EVALUATION OF JUVENILE FISH BYPASS AND ADULT FISH PASSAGE FACILITIES AT WATER DIVERSIONS IN THE UMATILLA RIVER

Annual and Interim Progress Reports

October 1990 - September 1991

Edited By

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EXECUTIVE SUMMARY

We report on our progress from October 1990 through September 1991 on evaluating juvenile fish bypass facilities at Three Mile Falls, Maxwell, and Westland dams on the Umatilla River. We also report on our progress from October 1990 through June 1991 on evaluating adult fish passage facilities at Three Mile Falls Dam. The study is a cooperative effort by the Oregon Department of Fish and Wildlife (ODFW) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). We report progress toward study objectives in three separate reports. Reports A and C comprise annual reports submitted to the Bonneville Power Administration (BPA) in October 1991. Report B is an interim report submitted to BPA in June 1992.

1. Report A (ODFW): Develop a sampling plan and prepare for the evaluation of the juvenile fish bypass system in the West Extension Irrigation District Canal at Three Mile Falls Dam and design traps for future evaluations at Maxwell and Westland dams.

2. Report B (ODFW): Evaluation of the juvenile fish bypass facility in the West Extension Irrigation District Canal at Three Mile Falls Dam and documentation of passage of juvenile salmonids through the bypass facility and east-bank adult fish ladder.

3. Report C (CTUIR): Examine the passage of adult salmonids at Three Mile Falls Dam.

The study is part of a program to rehabilitate anadromous fish stocks in the Umatilla River Basin that includes restorations of coho salmon *Oncorhynchus kisutch* and chinook salmon *O. tshawytscha* and enhancement of summer steelhead *O. mykiss*.

Report A

Highlights of results of our work in preparing for the juvenile fish bypass facility evaluation in the West Extension Irrigation District Canal at Three Mile Falls Dam and future evaluations at Maxwell and Westland dams are

1. A field sampling plan was developed that included detailed experimental designs for five tests: drum screen injury, drum screen leakage, bypass pipe and outfall injury, headgate injury and traveling screen leakage. Procedures for release, recapture, examination, data collection and data analysis for screen efficiency and injury estimates were also included.

2. We selected fall chinook fry for the screen leakage test since these fish would be potentially vulnerable to entrainment and screen impingement should natural production increase in the lower river in the future. Yearling summer steelhead and spring chinook salmon and subyearling fall chinook salmon were selected for the injury tests.

3. A system was devised to transport fall chinook fry using 32-gallon containers aerated with bottled oxygen. We planned to use ODFW's 370-gallon hauling tanker to transport the larger fish.

4. We developed an on-site holding system that allowed us to receive test fish in bulk and later separate into 100-fish brand groups in smaller containers. We used pumped water from the canal to create an effective water circulation system through large tanks which contained the smaller fish-holding containers. Plastic holding containers were perforated and mesh-covered. Small (18 cubic ft) and large (4-ft sq. x 2-ft deep) net pens were fabricated for use in holding fish in the canal or river.

5. Additional activities included fabrication of a branding table with side trough for transferring fish to a holding container, and a separator slide gate to prevent fish from entering the transfer flume during sample tank crowding. We installed additional lighting for nighttime activities and hand winches to deploy the bypass outfall net pen. A trailer was procured to serve as an on-site field office.

6. For the drum screen leakage test, we designed four fyke nets with frames to fit in the stoplog guides behind each drum screen and conform to the available space and water flow. Fyke nets were 20-ft to 25-ft long and tapered to a l-ft square, 1.5-ft deep cod end. The cod end contained a zipper to access the contents.

7. For the traveling screen leakage test, we designed and fabricated a 14-ft long fyke net and a 2.3 ft x 2.8 ft net frame for the river return drain pipe. Frame guides were affixed to the retaining wall at the pipe terminus to permit deployment of the net and frame.

8. An aluminum inclined plane trap was designed and fabricated for use in collecting fish in the bypass channel at the Maxwell Dam facility. The trap was designed to eliminate a lo-cubic feet per second (cfs) bypass flow, collect fish in a terminal live box, and had a pivot-rod front entrance assembly to permit leverage capabilities in adjusting water flow to the live box.

9. A 12.3 ft long fyke net with terminal floating live box (1.5 ft x 3 ft x 2 ft) was designed and fabricated for collecting fish in the juvenile fish holding pond at Westland Dam.

10. The wastewater channel at the Maxwell Dam facility was usually occluded with debris at the entrance. We hypothesize that juvenile fish may become stranded in the channel during periods of overflow abatement due to a relatively low return gradient to the river.

Report B

Highlights of results of our work in evaluating the juvenile fish bypass facility in the West Extension Irrigation District Canal at Three

Mile Falls Dam and documenting juvenile fish passage through the bypass facility and east-bank adult fish ladder are

1. Juvenile salmonids were not injured as they moved past the drum screens and into the bypass channel during day and night tests. Juvenile salmon were also not injured through the bypass pipe and outfall as they returned to the river at flows of 5 cfs and 25 cfs.

2. Limited testing showed that juvenile salmon were not injured as they traveled past the headgates into the screening facility during day and night tests.

3. The drum screens were 99.8% efficient in screening fall chinook salmon fry from the canal, with only 6 of the 900 fish released escaping through the screens. Lengths of these fish ranged from 60 mm to 66 mm, near the average length of fall chinook used in the tests. Mean efficiency rates for each of the four drum screens ranged from 99.6% to 99.9%. We observed one impinged fry on a drum screen.

4. We captured one fall chinook subyearling (85 mm long) in a fyke net at the end of the river return drain pipe, signifying possible leakage past the secondary traveling screen.

5. We observed 108 fall chinook salmon fry from the drum screen leakage test that became impinged on the secondary traveling screen. Impingement was more prevelant when the river return drain pipe was fully open than when the pumpback pumps were operating. Occasional impingement of fall chinook salmon subyearlings was also observed during pumpback pump operation; much impingement of subyearlings occurred when the drain pipe was fully open to sluice silt from the pump embayment area. No impingement was observed during a full bypass mode of 25 cfs.

6. Approximately 3 hours were required to capture 50% of the spring chinook salmon traveling through the upper screening facility during day and night tests. Fall chinook salmon traveled more quickly at night than during the day; fifty percent of the test fish were caught in one hour during nighttime tests compared to 5.5 hours for daytime tests. Summer steelhead traveled slowest, requiring 10.5 hours to capture 50% of the daytime test fish.

7. Movement of fish through the lower bypass at a 5-cfs flow was considerably slower for all species than at a 25-cfs flow or than through the upper screening facility. After one hour of sampling at a 5-cfs bypass flow, we recaptured 25%, 27%, and 2% of the spring chinook, fall chinook, and summer steelhead, respectively; at a 25-cfs bypass flow, we recaptured 32% of the spring chinook, 62% of the fall chinook, and 16% of the summer steelhead.

8. Die1 passage of hatchery-released and wild juvenile salmon through the bypass facility was greatest from sunrise through sunset. The highest hourly number of juvenile salmonids counted was about 1,800 on 24 April and 2,000 on 8 May 1991. We counted a total of 41,318 juvenile salmonids through the bypass facility from 5 April to 10 April and from 23 April to 9 May 1992.

9. We counted approximately 30,000 juvenile salmonids moving past the east-bank fish ladder viewing window from late March through early June in 1990. These counts tended to peak 10 to 13 days after Umatilla River flows reached their highest point.

Report C

Highlights of results of our work with the adult passage facility at Three Mile Falls Dam are

1. We counted 922 coho (410 adults and 512 jacks), 1,110 summer steelhead, 1,061 fall chinook (333,adults, 107 jacks and 621 subjacks), and 1,330 spring chinook (1,291 adults and 39 jacks) at the Three Mile Falls Dam east-bank trapping facility in Fall 1990 and Spring 1991.

