estuary in 1972 were undoubtedly subjected to additional losses from passage through slotted gates at Ice Harbor Dam, turbines in Columbia River dams, and additional exposure to high N_2 in the Columbia River. Although we have no precise measure of these losses there is some indication from lower river sampling, that losses in the Columbia River in 1972 may have been substantial.

Table 8.--Timing of the chinook outmigration in the Lower Snake River in relation to water quality (N_2 levels) and percent of river discharge through slotted gates, turbines, and spill, 1972.

Period	Percent of total chinook outmigration	Percent of river discharge[1/] through--			N_2 saturation-%
		Turbines	Slotted gates[2/]	Spill	
3/30-4/13	9	49	51	0	104
4/14-4/21	10	62	38	0	104
4/22-5/1	10	73	19	8	104
5/2-5/6	13	58	41	1	104
5/7-5/12	24	50	48	2	104
5/13-5/15	9	49	25	26	115-125[3/]
5/16-5/23	13	38	16	46	132
5/24-6/5	12	38	0	62	138

1/ Average of combined discharge at Little Goose and Lower Monumental Dams.

2/ Gates partially removed May 10; all removed by May 23.

3/ N_2 value estimated on basis of spill. No actual measurements taken during this period.

Numbers of yearling chinook collected at McNary and The Dalles Dams in 1972 declined significantly from collections made in 1967 when comparable populations of outmigrants, water flows, and sampling effort were in effect (Table 9).

If the declines in numbers collected in 1972 (76% at McNary and 90% at The Dalles from 1967) are at all indicative of the mortalities that may have occurred, then total survival to the estuary in 1972 may have been lower than in either 1970 or 1971.

Steelhead Trout

The outmigration of steelhead passing Ice Harbor Dam started on March 30, but no significant numbers were collected until May 3. The peak of the migration occurred on May 21, 9 days later than the main peak of the chinook outmigration. Insufficient numbers of steelhead were collected and marked at Riggins or at hatcheries to obtain a measure of travel time or survival to Ice Harbor Dam. Approximately 2.0 million steelhead were estimated passing Little Goose Dam and 1.5 million at Ice Harbor Dam for an estimated survival of 71%. The apparent higher survival for steelhead than for chinook is probably related to species and timing differences. Data available are insufficient for estimates of steelhead losses by cause, nor are there sufficient base data on which survival in 1972 can be related to the pre-dam (1966-68) period.

Table 9.--Numbers of yearling chinook collected at McNary and The Dalles Dams, 1967 and 1972[1/].

Location	1967	1972	Percent decline
McNary Dam	153,000	37,000	76%
The Dalles Dam	45,000	4,600	90%

1/ Total outmigrants from upriver areas, water flows, and sampling effort comparable in 1967 and 1972.

SUMMARY AND CONCLUSIONS

Results of recent studies at Little Goose Dam and related work in other areas of the Snake and Columbia Rivers are listed below:

1. Operation of the traveling screens was markedly improved over that in 1971. The three screens under test collectively ran 60% of the time; at least one of the screens was in operation throughout the spring migration period. Conversion from a single to dual drive system was the major factor influencing improved operation of the screens. Changes in bearing material should further enhance operation in the future. Tests on the effect of screen mesh size on descaling of fish were inconclusive.

2. Turbulence in the gatewells adversely affected fish passage through the bypass orifices and appeared instrumental in the descaling of fish. Plywood sheets attached to upper levels of the stationary vertical screens reduced surface turbulence in the gatewells and improved fish passage through the orifices. A dramatic improvement in fish passage from the gatewells was observed in conjunction with the shutdown of a turbine which eliminated all turbulence in the wells.

3. Approximately 900,000 juvenile chinook salmon and steelhead were handled at Little Goose Dam during the 1972 downstream migration. Overall, nearly 600,000 (375,000 chinook and 225,000 steelhead) of these were transported downstream for release below Bonneville Dam. About 200,000 chinook (81,000 controls and 119,000 transport) and 117,000 steelhead (66,000 controls and 51,000 transport) were marked for evaluation of the bypass and transportation system. An additional

430,000 unmarked fish (254,000 chinook and 176,000 steelhead) were transported and released below Bonneville Dam and nearly 150,000 (marked and unmarked) fish were released in the vicinity of Little Goose Dam.

4. Mortality of fish during transport was low--less than 1% for both chinook and steelhead. Delayed mortality (as determined from holding after transport) was high for chinook (averaging about 11%), but remained low for steelhead (about 1%). Although some evidence of cumulative stress was indicated from analysis of blood samples taken from fish at progressive points in the bypass and transportation system, no correlations were found between degree of stress and survival of fish. Descaling and other injuries that occurred during transit through the bypass and collection facilities appear to be the primary causes of the high post release mortality in chinook. Load density (up to 1.5 lbs of fish/gal) and duration of transport had no demonstrable effect on survival of fish.

5. Approximately 16% of all chinook entering the marking facility were descaled. (Fish were recorded as descaled when over 10% descaling was visible.) Four percent of the descaling apparently occurred before the fish entered the turbine intakes, another 4% was associated with the traveling screens or turbulence in the gatewells, and about 8.8% was incurred during passage through the bypass and collection systems. Debris lodged in inaccessible areas of the bypass is suspect in much of this descaling and needs to be removed.

6. Operation of the slotted bulkheads in the Snake River in April and early May 1972 significantly lowered concentrations of nigrogen and argon (below 110 percent) from those recorded in 1971.

7. Concentrations of nitrogen and argon in the Columbia River were also comparatively low until May 23 when the slotted bulkheads were removed and river flows began to rise.

8. Flow control measures undertaken on April 24 through April 28 reduced nitrogen concentrations about 5.6 percent at Prescott and more than 15 percent below McNary Dam. A marked increase in adult passage over Bonneville Dam was also noted during this period.

9. Tests of the prototype flow deflector (with dentates) at Lower Monumental indicated that this type deflector will reduce dissolved gas concentrations substantially regardless of tailwater depth.

10. Observations of symptoms of gas bubble disease on juveniles ranged from no symptoms during the time the bulkhead gates were installed to 100 percent after they removed. Benefits from control of gas saturation levels were also observed among adult fish migrating up the Snake River and tributaries. Prespawning fish arriving at Rapid River Hatchery were in excellent condition with no gas bubble symptoms observed.

11. The outmigration of juvenile chinook passing Ice Harbor Dam in 1972 started on March 30, peaked on May 12 and was mostly completed by June 15. Travel time from the Salmon River to Ice Harbor Dam averaged 19 days as compared to 17 days in 1971 and 25 days in 1970.

12. Approximately 3,000,000 juvenile chinook were estimated moving down the Salmon River at Riggins, Idaho, the largest outmigration since sampling began in 1966. An estimated 5-6 million juvenile chinook arrived at Little Goose Dam from all upstream sources. Only 1.8 million were estimated at Ice Harbor Dam, leaving approximately 3-3.5 million fish unaccounted for between the two dams.

13. Relative survival at chinook from the Salmon River to Ice Harbor Dam ranged from 27-36% of the pre-dam (1966-68) period. This compares with a relative survival of 53-70% in 1971 and 30-40% in 1970. Differences in survival can be related to varying environmental conditions encountered.

14. Approximately 50% of the juvenile chinook unaccounted for in the lower Snake River in 1972, or 1.5 to 1.7 million fish, could have been lost from passage through slotted gates. By contrast, most of the loss in 1970-71 was probably related to exposure of the juveniles to nitrogen concentrations in excess of 130%.

15. There is some indication from sampling below Ice Harbor that losses in the Columbia River in 1972 may have been substantial. Numbers of chinook collected at The Dalles in 1972 declined 90% from numbers collected in 1967 for comparable effort, water flow, and populations of outmigrants.

16. Peak of the steelhead outmigration passing Ice Harbor Dam occurred on May 21, 9 days later than the main peak of the chinook outmigration. Survival of steelhead was estimated at 71%. The apparent higher survival for steelhead is probably related to species and timing differences.

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Appendix Table 1.--Dissolved gas saturation data for Columbia River and tributaries, March - August 1972.

LOCATION	DATE DY	MO	YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GA/E OPEN	HOURLY FLOW RRRJAE/RRRR SPILL	HOURLY FLOW RRRJAE/RRRR TOTAL
SALMON R.													
1/4 MI ABOVE MTH	28	03	72	0805	00	5.7	11.90	98.2	15.80	99.5			
SNAKE R.													
ABOVE SALMON R.	28	03	72	0815	00	8.5	12.20	108.0	16.60	111.5			
COLUMBIA RIVER													
PRESCOTT ORE SIDE	28	03	72	0900	00	7.6	13.20	110.6	18.50	117.8			
SOAKE -.													
ABOVE CLEARWATER	28	03	72	0915	00	7.9	11.80	102.1	16.20	106.5			
CLEARWATER R.													
1/4 MI ABOVE MTH	28	03	72	0940	00	4.3	13.30	105.1	17.60	106.4			
LWR GRANITE SITE													
PRIOR TO OPERATION	28	03	72	1005	00	7.2	12.00	101.8	16.60	107.1			
LITTLE GOOSE FOREBAY													
1/4 MI UP CENTER	28	03	72	1025	00	7.5	11.60	99.1	15.80	102.6	8	023.0	123.0
LITTLE GOOSE FOREBAY													
1/4 MI UP CENTER	28	03	72	1025	33	7.2	11.50	97.5	16.00	103.2	8	023.0	123.0
LITTLE GOOSE TAILRACE													
1/4 MI DN SPILL SIDE	28	03	72	1035	00	7.2	12.20	103.1	17.10	109.9	8	023.0	123.0
PALOUSE R.													
1/2 MI ABOVE MTH	28	03	72	1045	00	7.9	12.50	107.5	16.10	105.2			
LWR MONUMENT FOREBAY													
1/4 MI UP CENTER	28	03	72	1105	00	7.8	12.30	105.5	16.40	106.9	0	000.0	100.0
LWR MONUMENT FOREBAY													
1/4 MI UP CENTER	28	03	72	1105	33	7.6	11.80	100.7	16.60	107.7	0	000.0	100.0
LWR MONUMENT TAILRACE													
1/2 MI DN SPILL SIDE	28	03	72	1115	00	7.5	12.30	104.3	17.30	111.6	0	000.0	100.0
ICE HARBOR FOREBAY													
1/4 MI UP CENTER	28	03	72	1130	00	8.0	13.00	111.6	18.40	120.0	10	059.0	108.0
ICE HARBOR FOREBAY													
1/4 MI UP CENTER	28	03	72	1130	33	7.7	13.00	110.8	18.00	116.6	10	059.0	108.0
ICE HARBOR TAILRACE													
1/2 MI DN SPILL SIDE	28	03	72	1140	00	7.7	13.90	118.1	19.30	124.6	10	059.0	108.0
COLUMBIA													
ABOVE SNAKE	28	03	72	1150	00	4.2	14.70	114.3	19.50	116.0			
MCNARY DAM FOREBAY													
1/4 MI UP SPILL SIDE WN.	28	03	72	1205	00	6.3	13.70	112.4	18.70	116.9	12	122.0	344.0

LOCATION	DATE DY	MO	YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	28	03	72	1205	33	5.1	13.70	109.0	18.70	113.7	12	122.0	344.0
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	28	03	72	1220	00	8.2	13.70	117.8	18.90	123.4	12	122.0	344.0
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	28	03	72	1220	33	6.2	14.10	115.4	18.90	117.9	12	122.0	344.0
MCNARY TAILRACE 1/4 MI DN SPILL SIDE WN.	28	03	72	1220	00	5.7	16.10	129.8	22.10	135.9	12	122.0	344.0
MCNARY TAILRACE 1/4 MI DN POWER SIDE OR.	28	03	72	1225	00	6.3	13.80	112.9	18.70	116.6	12	122.0	344.0
JOHN DAY FOREBAY 1/4 MI UP CNTR	28	03	72	1400	00	8.1	13.70	117.2	19.10	124.1	4	035.0	377.0
JOHN DAY FOREBAY 1/4 MI UP CNTR	28	03	72	1400	33	6.5	13.70	112.6	19.20	120.3	4	035.0	377.0
JOHN DAY TAILRACE 1/2 MI DN SPILL SIDE	28	03	72	1410	00	6.5	14.70	120.4	20.10	125.5	4	035.0	377.0
THE DALLES FOREBAY 1/4 MI UP CENTER	28	03	72	1425	00	6.6	13.40	110.0	18.50	115.7	23	160.0	373.0
THE DALLES FOREBAY 1/4 MI UP CENTER	28	03	72	1425	33	6.6	13.60	111.7	18.70	117.0	23	160.0	373.0
THE DALLES TAILRACE 1/2 MI DN SPILL SIDE	28	03	72	1435	00	6.6	14.40	117.9	19.88	124.0	23	160.0	373.0
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	28	03	72	1500	00	7.0	13.40	110.8	18.30	115.2		205.0	340.0
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	28	03	72	1500	33	6.8	13.40	110.3	18.60	116.5		205.0	340.0
BONNEVILLE TAILRACE 1/4 MI DN SPILL SIDE	28	03	72	1510	00	6.8	15.10	124.1	20.90	130.7		205.0	340.0

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LOCATION	DATE DY MO YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
LITTLE GOOSE TAILRACE 1/4 MI DN SPILL SIDE	11/04/72	0930	000	8.2	11.60	100.5	16.00	105.2	0	000.0	113.0
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	11/04/72	0930	000	8.1	11.50	99.7	15.70	103.4	0	000.0	113.0
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	11/04/72	0930	033	8.2	11.50	99.9	15.80	104.3	0	000.0	113.0
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SIDE	11/04/72	1010	000	8.4	11.80	102.3	16.40	108.0	0	000.0	112.0
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	11/04/72	1010	000	8.5	11.40	99.4	16.00	105.9	0	000.0	112.0
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	11/04/72	1010	033	8.5	11.10	96.8	15.90	105.3	0	000.0	112.0
ICE HARBOR TAILRACE 1/2 MI DN SPILL SIDE	11/04/72	1037	000	8.8	11.90	103.8	16.80	111.2	5	009.5	111.0
ICE HARBOR FOREBAY 1/4 MI UP CENTER	11/04/72	1037	000	8.8	11.10	97.2	15.50	102.9	5	009.5	111.0
ICE HARBOR FOREBAY 1/4 MI UP CENTER	11/04/72	1037	033	8.7	11.10	96.9	15.80	104.7	5	009.5	111.0
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	11/04/72	1050	000	8.2	13.10	112.6	17.50	114.3	15	091.0	327.0
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	11/04/72	1050	033	7.9	14.60	124.6	18.20	118.0	15	091.0	327.0
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	11/04/72	1050	000	8.4	13.10	113.2	17.70	116.1	15	091.0	327.0
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	11/04/72	1050	033	7.9	13.00	111.0	17.70	114.8	15	091.0	327.0
MCNARY TAILRACE 1/4 MI DN POWER SIDE OR.	11/04/72	1050	000	8.0	13.20	112.7	18.00	116.7	15	091.0	327.0
MCNARY TAILRACE 1/4 MI DN SPILL SIDE WN.	11/04/72	1050	000	7.8	15.10	128.3	20.00	129.1	15	091.0	327.0
COLUMBIA ABOVE SNAKE	11/04/72	1050	000	6.9	14.00	116.6	18.50	117.3			
JOHN DAY TAILRACE 1/2 MI DN SPILL SIDE	11/04/72	1325	000	8.4	12.80	109.9	17.70	115.4	11	022.0	365.0
JOHN DAY FOREBAY 1/4 MI UP CNTR	11/04/72	1325	000	9.1	12.90	113.1	17.50	116.3	11	022.0	365.0

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LOCATION	DATE DY	DATE MO	DATE YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
JOHN DAY FOREBAY 1/4 MI UP CNTR	11	04	72	1325	033	8.4	12.90	111.2	17.90	117.1	11	022.0	365.0
THE DALLES TAILRACE 1/2 MI DN SPILL SIDE	11	04	72	1346	000	8.4	13.10	112.1	17.80	115.7	23	147.0	352.0
THE DALLES FOREBAY 1/4 MI UP CENTER	11	04	72	1346	000	8.4	13.10	112.5	17.30	112.8	23	147.0	352.0
THE DALLES FOREBAY 1/4 MI UP CENTER	11	04	72	1346	033	8.5	12.90	111.0	17.60	115.0	23	147.0	352.0
BONNEVILLE TAILRACE 1/4 MI DN SPILL SIDE	11	04	72	1425	000	8.3	14.90	127.0	20.40	132.1	14	216.0	361.0
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	11	04	72	1425	000	8.2	12.90	109.9	17.60	113.9	14	216.0	361.0
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	11	04	72	1425	033	8.3	13.00	111.0	17.90	116.1	14	216.0	361.0
COLUMBIA RIVER PRESCOTT ORE SIDE	11	04	72	1510	000	8.6	13.10	112.4	18.30	119.2			