2. Migration periods of fall chinook and coho extended from early October through early December and mid-February, respectively. Summer steelhead migrated from mid-October through early June. Spring chinook migrated from early April through June. Return timing was similar for fall and spring chinook and coho salmon but earlier for summer steelhead compared to the previous year's returns.

3. The majority of the fall chinook and coho salmon migrated to Three Mile Falls Dam when flows were between 150 to 250 cfs; the flow trigger for peak numbers passing the dam in late October and early November was 150 cfs. We hypothesize that low flows (25 to 250 cfs) during fall may be the major cause for straying problems observed for fall chinook salmon. Most summer steelhead arrived at the dam between February and mid-April; large numbers were counted as flows approached and exceeded 500 cfs. The majority of spring chinook returned to Three Mile Falls Dam from late April through late May; peak movement occurred as water levels declined after high flow events (>l,OOO cfs).

4. Video-tape sampling occurred from October through mid-November 1990 using video-recording equipment installed in the east-bank adult passage facility viewing room of Three Mile Falls Dam. Based on taped images, we counted 236 coho salmon, 925 fall chinook, 83 summer steelhead and 1,660 unidentifiable fish. The hourly movement of fall chinook salmon varied greatly from day to day.

5. Variation in comparison of adult salmonid numbers by video-tape images and direct observations in the trapping facility exceeded 100%. Species identification and enumeration from video-taped images of fall chinook and coho salmon were difficult to make due to much back and forth movement and advanced species maturation. We hypothesize that fallback may be caused by inadequate attraction flows at the steep pass entrance in conjunction with attraction flow interference from the lead gate.

6. A three-day operation of the west-bank adult ladder and trap revealed structural and operational difficulties that may cause fish injuries and escape and preclude efficient and effective trapping.

7. Carcass surveys conducted downstream from Three Mile Falls Dam in the fall of 1990 counted 120 dead fall chinook, 5 dead coho, and 14 occupied and 39 unoccupied redds. A minimum of 24.8% of the fall chinook return to Three Mile Falls Dam spawned below the dam. We hypothesize that lower river spawning may have been due to lower river juvenile fish releases in 1986 and the existence of a structural barrier to large fish at the fish ladder.

8. We observed 194 spring chinook in prespawning surveys conducted in the upper Umatilla River and tributaries in late June through mid-July; four mortalities and two eminent mortalities were noted. An additional 73 spring chinook were observed in the Tribal harvest.

REPORT A

1. Sampling plan development and preparations for the evaluation of the juvenile fish bypass system in the West Extension Irrigation District Canal at Three Mile Falls Dam.

2. Trap designs for future evaluations at Maxwell and Westland dams.

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ABSTRACT

We report on our effort from October 1990 through March 1991 to prepare for the evaluation of the juvenile fish bypass facility in the West Extension Irrigation District Canal at Three Mile Falls Dam on the Umatilla River. We also report on our preliminary activities to prepare for future evaluations at Maxwell and Westland diversion dams. A detailed sampling plan was written to guide our efforts in the evaluation process and associated preparatory activities were conducted. In the sampling plan, we developed experimental designs for evaluating the passage of juvenile salmonids through the bypass system including the evaluation at design flow of injury and mortality rates, and passage of juvenile salmonids through and over the screens. We designed and fabricated fyke nets for screen leakage tests, and holding facilities for test fish. Modifications to improve evaluation activities were incorporated into the collection facility, and our sampling gear. We designed and fabricated collection systems for the juvenile fish bypass facilities at Maxwell and Westland diversion dams. Preliminary monitoring of system operation was performed at Westland Diversion Dam. We offer recommendations for improving preparations and designs of future evaluations, and also recommend that a detailed evaluation of the Maxwell and Westland juvenile facilities, including evaluation of fish condition and fish passage through or over the screens, be conducted.

INTRODUCTION

Background

The Northwest Power Planning Council's (NPPC) Columbia River Basin Fish and Wildlife Program (1987) directed the construction of anadromous fishery enhancement projects in the Umatilla River Basin in the form of passage improvements (Section 1403, Measure 4.2). Under contract with the Bonneville Power Administration (BPA) and in cooperation with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and fish and wildlife agencies, the U.S. Bureau of Reclamation (USBR) developed and implemented a program to improve fish passage facilities at Umatilla River diversion dams. State-of-the-art passage facilities at Three Mile Falls Dam were the first to be constructed, followed by Maxwell and Coldsprings diversion dams. Westland Diversion Dam passage facilities were reconstructed under the direction of the Oregon Department of Fish and Wildlife (ODFW). Passage facilities at Stanfield Diversion Dam are currently in the design phase by ODFW staff. New screening facilities are intended to prevent juvenile salmonids from entering the irrigation canals by guiding them unharmed back to the river from which they were diverted. Evaluation of the passage improvement projects at the five major diversion dams on the Umatilla River was suggested in A *Comprehensive Plan for Rehabilitation of Anadromous Fish Stocks in the Umatilla River Basin* (Boyce 1986).

Construction of similar fish passage and protection facilities at major (Phase I) irrigation diversions in the Yakima River Basin, Washington, has also been funded by BPA and USBR under Section 803 (b) of the NPPC's Columbia River Basin Fish and Wildlife Program (NPPC 1987). Evaluations of the effectiveness of these fish screening facilities on the Yakima River have been carried out by Neitzel et al. (1985, 1987, 1988, 1990a, 1990b) and Hosey & Associates (1988, 1989, 1990). We considered their experiences when designing evaluations of fish screening facilities in the Umatilla River Basin.

We began our evaluation of juvenile fish bypass facilities in the Umatilla River at Three Mile Falls Dam in November 1989 through September 1990. During this period, we operated and evaluated the efficiency of the juvenile bypass system in the West Extension Irrigation District (WEID) Canal at Three Mile Falls Dam. Improvements were made to the bypass collection facilities, a system was developed to collect juvenile salmonids at the bypass outfall, and preliminary information on juvenile fish passage and fish condition was collected (Knapp and Ward 1990).

In this report we describe our progress from October 1990 through March 1991 toward second year study objectives. These study objectives are to (1) evaluate the passage of juvenile salmonids through the bypass system in the WEID Canal facility at Three Mile Falls Dam, including the evaluation at design flow of injury and mortality rates, and passage of juvenile salmonids through and over the screens, and (2) perform preliminary activities that will facilitate passage evaluations at Maxwell and Westland diversion dams next year.

Study Sites

Description of Three Mile Falls Dam and the associated WEID Canal and fish screening facilities is provided in our first annual progress report (Knapp and Ward 1990).

Maxwell Diversion Dam is located at River Mile (RM) 14.8, 3 miles south of Hermiston, Oregon on the Umatilla River (Figure 1). The diversion dam and canal divert water to serve the Hermiston Irrigation District. From the diversion dam, the canal extends 1.5 miles to the fish screening facility and fish bypass. Reconstruction of the old juvenile screening facility was completed in 1989 to comply with revised screening criteria for excluding juvenile salmonids from the canal and returning them back to the river. Components of the new facility and associated canal structure include a trashrack, wastewater channel, three rotary drum screens, a bypass chamber and outlet structure, and a canal check structure (Figure 2). The drum screens are 4 ft in diameter x 12 ft long and are angled 24 degrees with respect to canal flow. Fish screened from the canal are diverted into the bypass chamber and carried back to the river via a 24-inch diameter bypass pipe.

Westland Diversion Dam is located at RM 27.3 on the Umatilla River (Figure 1). Westland Irrigation District diverts water through the canal to serve lands on the west side of the river. An improved juvenile fish bypass and holding facility was completed in 1990. Components of the new facility include a trashrack, wastewater channel, ten 6-ft diameter x 12-ft long rotary drum screens, two vertical traveling screens, a pumpback bay with two 9-cubic feet per second (cfs) pumps, fish separator, two fish holding ponds, and two river return pipes (Figure 2). Juvenile fish entering the facility are either routed back to the river via a bypass pipe or diverted into a holding pond for trapping and hauling purposes.