LOCATION	--DATE-- DY MO YR	TIME	DEPT FT	TEMP C	---OXYGEN-- MG/L	SAT	ATMOSPHERIC --NITROGEN- ML/L	SAT	NO. GATE OPEN	HOURLY FLOW ---KCFS---- SPILL	TOTAL
CLEARWATER R. 1/4 MI ABOVE MTH	25/04/72	0750	000	6.8	12.40	104.4	17.00	109.0			
SNAKE R. ABOVE CLEARWATER	25/04/72	0750	000	10.3	10.80	99.0	14.60	101.2			
SALMON R. 1/4 MI ABOVE MTH	25/04/72	0840	000	9.2	11.00	99.0	15.00	102.3			
SNAKE R. ABOVE SALMON R.	25/04/72	0840	000	10.2	11.10	102.3	15.20	106.0			
LWR GRANITE SITE PRIOR TO OPERATION	25/04/72	1015	000	9.2	11.30	100.6	15.40	103.9			
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	25/04/72	1045	000	9.2	11.20	99.7	15.00	101.2	0	0.0	078.0
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	25/04/72	1045	033	9.2	11.20	99.7	15.60	105.3	0	0.0	078.0
LITTLE GOOSE TAILRACE 1/4 MI DN SPILL SIDE	25/04/72	1100	000	9.2	11.20	99.4	15.60	104.9	0	0.0	078.0
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	25/04/72	1120	000	9.6	11.30	101.2	15.40	104.5	0	0.0	078.0
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	25/04/72	1120	033	9.4	11.30	100.7	15.80	106.7	0	0.0	078.0
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SIDE	25/04/72	1135	000	9.4	11.30	100.4	15.60	105.0	0	0.0	078.0
ICE HARBOR FOREBAY 1/4 MI UP CENTER	25/04/72	1155	000	9.4	11.30	100.4	16.00	107.7	0	0.0	076.0
ICE HARBOR FOREBAY 1/4 MI UP CENTER	25/04/72	1155	033	9.3	11.40	101.0	16.00	107.4	0	0.0	076.0
ICE HARBOR TAILRACE 1/2 MI DN SPILL SIDE	25/04/72	1218	000	9.4	11.90	105.3	17.10	114.7	0	0.0	076.0
COLUMBIA RIVER ABOVE MOUTH SNAKE	25/04/72	1235	000	8.4	13.00	112.3	16.80	110.2			
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	25/04/72	1320	000	9.2	12.20	107.5	16.70	111.5	0	0.0	205.0
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	25/04/72	1320	033	9.2	12.30	108.3	16.40	109.5	0	0.0	205.0
MCNARY TAILRACE 1/4 MI DN POWER SIDE OR.	25/04/72	1328	000	9.2	12.30	108.1	16.40	109.2	0	0.0	205.0

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LOCATION	DATE DY	DATE MO	DATE YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
MCNARY TAILRACE													
1/4 MI DN SPILL SIDE WN.	25	04	72	1330	000	9.2	12.50	109.8	16.60	110.6	0	0.0	205.0
MCNARY DAM FOREBAY													
1/4 MI UP SPILL SIDE WN.	25	04	72	1405	000	9.0	12.20	106.9	16.10	107.0	0	0.0	205.0
MCNARY DAM FOREBAY													
1/4 MI UP SPILL SIDE WN.	25	04	72	1405	033	8.1	12.20	104.6	16.50	107.5	0	0.0	205.0
JOHN DAY FOREBAY													
1/4 MI UP CNTR	25	04	72	1550	000	9.2	12.10	106.3	16.50	109.9	0	0.0	181.0
JOHN DAY FOREBAY													
1/4 MI UP CNTR	25	04	72	1550	033	9.2	12.00	105.4	16.20	107.9	0	0.0	181.0
JOHN DAY TAILRACE													
1/2 MI DN SPILL SIDE	25	04	72	1600	000	9.2	12.20	106.8	16.20	107.5	0	0.0	181.0
THE DALLES FOREBAY													
1/4 MI UP CENTER	25	04	72	1620	000	9.1	12.30	107.4	16.10	106.6	0	0.0	191.0
THE DALLES FOREBAY													
1/4 MI UP CENTER	25	04	72	1620	033	9.2	12.40	108.5	16.20	107.5	0	0.0	191.0
THE DALLES TAILRACE													
1/2 MI DN SPILL SIDE	25	04	72	1630	000	9.2	12.20	106.5	16.00	105.8	0	0.0	191.0
BONNEVILLE FOREBAY													
1/2 MI UP SPILL SIDE	25	04	72	1705	000	9.0	12.20	105.9	15.90	104.7	8	42.0	188.0
BONNEVILLE FOREBAY													
1/2 MI UP SPILL SIDE	25	04	72	1705	033	9.0	12.50	108.6	16.40	108.0	8	42.0	188.0
BONNEVILLE TAILRACE													
1/4 MI DN SPILL SIDE	25	04	72	1720	000	9.0	14.20	123.1	19.40	127.6	8	42.0	188.0
COLUMBIA RIVER													
PRESCOTT CENTER	25	04	72	1755	000	9.6	11.80	103.7	16.00	106.5			

LOCATION	DATE DY MO YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	09/05/72	0945	000	10.9	10.90	101.0	15.10	105.7	0	00.0	130.8
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	09/05/72	0945	033	11.0	10.80	100.3	15.20	106.7	0	00.0	130.8
LITTLE GOOSE TAILRACE 1/4 MI DN SPILL SIDE	09/05/72	1000	000	11.1	10.90	101.1	15.40	107.9	0	00.0	130.8
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	09/05/72	1023	000	11.5	10.90	102.1	15.00	106.0	0	00.0	132.7
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	09/05/72	1023	033	11.5	10.90	102.1	15.10	106.7	0	00.0	132.7
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SIDE	09/05/72	1039	000	11.5	11.10	103.6	15.50	109.2	0	00.0	132.7
ICE HARBOR FOREBAY 1/4 MI UP CENTER	09/05/72	1058	000	11.6	11.70	109.4	15.70	110.8	8	30.5	1331
ICE HARBOR FOREBAY 1/4 MI UP CENTER	09/05/72	1058	033	11.5	11.10	103.6	15.40	108.4	8	30.5	133.1
ICE HARBOR TAILRACE 1/2 MI DN SPILL SIDE	09/05/72	1106	000	11.6	12.40	115.6	16.70	117.4	8	30.5	133.1
COLUMBIA RIVER ABOVE MOUTH SNAKE	09/05/72	1122	000	10.2	12.80	115.5	16.90	115.3			
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	09/05/72	1147	000	11.2	12.60	116.3	16.50	115.0	15	98.0	325.0
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	09/05/72	1147	033	10.9	12.30	112.8	15.80	109.5	15	98.0	325.0
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	09/05/72	1147	000	11.3	12.30	113.8	15.80	110.4	15	98.0	325.0
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	09/05/72	1147	033	11.0	12.40	114.0	15.70	109.0	15	98.0	325.0
MCNARY TAILRACE 1/4 MI DN SPILL SIDE WN.	09/05/72	1206	000	11.0	14.30	131.1	19.20	133.0	15	98.0	325.0
MCNARY TAILRACE 1/4 MI DN POWER SIDE OR.	09/05/72	1217	000	11.0	12.30	112.8	16.20	112.2	15	98.0	325.0
JOHN DAY FOREBAY 1/4 MI UP CNTR	09/05/72	1414	000	12.2	11.90	112.1	15.40	109.4	20	32.0	356.0
JOHN DAY FOREBAY 1/4 MI UP CNTR	09/05/72	1414	033	12.1	12.30	115.6	15.70	111.3	20	32.0	356.0