METHODS

Three Mile Falls Dam Juvenile Fish Bypass Facility Evaluation

Sampling Plan

For the evaluation of the juvenile fish bypass system at Three Mile Falls Dam, we needed to develop a field sampling plan to guide our efforts in conducting the specific tests and other aspects of the study. In formulating the sampling plan, we needed to identify test fish to be used, and test-specific experimental designs, including release numbers, release and recapture methods and locations, examination procedures, data needs, and statistical methods. We also needed to identify brand marks to be used, facility operation procedures and consider strategies for hauling and holding fish.

Experimental Design: The basic experimental design of the evaluation included two types of tests: injury and leakage. The

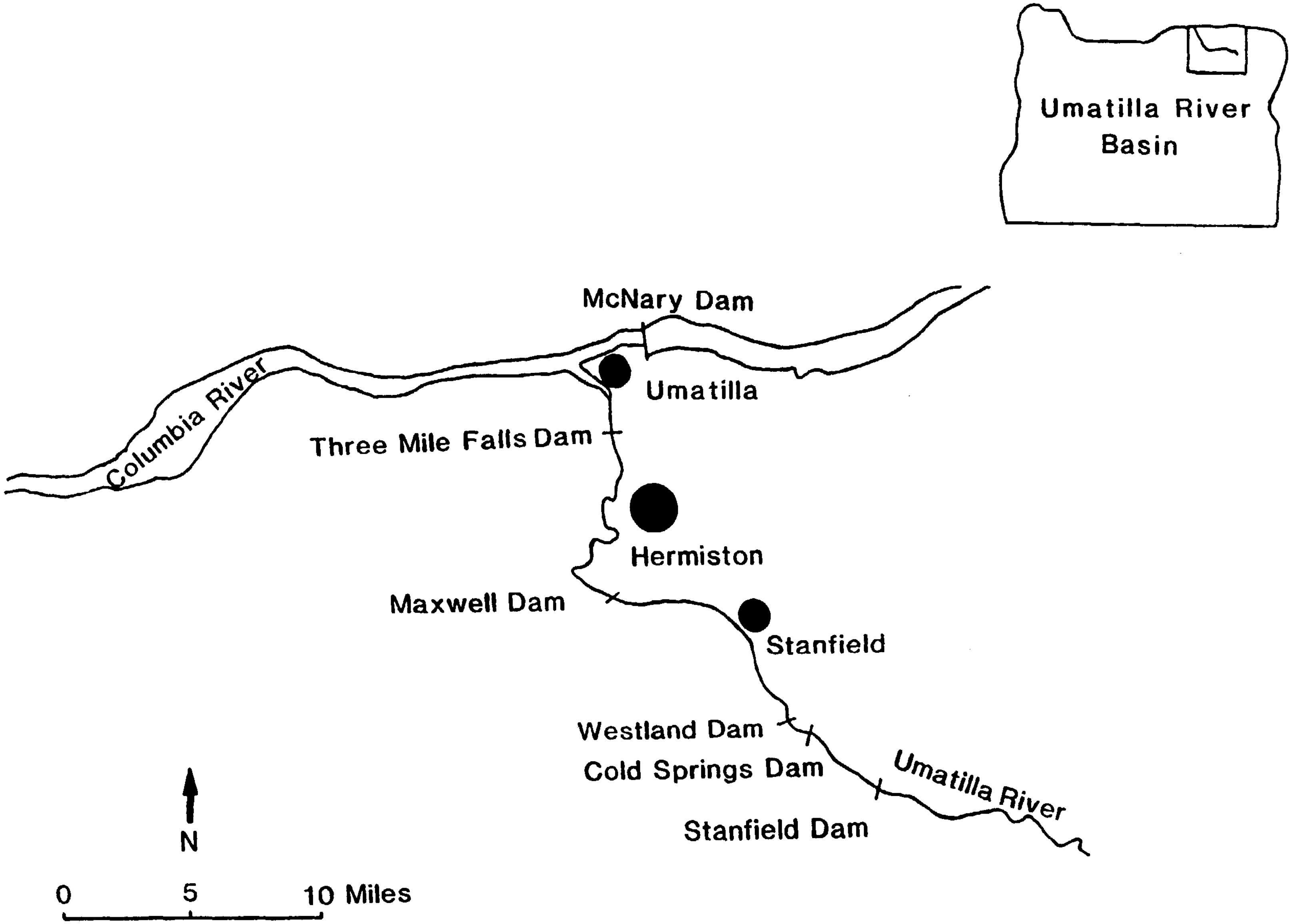


Figure 1. Locations of diversion dams on the lower Umatilla River, Oregon.

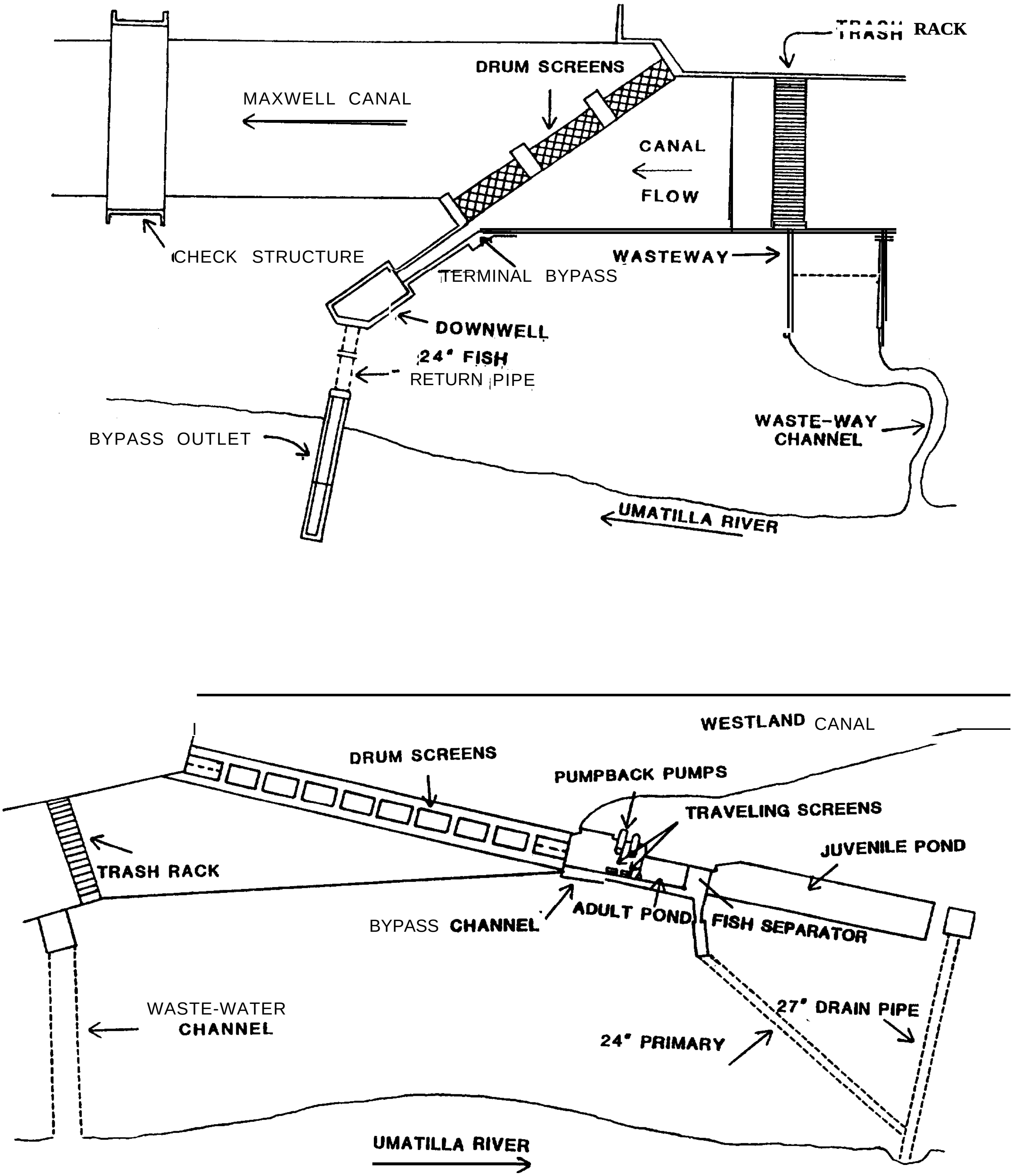


Figure 2. Schematic of the juvenile fish bypass facilities at Maxwell (upper) and Westland (lower) diversion dams. 13

primary objective in the injury test was to evaluate injury or injury-related mortality of fish as they passed by the screens and into the bypass or through the bypass pipe and out the outfall. We planned to accomplish this by releasing groups of marked fish in various locations in the screening facility, recapturing them in the bypass or bypass outfall, and inspecting them for mortality, descaling or other injury. We also planned to release groups of marked fish directly into collection facilities to assess and compare injury caused by the collection and handling process. To determine if injury levels varied with ambient light conditions, we planned to conduct the screen injury tests during the day and night. To determine if injury levels varied with bypass flow, we planned to conduct the bypass pipe and outfall injury test at a 5-cfs and 25-cfs bypass flow.

Our objective in the leakage test was to evaluate fish loss into the canal caused by passage through (entrainment) or over (impingement) the drum screens by releasing groups of fish upstream from the screens, and recapturing them in fyke nets set immediately downstream from the screens. We also planned to release marked fish between the screens and fyke nets and in the bypass channel to evaluate the sampling efficiency of the nets and collection facility, respectively.

In addition, we desired to determine if fish were leaking past the pumpback bay traveling screen during operation, and if fish were injured as they passed under the canal headgates. These tests were ancillary to work statement objectives and would be performed as secondary tests, if possible.

We designated the primary tests as the (1) screen injury test, (2) bypass pipe and outfall injury test, and (3) screen leakage test. Secondary tests were designated as the (1) traveling screen leakage test, and (2) headgate injury test.

Screen Injury *Test:* In designing the screen injury test, we needed to identify release locations above the screens and determine sampling frequency. Since we would be collecting a 100% sample to recapture all test fish, we were concerned with how to prevent fish in the transfer flume from entering behind the sample tank crowder during the sample crowding process. We needed to determine release and recapture strategies for control fish to preclude differential handling between treatment and control fish.

In determining release times for day and night treatment releases, we identified time of darkness during April and May for the night release. Subsequent day and night releases were established at 12 hour intervals.

The bypass collection facility at Three Mile Falls Dam had been previously modified to allow efficient sampling of bypassed fish (Knapp and Ward 1990). An effective anesthetic system would satisfy our need to identify and separate collected river-run fish from our branded test fish, and allow us to examine test fish for injury. A system to recover anesthetized fish and return them back to the river had also been developed. Our work in 1989 and 1990 helped prepare us for this year's sampling efforts and alerted us to problems we might encounter.

We were concerned with how to provide consistent lighting conditions during the examination process for both day and night tests to eliminate bias in evaluating injury. To be consistent, all fish within a particular test, including pre-release subsample and recaptured test fish, needed to be examined in the same manner and under the same conditions. Individual subjectiveness needed to be minimized or eliminated.

Our data needs for the screen injury test were to document condition of treatment and control fish in the form of scale loss or other injury, the number of treatment fish recaptured and time of recapture, and mortalities. Incidental information included the documentation of facility operations.

Bypass Pipe and Outfall Injury Test: In previous efforts, we had designed, fabricated and tested a floating net pen for the bypass outfall test to capture the majority of fish exiting the outfall (Knapp and Ward 1990). In designing the bypass pipe and outfall injury test, special consideration was given to how and when control fish were to be released into the net pen, where treatment fish were to be released, how fish were to be recovered from the net pen, and where examination for injury was to occur. We also needed to know the operational procedures for setting a 5-cfs and 25-cfs outfall flow. Other concerns were whether associated control and treatment groups should be released into the net pen together or separately, the length of time the net pen should be held in place to recapture the majority of treatment fish, and what method to use to restrict flow through the bypass to facilitate placement of the net pen.

Our concerns during the examination process were similar to those for the screen injury test. To be consistent, all fish needed to be examined in the same manner and under the same conditions. Recovering fish from the net pen at the base of the bypass outfall required that fish be examined in close proximity. Requirements such as holding, processing, recovery and disposal of fish at this location needed to be addressed.

Data needs for the bypass pipe and outfall injury test were the same as those for the screen injury test.

Screen Leakage: Development of an experimental design for the screen leakage test required a decision on a capture method. We decided on a series of fyke nets behind each of the four drum screens (see Preparatory Activities). Other considerations were where and how to release treatment and control fish, how to differentiate treatment fish from control fish, and the frequency and duration of "sampling" after each release to ensure recapture of the majority of fish. In our decision to use fry in this test, we could not brand the fish due to their small size which precluded our ability to differentiate release groups. Therefore, successive test releases needed to be spaced far enough apart to avoid recapturing previously released test fish.

A sampling mode would be required at the collection facility to recapture treatment fish and control fish released in the bypass channel. When in a sampling mode, a 20-cfs flow should be diverted from the bypass channel back to the canal or to the river. We were prevented in using the pumpback pumps to divert the water into the canal because the turbulent discharge would interfere with fyke net collection efficiency. Therefore, we were restricted to discharging the 20-cfs flow through the river return drain pipe. We could only monitor screen leakage of river-run fish when pumpback pump operation was not required.

Our specific data needs were the number of control fish and the number and length of treatment fish in the fyke net, the number of control and treatment fish collected in the sampling tank, and observations of "rollover" or screen impingement.

Traveling Screen Leakage Test: We had a concern on whether fish were getting by the traveling screen bottom seals or screen mesh and entering into the pumpback bay. To test for leakage, we considered options on where, when and how to capture fish.

Headgate Injury Test: We wanted to know if fish were being injured as they passed under the headgates into the canal facility. Availability of test fish was our major constraint. Experimental design would be similar to the screen injury test.

Test Fish: We desired to use the same fish species that were present in the Umatilla River system. Appropriate information could then be obtained on species and size specific behavior and potential for injury or leakage in the passage facility. We desired to use fry-sized fish for the screen leakage test since these fish would be potentially vulnerable to entrainment and impingement should natural production increase in the lower river in the future. For our tests, we wanted to procure unmarked (no CWT) production fish destined for release in the Umatilla River.

The proposed number of fish in each release group had been reviewed and approved by an ODFW staff biometrician. These numbers were based on sample sizes used by previous researchers (Fast et al. 1986, Hosey and Associates 1988), but were modified based on size of the WEID facility, expected recapture rates, and expected variation in results among release groups. We calculated the total number of test fish needed for the screen injury, bypass outfall injury, and screen leakage tests from the required number of treatment and control releases, release groups, and fish per group for each test category.

Test Schedules: Test schedules were primarily determined by fish availability from hatcheries. Fish availability was contingent on attainment of a desired target size. We also wanted to avoid conducting tests with a specific species when large numbers of hatchery released fish of the same species were expected to be in the river system.

Other considerations in scheduling day-to-day activities were the time required for branding and brand-setting, for carrying out tests or other activities, and for appropriate numbers of test fish to be recovered in a test.

We also considered ease and efficiency in equipment deployment and changing modes of operation when planning the sequence of tests. The difficulty in deploying the bypass channel sampling equipment and the time that it consumed favored the scheduling of all screen injury tests back-to- back. This would minimize equipment changes and allowed a greater length of time for total recapture for all screen injury test releases.

Brands: We were to mark fish using freeze-brands. Brand marks needed to be unique between all treatment and control release groups to permit differentiation. Fish length, number of replicates, and desired number of branding stations were factors in determining number, size and type of brand to use. For consistency in readability, all brands needed to be of the same series. Brands needed to be procured from the National Marine Fisheries Service.