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LOCATION	DATE DY	DATE MO	DATE YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
JOHN DAY TAILRACE 1/2 MI DN SPILL SIDE	09	05	72	1425	000	12.0	11.80	110.3	15.70	110.6	20	32.0	356.0
THE DALLES FOREBAY 1/4 MI UP CENTER	09	05	72	1442	000	11.9	11.60	108.1	15.40	108.3	23	144.0	345.0
THE DALLES FOREBAY 1/4 MI UP CENTER	09	05	72	1442	033	12.0	11.40	106.5	15.20	107.1	23	144.0	345.0
THE DALLES TAILRACE 1/2 MI DN SPILL SIDE	''	'8	84	448'	'''	44.'	44.8'	448.4	48.8'	448.4	44	444.'	448.'
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	09	05	72	1528	000	11.7	12.40	114.7	16.20	113.1	13	178.0	314.0
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	09	05	72	1528	033	11.9	11.90	110.6	15.70	110.1	13	178.0	314.0
BONNEVILLE TAILRACE 1/4 MI DN SPILL SIDE	09	05	72	1540	000	11.8	14.00	129.6	19.40	135.5	13	178.0	314.0
COLUMBIA RIVER PRESCOTT CENTER	09	05	72	1621	000	12.4	11.90	111.6	16.00	113.1			

LOCATION	DATE DY MO YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
SNAKE R. ABOVE CLEARWATER	23/05/72	0730	000	12.0	10.60	101.1	15.20	109.3			
CLEARWATER R. 1/4 MI ABOVE MTH	23/05/72	0800	000	7.6	12.80	110.0	17.60	114.9			
SNAKE R. ABOVE SALMON R.	23/05/72	0945	000	15.2	10.30	106.2	14.80	114.4			
SALMON R. 1/4 MI ABOVE MTH	23/05/72	1005	000	9.7	11.60	105.7	16.40	113.1			
LWR GRANITE SITE PRIOR TO OPERATION	23/05/72	1102	000	10.7	11.30	104.2	16.00	111.6			
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	23/05/72	1127	000	10.7	11.10	102.4	15.70	109.5	8	081.1	176.5
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	23/05/72	1127	033	10.8	11.10	102.6	15.60	109.0	8	081.1	176.5
LITTLE GOOSE TAILRACE 1/4 MI DN SPILL SIDE	23/05/72	1150	000	10.8	13.50	124.4	18.90	131.6	8	081.1	176.5
PALOUSE R. 1/2 MI ABOVE MTH	23/05/72	1209	000	14.0	10.60	105.0	15.10	112.4			
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	23/05/72	1230	000	11.1	13.40	124.3	19.20	134.5	8	072.8	174.0
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	23/05/72	1230	033	11.2	13.30	123.7	18.80	132.0	8	072.8	174.0
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SIDE	23/05/72	1243	000	11.2	13.80	127.9	19.30	135.1	8	072.8	174.0
ICE HARBOR FOREBAY 1/4 MI UP CENTER	23/05/72	1312	000	11.3	12.80	118.9	18.10	126.9	10	131.2	180.6
ICE HARBOR FOREBAY 1/4 MI UP CENTER	23/05/72	1312	033	11.3	13.20	122.6	18.60	130.4	10	131.2	180.6
ICE HARBOR TAILRACE 1/2 MI DN SPILL SIDE	23/05/72	1325	000	11.2	13.80	127.4	19.20	133.9	10	131.2	180.6
COLUMBIA RIVER ABOVE MOUTH SNAKE	23/05/72	1340	000	11.3	12.70	117.5	17.50	122.3			
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	23/05/72	1408	000	11.6	12.40	115.5	17.20	120.9	22	267.4	489.2
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	23/05/72	1408	033	11.6	12.40	115.5	17.40	122.3	22	267.4	489.2

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LOCATION	DATE DY	MO	YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	23	05	72	1420	000	11.6	12.00	111.8	17.20	120.9	22	267.4	489.2
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	23	05	72	1420	033	11.4	12.40	115.0	17.50	122.5	22	267.4	489.2
MCNARY TAILRACE 1/4 MI DN SPILL SIDE WN.	23	05	72	1425	000	11.6	14.10	131.1	19.80	138.9	22	267.4	489.2
MCNARY TAILRACE 1/4 MI DN POWER SIDE OR.	23	05	72	1443	000	11.4	12.40	114.7	17.50	122.2	22	267.4	489.2
JOHN DAY FOREBAY 1/4 MI UP CNTR	23	05	72	1640	000	12.2	11.50	108.3	16.80	119.3	20	163.6	497.8
JOHN DAY FOREBAY 1/4 MI UP CNTR	23	05	72	1640	033	12.5	11.70	111.0	16.80	120.1	20	163.6	497.8
JOHN DAY TAILRACE 1/2 MI DN SPILL SIDE	23	05	72	1646	000	12.2	14.10	132.4	19.40	137.3	20	163.6	497.8
THE DALLES FOREBAY 1/4 MI UP CENTER	23	05	72	1705	000	12.2	12.60	118.3	18.00	127.4	23	333.1	494.5
THE DALLES FOREBAY 1/4 MI UP CENTER	23	05	72	1705	033	12.3	12.40	116.7	17.70	125.5	23	333.1	494.5
THE DALLES TAILRACE 1/2 MI DN SPILL SIDE	23	05	72	1713	000	12.3	12.90	121.0	18.20	128.7	23	333.1	494.5
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	23	05	72	1749	000	12.4	11.80	110.9	17.20	121.8	18	355.8	485.9
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	23	05	72	1749	033	12.5	11.90	112.1	17.00	120.7	18	355.8	485.9
BONNEVILLE TAILRACE 1/4 MI DN SPILL SIDE	23	05	72	1755	000	12.4	13.30	124.8	19.00	134.4	18	355.8	485.9
COLUMBIA RIVER PRESCOTT CENTER	23	05	72	1832	000	12.6	11.60	109.3	17.20	122.1			

// LOCATION	--DATE-- DY MO YR	TIME	DEPT FT	TEMP C	---OXYGEN-- MG/L	SAT	ATMOSPHERIC --NITROGEN- ML/L	SAT	NO. GATE OPEN	HOURLY FLOW ---KCFS---- SPILL	TOTAL
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	06/06/72	0930	000	11.7	11.20	105.7	15.60	111.1	08	118.0	186.0
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	06/06/72	0930	033	11.7	11.10	104.8	16.10	114.7	08	118.0	186.0
COLUMBIA LONGVIEW	06/06/72	0935	000	15.0	11.80	117.3	16.80	125.2			
LITTLE GOOSE TAILRACE 1/4 MI DN SPILL SIDE	06/06/72	0952	000	11.9	14.10	133.2	20.00	142.5	08	118.0	186.0
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	06/06/72	1016	000	12.3	13.10	124.9	19.60	140.9	08	107.3	178.3
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	06/06/72	1016	033	11.7	13.50	127.0	19.30	137.0	08	107.3	178.3
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SIDE	06/06/72	1031	000	11.8	13.90	130.6	19.60	138.9	08	107.3	178.3
ICE HARBOR FOREBAY 1/4 MI UP CENTER	06/06/72	1057	000	13.1	13.30	128.7	18.70	136.1	10	144.1	181.0
ICE HARBOR FOREBAY 1/4 MI UP CENTER	06/06/72	1057	033	12.3	13.50	128.3	19.40	138.9	10	144.1	181.0
ICE HARBOR TAILRACE 1/2 MI DN SPILL SIDE	06/06/72	1112	000	12.4	13.20	125.3	18.60	133.0	10	144.1	181.0
COLUMBIA ABOVE SNAKE	06/06/72	1129	000	12.8	12.40	118.7	17.40	125.5			
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	06/06/72	1218	000	13.5	11.70	113.8	17.30	126.5	22	294.2	530.4
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	06/06/72	1218	033	13.7	12.10	118.2	17.00	124.8	22	294.2	530.4
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	06/06/72	1230	000	13.5	12.60	122.6	18.20	133.1	22	294.2	530.4
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	06/06/72	1230	033	13.0	12.00	115.4	18.10	131.0	22	294.2	530.4
MCNARY TAILRACE 1/4 MI DN SPILL SIDE WN.	06/06/72	1240	000	13.4	13.40	129.7	19.20	139.8	22	294.2	530.4
MCNARY TAILRACE 1/4 MI DN POWER SIDE OR.	06/06/72	1253	000	13.2	12.30	118.5	17.80	129.1	22	294.2	530.4
JOHN DAY FOREBAY 1/4 MI UP CNTR	06/06/72	1425	000	15.2	12.70	127.9	18.10	136.6	20	223.1	563.4