Examination: Criteria used for the evaluation of descaling or other injury needed to be consistent with criteria used elsewhere in the Columbia River Basin for comparative purposes.

Data Analysis: Our primary goal in the evaluation of injury was to determine if fish were injured or killed during their passage through the screening facility and as they were diverted back to the river. We needed to ascertain if there was significant differences in injury between treatment and control fish from the various tests to determine if injury was facility-caused. In this analysis, we needed to take into account affects of the collection systems and the handling process on fish condition, and pre-release condition of the fish. Data on injury needed to be collected, manipulated and presented in a manner that was conducive to analysis and comparison with results from other studies. The ability to pool the data from the various releases and tests to reach a higher level of confidence was an important consideration. We considered various statistical tests that would provide us with the information we wanted with the type of data we were collecting.

We were also concerned with travel time through the facility. The time required to recapture 50% and 95% of the test releases in the collection facility or at the bypass outfall would provide us with an overall estimate of system efficiency in returning fish back to the river.

The data collected from the screen leakage tests would test the null hypothesis that no fish pass through the drum screens and enter the irrigation canal and all fish that encounter the drum screens are guided into the bypass. To carry out the computations for determining screening efficiency, we would need to determine bypass and net collection efficiency.

Preparatory Activities

Hauling and Holding: We needed to determine a method for transporting test fish from hatcheries to a nearby temporary holding site prior to use in the evaluation. This method should be efficient and non-injurous to fish.

To determine a temporary holding location for all the test fish, we evaluated the merits and feasibility of holding fish on-site at Three Mile Falls Dam vs. a nearby hatchery or acclimation pond. In both cases, special consideration was given to space availability, staff needs, and fish handling requirements.

If held off-site, we needed to develop a method for hauling the various fish species to the test site when needed. We considered available transport vehicle options, their accessibility, convenience, size, and ease in loading and unloading fish. We desired to load and unload fish with the least amount of handling. The transport method would need a sufficient oxygen supply system and not be stressful to fish.

We needed to design a system for receiving and holding a specific group of test fish at the site prior to branding. We considered ease of unloading without injury to fish, availability of a sufficient water supply system, space availability, fish accessibility for branding or monitoring, and safety and welfare of the fish.

After branding, we needed individual containers to hold the separate release groups. Considerations in selecting appropriate containers were adequate capacity, availability, cost, versatility, ease in handling and in accessing and releasing fish, and capability of allowing sunlight penetration without fish escape. An associated water supply or oxygen system was also a concern.

A water supply system would be required to provide adequate inflow for fish survival. This system needed to be conducive to our selected fish holding arrangement. We consulted with biologists from the Yakima Indian Nation, ODFW, Battelle, Pacific Northwest Laboratories (PNL), and Hosey & Associates in developing ideas for holding facilities and an associated water supply system.

Marking: We considered location, equipment needs, and safety concerns in devising a workable branding system. We wanted a system that was non-injurous or stressful to fish and efficient in operation.

We consulted with others proficient in branding to learn specific techniques and use and care of equipment.

We had to develop a marking method for the fry-sized fish to be used in the screen leakage test since treatment and control fish needed to be differentiated to effectively run the test. The small size of the fish precluded branding. We consulted with other biologists and considered their experiences in devising a marking method.

Trap Designs: To aide us in our evaluation of drum screen leakage, we needed to design a system that would capture fish in the WEID Canal behind the drum screens. Since juvenile fish had been observed in the canal downstream of the drum screens (Knapp and Ward 1990), it was important to know from which screen(s) leakage was a potential problem. We decided on a system of fyke nets behind each of the four drum screens. Prior to the design of fyke nets, we consulted with biologists from Battelle, PNL on their approach to fyke net and fyke net frame design used in Phase I fish screening facility evaluations in the Yakima River Basin.

In our decision to use fyke nets, we considered ease of deployment, cost, efficiency, effectiveness and operational constraints. We inspected the WEID Canal site behind the drum screens to determine exact specifications for the fyke nets. We measured available distance downstream of each screen to the canal wall, angle of canal wall, depth, angle, volumn and velocity of water flow through the screens, and drum screen width. We used simple trigonomic functions to determine correct side lengths and corner angles for each of the four respective nets. The unequal sides and corresponding angles would allow the nets to lay parallel to the angle of the flow. Mesh size was contingent on fish size. We also considered means for efficiently removing fish from the cod end.

We patterned the fyke net frames after the baffle board frames already installed behind the drum screens in the WEID Canal for use in flushing out bottom silt. We included minor modifications for fyke net attachment. We measured frame width and depth, number, width and spacing of baffle boards, and distance between frame lifting brackets.

For the traveling screen leakage test, we evaluated conditions at the terminus of the river return drain pipe which drains the pumpback bay, and decided this was the only logical location for collecting fish that may leak past the screen. We selected a fyke net design at the pipe terminus as the most practical and effective means of capturing fish To design the fyke net and frame, we measured the length and depth of the discharge pool, and diameter and position of the pipe terminus, and estimated flow and velocity of the discharge water. We considered how to secure the net frame to the cement wall, and efficient deployment and retreival methods.

Equipment Needs: We assessed equipment and gear needs in accordance with each evaluation activity. We consulted with other biologists to determine what worked best for them and researched available suppliers. We considered safety, fish handling, data collection, equipment operation, and personnel in deciding on the type of gear and equipment we needed.

Facility and Gear Modifications: After sampling activities in 1990, we identified areas for modification and improvement to enhance evaluation activities in 1991. These included modifications to the sampling tank, modifications to our sampling gear, and minor modifications to the site.

Personnel: Personnel needs were determined based on the summation of activities that we would be performing and the number of persons required to perform each activity. We were to operate a daily, 24-hour study that would require sufficient field personnel to haul, monitor and brand the fish, and perform the tests.

Upriver Activities at Maxwell and Westland Diversion Dams

Our second objective in this year's efforts was to perform preliminary activities that would facilitate juvenile fish passage evaluations at Maxwell and Westland diversion dam fish bypass facilities. To meet this objective, we were to operate and evaluate the efficiency of the juvenile fish bypass system at Westland Diversion Dam, and design bypass and bypass outfall capture facilities for the Maxwell and Westland juvenile salmonid bypass systems.

Trap Design

We conducted site-specific evaluations at Maxwell and Westland diversion facilities in the fall of 1990 to assist in developing designs for bypass channel collection traps for future evaluations. To further assist in designing bypass traps, we consulted with biologists from Battelle, PNL who had performed similar evaluations at Yakima River Phase I fish screening projects. We also toured the Phase I and Phase II (small to medium) fish screening facilities in the Yakima River Basin to familiarize ourselves with facility design and operations. We consulted with biologists from National Marine Fisheries Service who were instrumental in developing operating criteria for the Umatilla River fish passage facilities.

Structural and operational features used to determine appropriate trap design for the bypass channel at each dam's screening facility included configuration of the bypass channel and bypass downwell., maximum design bypass flow, heigth of water surcharge over the channel weir at maximum design flow, available structures for trap securement and deployment, and access. In our design process, we considered how to eliminate water during fish collection, adjust the trap with flow fluctuations, efficiently collect fish in a non-injurous manner, and efficiently deploy, retrieve and clean the trap.

The design of the fish screening and holding facility at Westland Diversion Dam was constrained by a low head differential between the facility and the river. Elements of this design relating to the bypass channel confounded our attempts to design a bypass channel trap. We inspected the structure and configuration of the bypass downwell and determined that it would be difficult to locate a trap in this area. Subsequently, we turned our attention to the juvenile salmonid holding pond as a potential trap location. Stoplog guides at the entrance to the pond suggested a fyke net design to be most appropriate. We measured the stoplog guides, and determined pond water depth and inflow current during normal operations. Our concerns were how to effectively contain and access the collected fish, and how to deploy and retreive the net.