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LOCATION	DATE DY	DATE MO	DATE YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
JOHN DAY FOREBAY 1/4 MI UP CNTR	06	06	72	1425	033	14.1	12.70	124.8	18.40	135.9	20	223.1	563.4
JOHN DAY TAILRACE 1/2 MI DN SPILL SIDE	06	06	72	1439	000	14.5	13.80	136.4	19.40	143.9	20	223.1	563.4
THE DALLES FOREBAY 1/4 MI UP CENTER	06	06	72	1500	000	14.3	13.00	127.9	18.50	136.6	23	393.5	545.4
THE DALLES FOREBAY 1/4 MI UP CENTER	06	06	72	1500	033	14.5	12.70	125.5	18.90	140.2	23	393.5	545.4
THE DALLES TAILRACE 1/2 MI DN SPILL SIDE	06	06	72	1515	000	14.6	12.60	124.4	18.10	134.1	23	393.5	545.4
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	06	06	72	1550	000	14.6	12.10	119.4	17.30	128.2	18	402.5	544.7
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	06	06	72	1550	033	14.8	12.70	125.9	17.30	128.7	18	402.5	544.7
BONNEVILLE TAILRACE 1/4 MI DN SPILL SIDE	06	06	72	1600	000	14.7	12.80	126.4	18.90	140.1	18	402.5	544.7

13 LOCATION	DATE DY MO YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
SNAKE R. ABOVE CLEARWATER	20/06/72	0712	000	15.1	9.70	99.1	13.70	104.9			
CLEARWATER R. 1/4 MI ABOVE MTH	20/06/72	0730	000	9.7	11.00	99.4	16.00	109.5			
SALMON R. 1/4 MI ABOVE MTH	20/06/72	0830	000	11.9	10.60	101.6	15.40	111.3			
SNAKE R. ABOVE SALMON R.	20/06/72	0840	000	18.2	9.40	103.3	13.60	111.4			
LWR GRANITE SITE PRIOR TO OPERATION	20/06/72	0930	000	13.8	10.40	102.9	14.80	110.1			
LITTLE GOOSE TAILRACE 1/4 MI DN SPILL SIDE	20/06/72	1000	000	14.5	10.30	103.2	15.50	116.5	08	016.6	147.7
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	20/06/72	1000	000	14.5	9.90	99.5	14.50	109.4	08	016.6	147.7
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	20/06/72	1000	033	14.4	10.20	102.3	14.60	109.9	08	016.6	147.7
PALOUSE R. 1/2 MI ABOVE MTH	20/06/72	1030	000	20.3	11.30	127.7	11.80	99.1			
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SIDE	20/06/72	1055	000	15.1	11.30	114.2	16.60	125.8	01	015.2	144.9
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	20/06/72	1055	000	15.1	10.90	110.6	15.70	119.4	01	015.2	144.9
ICE HARBOR TAILRACE 1/2 MI DN SPILL SIDE	20/06/72	1134	000	15.0	12.40	124.7	17.40	131.2	10	044.3	147.5
ICE HARBOR FOREBAY 1/4 MI UP CENTER	20/06/72	1134	000	15.3	11.60	117.8	16.30	124.0	10	044.3	147.5
ICE HARBOR FOREBAY 1/4 MI UP CENTER	20/06/72	1134	033	15.2	11.80	119.5	16.40	124.6	10	044.3	147.5
COLUMBIA RIVER ABOVE MOUTH SNAKE	20/06/72	1205	000	13.9	12.00	117.8	16.90	124.6			
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	20/06/72	1304	033	14.5	12.00	119.3	16.00	119.4	22	325.2	548.5
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	20/06/72	1323	000	14.7	11.80	117.8	17.00	127.4	22	325.2	548.5
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	20/06/72	1323	033	14.5	11.90	117.8	16.80	124.9	22	325.2	548.5

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LOCATION	DATE DY	DATE MO	DATE YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
MCNARY TAILRACE 1/4 MI DN SPILL SIDE WN.	20	06	72	1332	000	14.6	13.00	129.2	18.80	140.2	22	325.2	548.5
MCNARY TAILRACE 1/4 MI DN POWER SIDE OR.	20	06	72	1405	000	14.6	12.40	123.3	17.10	127.6	22	325.2	548.5
THE DALLES FOREBAY 1/4 MI UP CENTER	20	06	72	1615	000	14.6	12.50	123.8	18.20	135.2	23	477.5	608.1
THE DALLES FOREBAY 1/4 MI UP CENTER	20	06	72	1615	033	15.0	12.80	127.8	18.20	136.3	23	477.5	608.1
THE DALLES TAILRACE 1/2 MI DN SPILL SIDE	20	06	72	1622	000	14.7	12.40	122.7	17.60	130.7	23	477.5	608.1
BONNEVILLE TAILRACE 1/4 MI DN SPILL SIDE	20	06	72	1655	000	14.7	12.90	127.4	19.10	141.6	18	438.3	576.6
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	20	06	72	1655	033	14.8	12.10	120.0	17.90	133.1	18	438.3	576.6
COLUMBIA RIVER PRESCOTT CENTER	20	06	72	1745	000	15.5	11.50	115.5	17.40	130.9			

LOCATION	--DATE-- DY MO YR	TIME	DEPT FT	TEMP C	---OXYGEN-- MG/L	SAT	ATMOSPHERIC --NITROGEN- ML/L	SAT	NO. GATE OPEN	HOURLY FLOW ---KCFS---- SPILL	TOTAL
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	05/07/72	1000	00	18.2	10.00	108.7	13.60	110.2	00	0.0	069.6
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	05/07/72	1000	33	16.7	9.30	98.0	13.60	107.1	00	0.0	069.6
LITTLE GOOSE TAILRACE 1/4 MI DN SPILL SIDE	05/07/72	1016	00	16.7	9.50	99.7	13.40	105.2	00	0.0	069.6
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	05/07/72	1041	00	18.7	9.40	102.9	13.30	108.4	00	0.0	087.9
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	05/07/72	1041	33	17.5	9.30	99.3	13.40	106.8	00	0.0	087.9
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SIDE	05/07/72	1055	00	17.4	9.20	97.7	13.40	106.2	00	0.0	087.9
ICE HARBOR FOREBAY 1/4 MI UP CENTER	05/07/72	1120	00	18.2	9.60	103.6	13.40	107.8	00	0.0	066.1
ICE HARBOR FOREBAY 1/4 MI UP CENTER	05/07/72	1120	33	17.0	9.50	100.0	13.60	107.0	00	0.0	066.1
ICE HARBOR TAILRACE 1/2 MI DN SPILL SIDE	05/07/72	1134	00	17.2	10.90	114.8	16.10	126.7	00	0.0	066.1
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	05/07/72	1235	00	16.0	11.50	118.1	15.40	118.4	22	155.9	374.7
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	05/07/72	1235	33	15.8	11.50	117.6	15.40	117.9	22	155.9	374.7
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	05/07/72	1248	00	16.2	11.30	116.5	15.30	118.1	22	155.9	374.7
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	05/07/72	1248	33	15.6	11.40	116.1	15.40	117.5	22	155.9	374.7
MCNARY TAILRACE 1/4 MI DN SPILL SIDE WN.	05/07/72	1255	00	15.8	13.20	134.7	18.10	138.3	22	155.9	374.7
MCNARY TAILRACE 1/4 MI DN POWER SIDE OR.	05/07/72	1321	00	15.8	11.40	116.3	15.50	118.4	22	155.9	374.7
JOHN DAY FOREBAY 1/4 MI UP CNTR	05/07/72	1444	00	17.3	12.10	127.4	16.20	127.4	20	049.0	379.8
JOHN DAY FOREBAY 1/4 MI UP CNTR	05/07/72	1444	33	16.1	12.00	123.2	16.50	126.8	20	049.0	379.8
JOHN DAY TAILRACE 1/2 MI DN SPILL SIDE	05/07/72	1500	00	16.4	11.30	116.3	15.20	117.0	20	049.0	379.8

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LOCATION	--DATE-- DY	MO	YR	TIME	DEPT FT	TEMP C	---OXYGEN-- MG/L	SAT	ATMOSPHERIC --NITROGEN- ML/L	SAT	NO. GATE OPEN	HOURLY FLOW ---KCFS---- SPILL	TOTAL
COLUMBIA ABOVE SNAKE	05	07	72	1510	00	15.4	12.00	121.7	16.20	123.1			
THE DALLES FOREBAY 1/4 MI UP CENTER	05	07	72	1525	00	16.2	12.50	128.1	17.10	131.1	23	236.4	382.5
THE DALLES FOREBAY 1/4 MI UP CENTER	05	07	72	1525	33	16.3	12.50	128.4	17.20	132.2	23	236.4	382.5
THE DALLES TAILRACE 1/2 MI DN SPILL SIDE	05	07	72	1541	00	16.4	12.20	125.2	16.40	125.9	23	236.4	382.5
BONNEVILLE TAILRACE 1/4 MI DN SPILL SIDE	05	07	72	1615	00	16.6	13.00	133.7	18.00	138.5	18	227.4	381.0
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	05	07	72	1615	00	16.5	12.00	123.4	15.40	118.4	18	227.4	381.0
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	05	07	72	1615	33	16.7	12.00	123.9	16.10	124.3	18	227.4	381.0
COLUMBIA RIVER PRESCOTT CENTER	05	07	72	1700	00	17.9	11.40	120.4	15.50	122.2			

17 LOCATION	DATE DY	MO	YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
SNAKE R. ABOVE CLEARWATER	18	07	72	0730	00	20.4	8.20	93.5	12.00	101.6			
CLEARWATER R. 1/4 MI ABOVE MTH	18	07	72	0755	00	16.2	9.70	101.4	13.50	105.6			
SALMON R. 1/4 MI ABOVE MTH	18	07	72	0845	00	19.7	8.90	100.8	12.50	105.3			
SNAKE R. ABOVE SALMON R.	18	07	72	0900	00	19.8	8.40	95.4	11.90	100.4			
LWR GRANITE SITE PRIOR TO OPERATION	18	07	72	1000	00	19.6	8.80	98.4	12.60	104.8			
LITTLE GOOSE FOREBAY 1/4 MI. UP CENTER	18	07	72	1035	00	21.0	9.70	111.5	12.50	106.6	0	00.0	040.0
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	18	07	72	1035	33	19.2	8.60	95.4	12.90	106.5	0	00.0	040.0
LITTLE GOOSE TAILRACE 1/4 MI DN SPILL SIDE	18	07	72	1045	00	19.1	8.50	93.8	13.10	107.6	0	00.0	040.0
PALOUSE R. 1/2 MI ABOVE MTH	18	07	72	1100	00	22.5	7.90	93.2	11.70	102.1			
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	18	07	72	1130	00	20.6	9.60	109.1	12.80	108.0	1	11.6	050.4
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	18	07	72	1130	33	18.8	8.60	94.3	13.10	107.0	1	11.6	050.4
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SIDE	18	07	72	1140	00	18.7	9.30	101.4	14.30	116.2	1	11.6	050.4
ICE HARBOR FOREBAY 1/4 MI UP CENTER	18	07	72	1155	00	20.3	9.70	109.2	13.30	111.2	2	04.4	048.2
ICE HARBOR FOREBAY 1/4 MI UP CENTER	18	07	72	1155	33	19.4	8.80	97.3	13.40	110.3	2	04.4	048.2
ICE HARBOR TAILRACE 1/2 MI DN SPILL SIDE	18	07	72	1205	00	19.5	9.20	101.6	13.60	111.7	2	04.4	048.2
COLUMBIA RIVER ABOVE MOUTH SNAKE	18	07	72	1218	00	16.0	11.70	120.2	16.10	123.8			
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	18	07	72	1334	00	17.7	11.60	123.5	15.20	120.7	9	84.2	302.6
MCNARY DAM FOREBAY 1/4 MI UP SPILL SIDE WN.	18	07	72	1334	33	17.2	11.20	118.0	15.50	121.9	9	84.2	302.6

18 LOCATION	--DATE-- DY	MO	YR	TIME	DEPT FT	TEMP C	---OXYGEN-- MG/L	SAT	ATMOSPHERIC --NITROGEN- ML/L	SAT	NO. GATE OPEN	HOURLY FLOW ---KCFS---- SPILL	TOTAL
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	18	07	72	1346	00	17.6	11.70	124.3	15.30	121.3	9	84.2	302.6
MCNARY DAM FOREBAY 1/4 MI UP POWER SIDE OR.	18	07	72	1346	33	16.8	10.90	113.9	15.50	121.0	9	84.2	302.6
MCNARY TAILRACE 1/4 MI DN SPILL SIDE WN.	18	07	72	1403	00	17.2	12.60	132.4	18.20	142.8	9	84.2	302.6
MCNARY TAILRACE 1/4 MI DN POWER SIDE OR.	18	07	72	1417	00	17.1	11.30	118.5	15.40	120.6	9	84.2	302.6
JOHN DAY FOREBAY 1/4 MI UP CNTR	18	07	72	1525	00	18.2	11.10	119.1	15.30	122.3	0	00.0	303.2
JOHN DAY FOREBAY 1/4 MI UP CNTR	18	07	72	1525	33	18.2	11.40	122.3	15.30	122.3	0	00.0	303.2
JOHN DAY TAILRACE 1/2 MI DN SPILL SIDE	18	07	72	1536	00	18.1	11.10	118.4	15.10	120.1	0	00.0	303.2
THE DALLES FOREBAY 1/4 MI UP CENTER	18	07	72	1558	00	18.0	10.80	114.9	14.90	118.3	23	72.0	258.8
THE DALLES FOREBAY 1/4 MI UP CENTER	18	07	72	1558	33	18.0	10.90	116.0	15.00	119.1	23	72.0	258.8
THE DALLES TAILRACE 1/2 MI DN SPILL SIDE	18	07	72	1603	00	18.0	10.90	115.7	15.10	119.5	23	72.0	258.8
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	18	07	72	1650	00	18.4	10.60	113.4	14.40	114.8	18	102.2	238.4
BONNEVILLE FOREBAY 1/2 MI UP SPILL SIDE	18	07	72	1650	33	18.4	10.60	113.4	14.60	116.4	18	102.2	238.4
BONNEVILLE TAILRACE 1/4 MI DN SPILL SIDE	18	07	72	1700	00	18.4	12.10	129.2	17.50	139.3	18	102.2	238.4
COLUMBIA RIVER PRESCOTT CENTER	18	07	72	1740	00	19.3	10.70	116.3	15.00	121.3			

LOCATION	DATE DY	MO	YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
COLUMBIA RIVER													
PRESCOTT CENTER	01	08	72	0910	00	19.5	10.00	109.2	13.65	110.8			
BONNEVILLE TAILRACE													
1/4 MI DN SPILL SIDE	01	08	72	0955	00	18.6	11.80	126.5	16.50	131.8	11	64.6	199.2
BONNEVILLE FOREBAY													
1/2 MI UP SPILL SIDE	01	08	72	1006	00	18.5	9.70	104.0	13.20	105.4	11	64.6	199.2
BONNEVILLE FOREBAY													
1/2 MI UP SPILL SIDE	01	08	72	1006	33	18.5	9.80	105.1	13.05	104.2	11	64.6	199.2
THE DALLES TAILRACE													
1/2 MI DN SPILL SIDE	01	08	72	1027	00	18.6	9.90	106.4	13.20	105.6	00	00.0	226.0
JOHN DAY FOREBAY													
1/4 MI UP CNTR	01	08	72	1103	00	18.7	10.35	112.2	13.30	107.4	00	00.0	257.1
JOHN DAY FOREBAY													
1/4 MI UP CNTR	01	08	72	1103	33	18.7	10.45	113.2	13.50	109.0	00	00.0	257.1
JOHN DAY TAILRACE													
1/2 MI DN SPILL SIDE	01	08	72	1112	00	18.8	10.35	112.0	13.80	111.2	00	00.0	257.1
MCNARY DAM FOREBAY													
1/4 MI UP SPILL SIDE WN.	01	08	72	1200	00	19.8	11.80	131.1	13.90	114.8	00	00.0	238.4
MCNARY DAM FOREBAY													
1/4 MI UP SPILL SIDE WN.	01	08	72	1200	33	18.8	11.25	122.5	14.08	114.2	00	00.0	238.4
MCNARY DAM FOREBAY													
1/4 MI UP POWER SIDE OR.	01	08	72	1210	00	19.5	11.50	127.0	13.70	112.5	00	00.0	238.4
MCNARY DAM FOREBAY													
1/4 MI UP POWER SIDE OR.	01	08	72	1210	33	18.3	11.00	118.5	14.10	113.3	00	00.0	238.4
MCNARY TAILRACE													
1/4 MI DN SPILL SIDE WN.	01	08	72	1221	00	18.7	11.31	122.6	14.10	113.8	00	00.0	238.4
MCNARY TAILRACE													
1/4 MI DN POWER SIDE OR.	01	08	72	1226	00	18.6	11.22	121.4	14.10	113.6	00	00.0	238.4
COLUMBIA RIVER													
ABOVE MOUTH SNAKE	01	08	72	1403	00	17.9	11.22	119.9	14.44	115.1			
ICE HARBOR TAILRACE													
1/2 MI DN SPILL SIDE	01	08	72	1410	00	21.0	7.80	88.8	12.10	102.1	00	00.0	042.3
ICE HARBOR FOREBAY													
1/4 MI UP CENTER	01	08	72	1415	00	22.1	8.70	101.5	12.20	105.4	00	00.0	042.3
ICE HARBOR FOREBAY													
1/4 MI UP CENTER	01	08	72	1415	33	21.0	7.90	90.2	11.80	99.9	00	00.0	042.3