Other Activities

To familiarize ourselves with the design and operation of the juvenile fish bypass facility at Westland Dam, we reviewed operating criteria and inspected the facility in depth with ODFW engineering personnel both during and after construction. We also monitored juvenile salmonid trap and haul operations when possible.

We investigated the condition of the wastewater channel at the Maxwell Dam fish screening facility. We were concerned with the potential for fish passage and injury during overflow periods and with fish stranding during periods of overflow abatement.

RESULTS

Three Mile Falls Dam Juvenile Fish Bypass Facility Evaluation

Sampling Plan

Experimental Design: We will segregate the evaluation of the juvenile fish bypass facility at Threemile Falls Dam into different tests in order to evaluate various components of the facility at designed operating criteria and flow. The primary tests to be conducted include the screen injury, bypass pipe and outfall injury, and screen leakage tests. Secondary tests include traveling screen leakage and headgate injury tests. We will conduct these tests with different species or races (sizes) of juvenile salmonids in April and May of 1991.

Screen Injury *Test:* To evaluate injury and mortality rates associated with the drum screens, we will release replicate groups of healthy, freeze-branded fish upstream of the drum screens, recapture them at the bypass collection facility, and examine the fish for descaling and other injuries (treatment). We will also release replicate groups of healthy fish directly into the collection facility (sample tank) to allow us to evaluate injury caused by the collection and handling process (control).

We will conduct tests during the day and at night from mid-April to mid-May when fish are available (Figure 3). We will repeat each test on three different dates at maximum design flow for each species or race of test fish. Each treatment and control, day and night release will consist of three 100-fish groups. For each species or race of test fish, total number of release groups will be 36 and the total number of fish will be 3,600 (2 groups (treatment t control) x 2 tests (day t night) x 3 releases (dates) x 3 groups per release x 100 fish per group = 3,600 fish; Table 1).

We will adhere to operation criteria for a sampling mode when capturing released test fish in the collection facility. This includes the installation of sampling equipment (orifice plate, inclined screen, fish separator), and operation of the traveling screen and pumpback pumps, and the proper setting of weir gate positions and headworks water levels (USBR 1989). If bypass flow does not need to be returned to the canal, we will open the El-inch diameter drain pipe gate to return water to the river.

We will examine a 10% subsample from each replicate group for condition prior to releasing them to ascertain pre-release condition. We will later compare this pre-release condition with the condition of fish after they have been handled. These subsample fish will not be returned to their groups. We will release, recapture and process each day and night control group as we recapture previously released test groups. We will release groups of control fish directly into the collection facility sample tank and will handle them during examination in the same manner as the treatment fish. We will release treatment groups immediately below the headgates in each of three flume sections in the canal headworks (Figure 4). We will release day and night treatment groups at approximately 0900 hours and 2100 hours, respectively, for three consecutive 24-hour periods. We will record release information on a screen injury release form.

We will recapture treatment fish in the sample tank at the bypass collection facility (Figure 4). With sampling equipment in place, fish will enter the bypass channel through the orifice plate, move up the inclined screen and onto the fish separator, and travel along the transfer flume to the south holding (sample) tank. We will crowd and remove the fish from the tank every hour to determine travel time and begin processing. Sample tank crowding may occur more frequently if the tank becomes too full of incoming fish. To prevent fish from entering the tank behind the crowder during crowding, we will insert a slide gate into the fish separator to hold incoming fish temporarily. We will continue to recapture treatment fish for 96 hours after the last treatment release group to allow sufficient time for a 95% recovery. We will record the time of release and recapture to ascertain movement rates through the facility.

We will separate river-run fish that are collected during the evaluation from the test fish and return them to the river. We will

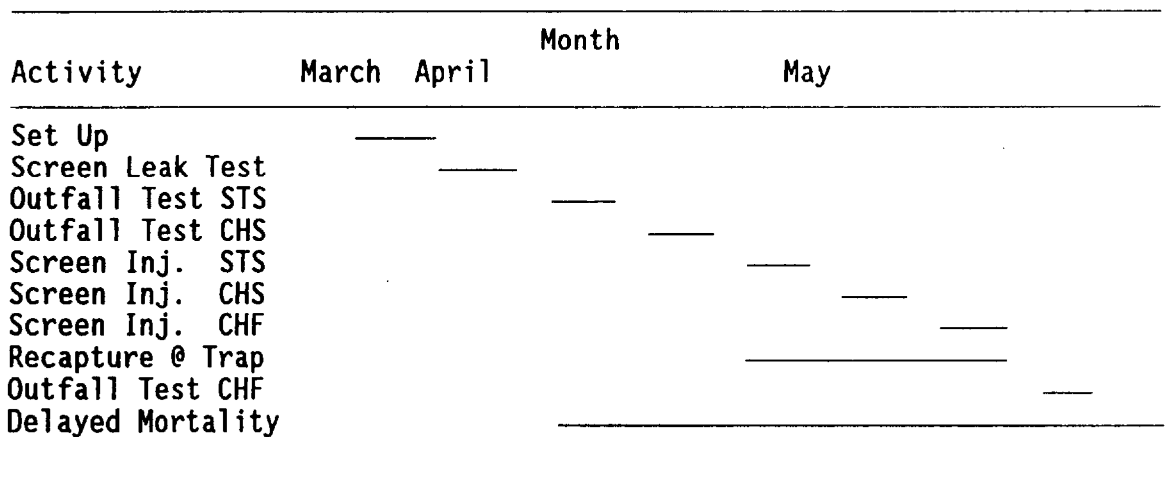
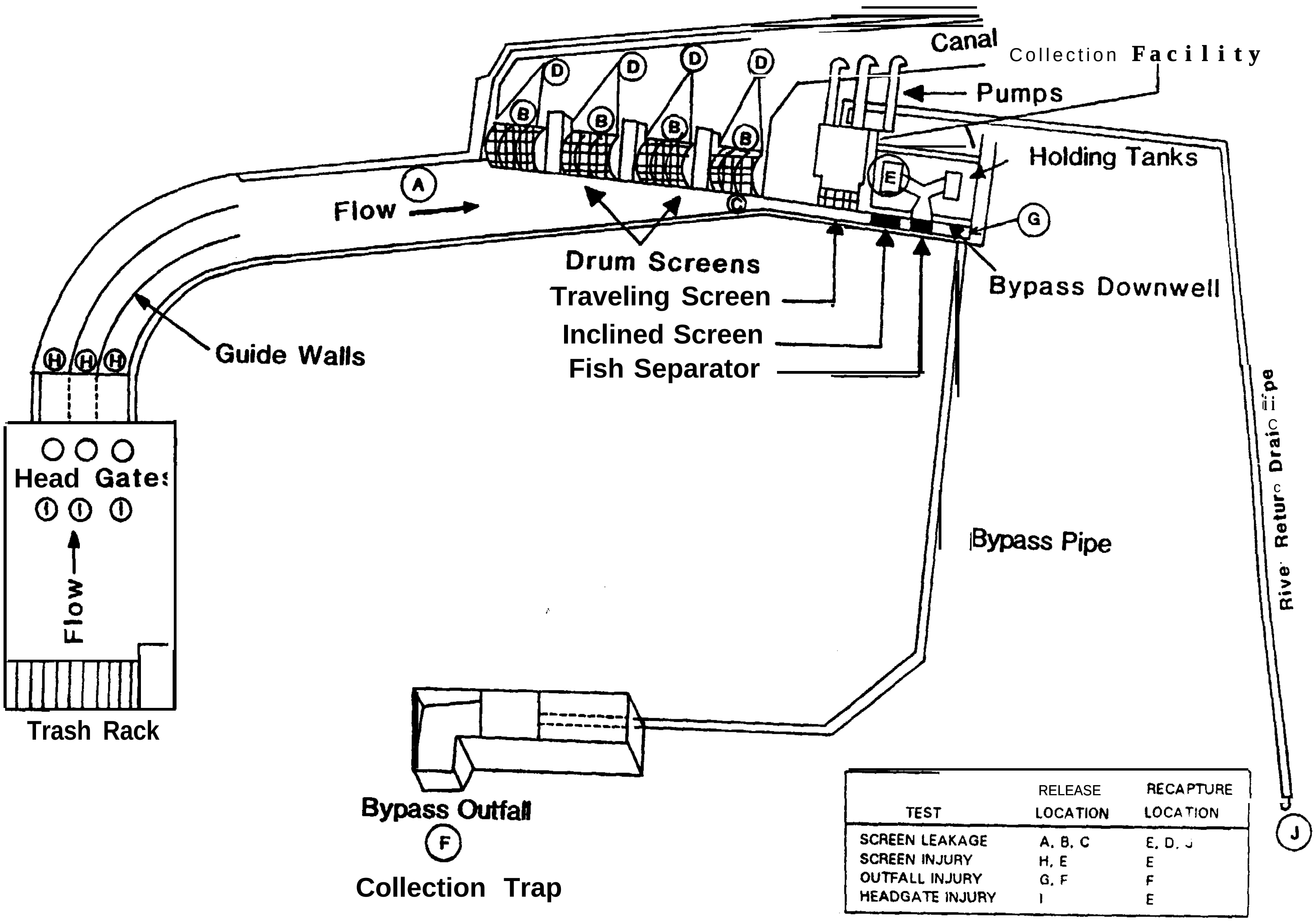


Figure 3. Schedule of evaluation activities at the WEID Canal juvenile fish bypass facility at Three Mile Falls Dam, Spring 1991.

Table 1. Summary of primary test fish releases in the WEID Canal at Three Mile Falls Dam, Umatilla River, spring 1991.

Fish species, test	Release location	Recovery location	No. per rel.	No. of releases	Total rel.
Fall chinook fry:					
Screen leakage	Net mouth	Fyke net	75	12	900
	Headworks	Fyke Net	300	3	900
	Bypass	Sample tank	300	3	900
Fall chinook (0t):					
Screen injury	Sample tank	Sample tank	100	9	900
@ day	Canal	Sample tank	100	9	900
Screen injury	Sample tank	Sample tank	100	9	900
@ night	Canal	Sample tank	100	9	900
Bypass outfall	Net pen	Net pen	100	9	900
@ 5 cfs	Downwell	Net pen	100	9	900
Bypass outfall	Net pen	Net pen	100	9	900
@ 25 cfs	Downwell	Net pen	100	9	900
Spring chinook (1+)					
Screen injury	Sample tank	Sample tank	100	9	900
@ day	Canal	Sample tank	100	9	900
Screen injury	Sample tank	Sample tank	100	9	900
@ night	Canal	Sample tank	100	9	900
Bypass outfall	Net pen	Net pen	100	9	900
@ 5 cfs	Downwell	Net pen	100	9	900
Bypass outfall	Net pen	Net pen	100	9	900
@ 25 cfs	Downwell	Net pen	100	9	900
Summer steelhead					
Screen injury	Sample tank	Sample tank	100	9	900
@ day	Canal	Sample tank	100	9	900
Screen injury	Sample tank	Sample tank	100	9	900
@ night	Canal	Sample tank	100	9	900
Bypass outfall	Net pen	Net pen	100	9	900
@ 5 cfs	Downwell	Net pen	100	9	900
Bypass outfall	Net pen	Net pen	100	9	900
@ 25 cfs	Downwell	Net pen	100	9	900

1 Actual release number will be approximately 90 for all injury tests (100 minus the 10% pre-release subsample).



TEST	RELEASE LOCATION	RECAPTURE LOCATION
SCREEN LEAKAGE	A, B, C	E, D, J
SCREEN INJURY	H, E	E
OUTFALL INJURY	G, F	F
HEADGATE INJURY	I	E

Figure 4. Schematic of the WEID Canal juvenile fish bypass facility at Three Mile Falls Dam including sampling locations for release and recapture of fish.

anesthetize all fish to ascertain test from river-run fish. We will examine test fish immediately for descaling or transfer them to holding containers for later processing. We will place river-run and test fish in the north holding tank to recover from the anesthetic and then release them into the bypass downwell.

We will examine fish for descaling in the collection facility during day and night release tests. An overhead canopy will provide protection from the weather and a high pressure sodium lamp directly above the work table will provide consistent lighting conditions for day and night examinations. We will retreive control and treatment fish from the collection tank, place them in an anesthetic trough, and anesthetize them with Finquel (MS222). We will determine condition using descaling criteria developed by the U.S. Army Corps of Engineers (USACE) and record it on descaling forms.

After processing, we will place treatment and control fish in containers to recover and either release them back into the river, or hold them for use in secondary tests.

Bypass Pipe and Outfall Injury Test: To evaluate injury and mortality rates associated with the bypass pipe and bypass outfall, we will release replicate groups of freeze-branded healthy fish at the entrance of the bypass pipe, recapture them at the bypass outfall to the river, and examine the fish for descaling and other injuries (treatment). We will also release replicate groups of fish directly into the bypass outfall collection trap (floating net pen) to allow us to evaluate injury caused by the collection and handling process (control).

We will conduct the test from mid-April to late May when fish are available (see Figure 3). We will repeat each test on three different dates for each species or race of test fish and at flows of 5 cfs and 25 cfs. Each treatment and control, 5-cfs and 25-cfs release will consist of three 1oo-fish groups. For each species or race of test fish, total number of.release groups will be 36 and total number of fish will be 3,600 (2 groups (treatment t control) x 2 tests (5 cfs t 25 cfs) x 3 replicates (dates) x 3 groups per release x 100 fish per group = 3,600 fish; Table 1).

We will adhere to operation criteria for respective bypass flow when performing the tests at a 5-cfs or 25-cfs bypass flow. This will include the installation of the restrictive orifice plate for 5-cfs flow and the concurrent operation of the traveling screen and pumpback pumps (USBR 1989). If bypass flow does not need to be returned to the canal, the river return drain pipe gate shall be open to return water to the river. Weir gate positions for both flow regimes will also be properly set according to operating criteria.

We will examine a 10% subsample from each treatment and control replicate group for condition prior to release to ascertain pre-release condition. These subsample fish will not be returned to their groups. We will release treatment fish at the weir crest in the upper bypass channel. We will release control fish directly into the net pen from shore and then position the net pen under the bypass outfall (see Figure 4). We will release control fish immediately prior to releasing treatment fish. Therefore, both treatment and control groups will be in the net pen at the same time. During the 25-cfs tests, we will install the bypass channel stoplog to reduce flows during control releases and subsequent net positioning. The stoplog will be removed and a full 25-cfs flow will be achieved prior to releasing the treatment groups.

To capture the majority of the test fish released, the net pen will remain in position for at least 30 minutes, or longer, if necessary. We will retrieve the net pen after each group release has been recaptured. We will dip net fish out from the net pen, place them in containers and transfer them to the examination area. We will record release and recovery information on a bypass outfall test form.

We will hold recaptured fish in small net pens in the river for immediate examination along the shore.. We will handle fish and examine them for injury in the same manner as in the screen injury test. We will record data on a fish condition form.

We will allow examined fish to fully recover from the anesthetic in additional net pens placed in the river; fish will be released to the river after recovery. Fish in good condition will be retained for use in secondary tests.

Drum Screen Leakage Test: To evaluate passage of juvenile salmonids through (leakage) and over (impingement) the drum screens, we will release test groups of fall chinook fry upstream of the screens and recapture them in fyke nets placed immediately behind the screens in the WEID Canal and in the bypass collection facility. We will also release groups of control fish in the fyke net mouth to obtain an estimate of net collection and.retention efficiency. To obtain an estimate on bypass collection efficiency, we will release groups of control fish in the bypass channel and recapture them in the sample tank at the collection facility. We will correct estimates of the percent of fish released above the screens and subsequently recaptured in the fyke nets for sampling efficiency of the nets and the bypass collection facility. We will monitor fish passing over the screens during the test to segregate estimates for screen passage and rollover caused by impingement.