LOCATION	--DATE-- DY	MO	YR	TIME	DEPT FT	TEMP C	---OXYGEN-- MG/L	SAT	ATMOSPHERIC --NITROGEN- ML/L	SAT	NO. GATE OPEN	HOURLY FLOW ---KCFS---- SPILL	TOTAL
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SIDE	01	08	72	1440	00	19.7	7.90	87.9	12.25	101.4	00	00.0	041.7
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	01	08	72	1454	00	21.2	8.50	97.8	12.10	103.2	00	00.0	041.7
LWR MONUMENT FOREBAY 1/4 MI UP CENTER	01	08	72	1454	33	20.0	7.90	88.7	12.30	102.7	00	00.0	041.7
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	01	08	72	1530	00	21.6	8.90	103.5	12.30	106.0	00	00.0	041.8
LITTLE GOOSE FOREBAY 1/4 MI UP CENTER	01	08	72	1530	33	20.8	8.80	100.8	12.73	108.2	00	00.0	041.8
LITTLE GOOSE TAILRACE 1/4 MI DN SPILL SIDE	01	08	72	1540	00	19.9	8.10	90.8	12.50	104.2	00	00.0	041.8

LOCATION	DATE DY	MO	YR	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN SAT	ATMOSPHERIC NITROGEN ML/L	ATMOSPHERIC NITROGEN SAT	NO. GATE OPEN	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL
SNAKE R.													
ABOVE CLEARWATER	15	08	72	0700	00	21.3	8.60	99.8	12.30	105.8			
CLEARWATER R.													
1/4 MI ABOVE MTH	15	08	72	0715	00	18.4	8.65	94.7	12.70	103.6			
LITTLE GOOSE FOREBAY													
1/4 MI UP CENTER	15	08	72	1320	00	23.2	7.80	93.6	11.40	101.1	0	00.0	023.3
LITTLE GOOSE FOREBAY													
1/4 MI UP CENTER	15	08	72	1320	33	22.2	7.35	86.5	11.45	99.8	0	00.0	023.3
LITTLE GOOSE TAILRACE													
1/4 MI DN SPILL SIDE	15	08	72	1326	00	22.4	7.16	84.3	11.71	102.0	0	00.0	023.3
COLUMBIA RIVER													
ABOVE MOUTH SNAKE	15	08	72	1400	00	17.8	10.68	113.9	14.27	113.6			
MCNARY DAM FOREBAY													
1/4 MI UP SPILL SIDE WN.	15	08	72	1413	00	19.5	11.25	124.2	13.50	110.9	0	00.0	195.3
MCNARY DAM FOREBAY													
1/4 MI UP SPILL SIDE WN.	15	08	72	1413	33	19.2	10.80	118.5	13.60	111.1	0	00.0	195.3
MCNARY DAM FOREBAY													
1/4 MI UP POWER SIDE OR.	15	08	72	1424	00	19.2	10.70	117.4	13.50	110.3	0	00.0	195.3
MCNARY DAM FOREBAY													
1/4 MI UP POWER SIDE OR.	15	08	72	1424	33	18.9	10.45	114.0	13.60	110.5	0	00.0	195.3
MCNARY TAILRACE													
1/4 MI DN SPILL SIDE WN.	15	08	72	1455	00	19.3	10.98	120.5	13.60	111.0	0	00.0	195.3
MCNARY TAILRACE													
1/4 MI DN POWER SIDE OR.	15	08	72	1500	00	19.1	10.48	114.5	13.50	109.8	0	00.0	195.3
BONNEVILLE FOREBAY													
1/2 MI UP SPILL SIDE	15	08	72	1610	00	19.7	9.15	100.5	12.55	102.5	11	73.3	220.3
BONNEVILLE FOREBAY													
1/2 MI UP SPILL SIDE	15	08	72	1610	33	19.8	9.30	102.4	13.05	106.8	11	73.3	220.3
BONNEVILLE TAILRACE													
1/4 MI DN SPILL SIDE	15	08	72	1620	00	19.8	11.54	126.8	15.80	129.1	11	73.3	220.3
COLUMBIA RIVER													
PRESCOTT CENTER	15	08	72	1655	00	20.3	9.25	102.6	12.90	106.3			

Appendix Table 2.--Dissolved gas saturation data collected at Lower Monumental Dam during evaluation of spillway deflector, April - June 1973.

Appendix Table 2.--Dissolved gas saturation data collected at Lower Monumental Dam during evaluation of spillway deflector April-June, 1973.

LOCATION	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN PCT SAT	NITROGEN ML/L	NITROGEN PCT SAT	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL	NO. GATE OPEN	TAILWT ELEV FEET
APRIL 3, 1972											
LWR MONUMENT FOREBAY SPILL SIDE	0900	050	08.2	11.80	100.1	16.20	104.5	.	.		.
LWR MONUMENT FOREBAY SPILL SIDE	0915	050	08.2	1 . 0	1 .	15.80	101.9	.	.		.
LWR MONUMENT FOREBAY SPILL SIDE	0915	000	08.2	1 . 0	1 .	16.00	103.2	.	.		.
LWR MONUMENT TAILRACE SKELETON BAY	0940	000	08.3	1 . 0	1 .	16.70	108.0	.	.		.
LWR MONUMENT FOREBAY SPILL SIDE	1540	050	08.5	12.20	104.4	16.70	108.4				
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1315	000	08.5	12.30	105.2	17.00	110.4	02.5	114.1	1	442.3
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SI	1325	000	08.4	12.70	108.5	17.70	114.7	02.5	114.1	1	442.3
LWR MONUMENT TAILRACE BAY 3	1400	000	08.5	14.70	125.8	20.30	131.8	04.6	096.2	1	442.3
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SI	1407	000	08.5	12.10	103.5	16.90	109.7	04.6	110.3	1	443.2
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1010	000	08.3	12.20	103.8	16.70	108.0	04.6	120.4	1	443.7
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SI	1015	000	08.3	12.20	103.8	16.50	106.7	04.6	120.4	1	443.7
LWR MONUMENT TAILRACE BAY 3	1430	000	08.5	13.50	115.3	18.50	120.4	09.7	115.4	1	443.2
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SI	1435	000	08.5	11.80	100.9	17.00	110.4	09.7	115.4	1	443.2
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1040	000	08.4	12.40	105.6	17.00	109.7	09.7	125.5	1	443.7
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SI	1045	000	08.4	12.30	105.0	17.00	110.2	09.7	125.5	1	443.7
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SI	1505	000	08.4	13.10	111.9	18.00	116.7	14.9	120.7	1	442.7

Appendix Table 2.--Continued

April 3, 1972

LOCATION	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN PCT SAT	NITROGEN ML/L	NITROGEN PCT SAT	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL	NO. GATE OPEN	TAILWTR ELEV FEET
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1115	000	08.4	12.60	107.6	17.10	110.7	14.9	109.5	1	442.9
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SI	1120	000	08.4	13.00	111.0	17.50	113.4	14.9	109.5	1	442.9
LWR MONUMENT TAILRACE BAY 3	1455	000	08.5	13.80	117.8	19.00	123.4	14.9	120.6	1	443.2
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1145	000	08.4	13.10	111.9	17.70	114.7	20.1	114.7	1	442.9
LWR MONUMENT TAILRACE 1/2 MI DN SPILL SI	1150	000	08.4	13.30	113.6	18.00	116.7	20.1	114.7	1	442.9

Appendix Table 2.--Continued

APRIL 12, 1972

LOCATION	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN PCT SAT	NITROGEN ML/L	NITROGEN PCT SAT	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL	NO. GATE OPEN	TAILWTR ELEV FEET
LWR MONUMENT FOREBAY POWER SIDE	1005	050	08.3	11.30	096.3	16.00	103.5	.	.		.
LWR MONUMENT FOREBAY SPILL SIDE	1015	050	08.2	11.20	095.2	16.00	103.3	.	.		.
LWR MONUMENT FOREBAY SPILL SIDE	1025	050	08.2	11.50	097.7	16.30	104.7	.	.		.
LWR MONUMENT FOREBAY SPILL SIDE	1035	000	08.1	11.10	094.1	16.00	103.1	.	.		.
LWR MONUMENT FOREBAY SPILL SIDE	1620	050	08.4	11.40	097.8	16.40	106.4	.	.		
LWR MONUMENT TAILRACE POWER SIDE	1519	000	08.3	11.30	096.3	16.00	103.2	00.0	100.9		440.4
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1105	000	08.3	11.80	100.5	16.70	107.7	00.0	102.8		440.9
LWR MONUMENT TAILRACE POWER SIDE	1112	000	08.3	11.60	098.4	16.40	105.5	00.0	102.8		440.9
LWR MONUMENT FOREBAY SPILL SIDE	1338	050	08.4	11.50	098.3	16.20	105.1	.0	883.8		440.4
LWR MONUMENT TAILRACE BAY 3	1338	000	08.4	14.20	121.7	19.10	123.7	02.5	083.8	1	440.4
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1126	000	08.3	11.90	101.2	16.40	106.1	02.5	102.8	1	440.9
LWR MONUMENT TAILRACE BAY 3	1257	000	08.3	14.40	123.1	19.20	123.5	04.6	091.9	1	440.8
LWR MONUMENT TAILRACE BAY 3	1257	000	08.3	14.20	121.4	19.20	123.5	04.6	091.9	1	440.8
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1150	000	08.2	11.90	101.2	16.60	106.6	04.8	102.8	1	440.9

Appendix Table 2.--Continued

April 12, 1972

LOCATION	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN PCT SAT	NITROGEN ML/L	NITROGEN PCT SAT	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL	NO. GATE OPEN	TAILWTR ELEV FEET
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1417	000	08.4	11.90	102.0	17.00	110.0	09.6	086.8	1	440.4
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1417	000	08.4	12.10	103.1	16.60	107.4	09.6	086.8	1	440.4
LWR MONUMENT TAILRACE BAY 3	1520	000	08.3	14.60	124.8	19.20	124.2	09.6	100.9	1	440.4
LWR MONUMENT TAILRACE BAY 3	1520	000	08.3	14.00	119.7	19.30	124.5	09.6	100.9	1	440.4
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1452	000	08.4	12.40	106.3	17.00	110.3	14.7	086.8	1	440.4
LWR MONUMENT TAILRACE BAY 3	1546	000	08.4	14.00	119.6	19.00	122.9	14.7	100.9	1	440.4
LWR MONUMENT TAILRACE BAY 3	1546	000	08.4	13.30	113.6	18.70	121.0	14.7	100.9	1	440.4
LWR MONUMENT TAILRACE SKELETON BAY	.1117	000	08.3	11.80	100.5	16.80	108.7	35.0	102.8	0	440.9

Appendix Table 2.--Continued

MAY 10, 1972

LOCATION	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN PCT SAT	NITROGEN ML/L	NITROGEN PCT SAT	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL	NO. GATE OPEN	TAILWTR ELEV FEET
LWR MONUMENT TAILRACE SKELETON BAY	1224	000	12.0	11.3	104.1	15.5	107.7	63.3		1	444.7
LWR MONUMENT TAILRACE SKELETON BAY	1315	000	11.9	11.5	105.6	15.8	109.6	63.3		1	445.1
LWR MONUMENT TAILRACE POWER SIDE	1230	000	11.8	11.3	103.6	15.2	105.2	67.6		1	444.7
LWR MONUMENT TAILRACE POWER SIDE	1320	000	11.8	11.7	107.2	15.8	109.3	67.8		1	445.1

Appendix Table 1.--Continued

JUNE 21, 1972

LOCATION	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN PCT SAT	NITROGEN ML/L	NITROGEN PCT SAT	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL	NO. GATE OPEN	TAILWTR ELEV FEET
LWR MONUMENT FOREBAY SPILL SIDE	1520	50	15.3	09.9	101.5	15.0	112.0	-0.0	-0.0		539.6
LWR MONUMENT FOREBAY POWER SIDE	1530	50	15.0	10.1	100.3	15.0	111.7	-0.0	-0.0		539.6
LWR MONUMENT FOREBAY SPILL SIDE	1215	50	15.0	10.3	102.3	15.4	114.7	-0.0	-0.0		539.6
LWR MONUMENT FOREBAY POWER SIDE	1230	50	15.0	10.0	099.3	14.9	110.9	-0.0	-0.0		539.6
LWR MONUMENT TAILRACE POWER SIDE	1505	00	15.0	10.0	099.8	14.9	109.5	00.0	63.0		444.2
LWR MONUMENT TAILRACE SKELETON BAY	1510	00	15.0	10.2	101.3	15.0	111.7	00.0	63.3		444.2
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1140	00	15.1	10.5	104.5	15.3	115.0	00.0	00.0	0	444.1
LWR MONUMENT TAILRACE SKELETON BAY	1145	00	14.7	10.2	100.7	15.2	112.5	00.0	63.3		444.1
LWR MONUMENT TAILRACE POWER SIDE	1150	00	14.6	10.2	099.9	15.0	110.9	00.0	63.3		444.1
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1200	00	14.7	10.4	102.7	15.0	111.4	04.6	.	1	444.2
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1200	00	14.7	10.6	104.1	15.0	111.4	04.6	.	1	444.2
LWR MONUMENT TAILRACE BAY 3	1405	00	15.8	12.6	127.3	18.0	136.2	04.8	.	1	444.5
LWR MONUMENT TAILRACE BAY 3	1405	00	15.8	12.2	123.2	17.7	133.9	04.8	.	1	444.5
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1305	00	15.0	10.8	107.2	15.4	114.7	09.8	.	1	444.4
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1305	00	15.0	10.5	104.3	15.7	116.9	09.8	.	1	444.4
LWR MONUMENT TAILRACE BAY 3	1430	00	15.3	12.6	126.0	18.5	138.6	09.8	.	1	444.5

Appendix Table 2.--Continued

June 21, 1972

LOCATION	TIME	DEPT FT	TEMP C	OXYGEN MG/L	OXYGEN PCT SAT	NITROGEN ML/L	NITROGEN PCT SAT	HOURLY FLOW KCFS SPILL	HOURLY FLOW KCFS TOTAL	NO. GATE OPEN	TAILWTR ELEV FEET
LWR MONUMENT TAILRACE BAY 3	1430	00	15.3	12.2	122.0	18.0	134.8	09.8	.	1	444.5
LWR MONUMENT TAILRACE BAY 3	1435	00	15.0	12.9	128.1	18.7	139.2	09.8	.	1	444.5
LWR MONUMENT TAILRACE BAY 3	1435	00	15.0	13.0	129.0	18.8	139.6	09.8	.	1	444.5
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1325	00	15.3	10.9	109.0	15.8	118.4	15.0	.	1	444.4
LWR MONUMENT TAILRACE BAY 2 SPILL DEFL	1325	00	15.3	10.0	108.0	15.7	117.7	15.0	.	1	444.4
LWR MONUMENT TAILRACE BAY 3	1455	00	15.3	12.0	120.0	18.0	134.8	15.0	.	1	444.5
LWR MONUMENT TAILRACE BAY 3	1455	00	15.3	12.1	115.5	17.4	130.3	15.0	.	1	444.5