We will use fall chinook fry in the screen leakage test. We will perform tests as close to design. canal flow as possible on three different dates in early April when fall chinook are in the fry stage (see Figure 3). Control fish will be differentiated from treatment fish with the use of a bismark brown dye. Because of our inability to designate separate groups for each test release, we will release an entire 300-fish treatment group in front of the screens, and a 300-fish control group in the bypass channel for each test day. The 300-fish control release in the mouth of the fyke nets will be separated into 75-fish group releases behind each of the four drum screens. Each of the three-day test releases will be comprised of 900 fish for a total of 2,700 fry (see Table 1).

We will place fyke nets behind the screens prior to releases. To capture released test fish in the collection facility, we will adhere to operation criteria for a sampling mode. This includes the installation of bypass channel sampling equipment, operation of the traveling screen, opening of the river return drain pipe (pumpback pumps cannot be operated with fyke nets in place), and proper setting of weir gate positions and headworks water levels (USBR 1989).

We will release test fish directly into the canal headworks upstream of the screens. We will release dyed control fish behind each screen in the net mouth in separate 75-fish groups. We will use a PVC pipe extended into the water to release fish further down into the water column. We will also release dyed control fish in the bypass channel (see Figure 4). We will make all releases at approximately the same time. We will make succeeding test releases every 48 hours for a total of three test releases. The 48-hour interval is necessary to allow time for fish from one test replicate to clear the system before release of the next replicate, since separate test fish cannot be differentiated.

We will fish behind the screens for approximately 48 hours after release to capture control fish and any test fish that leaked past or rolled over the screens. At 4-hour to 6-hour intervals during this 48-hour period, we will examine the contents of the fyke net by individually raising the nets, removing the contents of the cod end, and placing the contents in buckets. We will clean the nets with water supplied from the traveling screen spray water pump and immediately lower them back into place. We will collect fry from the sampling tank in the bypass collection facility every hour. We will release river run fish collected in the sampling tank back to the river.

We will also set the fyke nets in position during the major migration periods of hatchery-released and native fish to document any screen leakage or impingement of smolts. This will occur at periodic intervals from April through June.

We will record numbers of fry (treatment and control)hourly from the sample tank and during each fyke net retrieval. During the tests, we will monitor the drum screens for any indication of fry impingement and document numbers of "rollover" fish. We will record lengths of all treatment fish that have passed through or over the screens and representative lengths of treatment and control release fish. We will record numbers and lengths of smolts in the nets during peak passage through the facility.

We will return fry and river-run fish retrieved from the nets and the sampling tank back to the river.

Traveling Screen Leakage Test: To determine the existence and extent of fish leakage through the traveling screen between the bypass channel and the pumpback bay, we will install a fyke net at the terminus of the 21-inch diameter river return drain pipe. The drain pipe will be in operation during the sampling mode when the traveling screen is functioning but the pumpback pumps are not. All fish that pass through the operating traveling screen will eventually be diverted through the drain pipe and recaptured in the fyke net (see Figure 4).

This test will be performed whenever it is necessary to operate the traveling screen and open the river return drain pipe (operation criteria during a 5-cfs flow through the bypass channel when excess bypass flow can be returned to the river). We will conduct this test during the drum screen leakage test, the screen injury test, the bypass outfall injury test at 5-cfs, and the headgate injury test. When river flow drops and bypass flow needs to be diverted back to the canal via the pumpback pumps, the drain pipe will be closed.

We will periodically inspect fyke net contents by closing the pipe to reduce outflow, and extracting the contents from the cod end via a zippered opening.

Headgate Injury Test: To evaluate injury and mortality associated with passage through the headgates, we will release groups of healthy, freeze-branded fish upstream of the headgates, recapture them at the collection facility, and examine them for injury or descaling. We will use information obtained from the screen injury tests to evaluate injury caused by the collection and handling process.

We will adhere to normal canal operations and operating criteria for a sampling mode at the collection facility.

We will use either river-run fish collected at the facility, fish used in previous tests that are in good condition, or extra unbranded test fish. We will freeze-brand unmarked fish with a unique brand or use previously branded fish to differentiate them from river-run fish.

We will release fish in separate groups in front of the headgates (see Figure 4). Depending on test fish availability, we will release three replicate groups of fish per day for three days at a specific headgate opening. Approximately 50 to 100 fish will comprise a group. We will make both day and night releases to determine passage rates and potential for injury under the respective ambient light conditions. Tests will be performed when possible in April and May.

We will recapture the fish in the bypass collection facility at hourly intervals, and examine them for descaling and other injury, following the same procedure used in the screen injury test. We will record fish condition, and time of release and recapture. After processing, we will release the fish back to the river.

Descaling Eval uation: We will determine fish condition using descaling criteria developed by the U.S. Army Corps of Engineers (Neitzel et al. 1985) for all injury tests. We will record exact observations of fish injury and scale loss, but for purposes of analysis, we will eventually classify condition as percent healthy, partially descaled or descaled. We will base condition on the percentage of scale loss in each of five designated sections per side of fish and classify fish as "healthy" (scale loss $\leq$ 3% per section), "partially descaled" (scale loss > 3% but < 40% per section), or "descaled" (cumulative scale loss $\geq$ 40% in any two sections). Cumulative scale loss equals the sum of the area of all patterns of scale loss on one side of a fish. We will record observations of other injury types such as cuts, bruises, eye or head injuries, and torn operculums.

Test Fish: We will use yearling summer steelhead, yearling spring chinook salmon, subyearling fall chinook salmon, and fall chinook salmon fry in our evaluation. These species were selected because they are present in the Umatilla River system and because they occur at the desired sizes to be tested. We will conduct all injury tests using summer steelhead and spring chinook yearlings, and fall chinook subyearlings. We will conduct the drum screen leakage test with fall chinook fry.

Spring Chinook: We will obtain approximately 8,000 yearling spring chinook salmon smolts from the Carson National Fish Hatchery in Carson, Washington. Fish will weigh approximately 18/lb and have an average length of 135 mm. In early April, the ODFW Liberation Program will transport the fish from the hatchery to the Minthorn acclimation facility operated by the Confederated Tribes of the Umatilla Indian Reservation. These fish will be held at the pond until needed for the evaluation.

Fall Chinook: We will obtain approximately 2,700 fall chinook salmon fry from Irrigon Hatchery in Irrigon, Oregon, in early April. Fish will weigh approximately 200/lb and have an average length of 35 mm. We will obtain approximately 8,000 subyearling fall chinook salmon smolts from the Irrigon Hatchery in early May. Fish will weigh approximately 60/1b and have an average length of 90 mm.

Summer Steelhead: We will obtain 8,000 yearling summer steelhead smolts (gradeouts) from Oak Springs Hatchery in Maupin, Oregon. Fish will weigh approximately 8/lb and have an average length of 175 mm. The ODFW Liberation Program will transport the fish from the hatchery to CTUIR's Minthorn acclimation facility in early April where they will be held until needed for the evaluation.

Hauling: We will haul the test fish from their holding locations approximately four days prior to the scheduled test release date. To transport the spring chinook and summer steelhead from Minthorn, and the fall chinook subyearlings from Irrigon Hatchery, we will use ODFW's 370-gallon tanker equipped with a circulation and oxygen system. To load the fish into the tankers, we will need to crowd and net the fish from the ponds at the respective holding sites. At the test site, we will unload the test fish into a large, net-lined receiving tank supplied with river water. We will position the tank in an accessible location to easily unload the fish from the tanker (Figure 5).

We will haul fall chinook fry from Irrigon Hatchery to the test site one day prior to the test. We will use 32-gallon containers aerated with bottled oxygen to transport the fry.

Harking: We developed a workable and sufficient number of unique brands using a four rotation and four position scheme for each available brand. We will mark each treatment group with a unique brand. We will use the right dorsal position for all control fish, as control groups within each replicate release do not need to be differentiated (Table 2).

We will begin freeze-branding replicate treatment and control groups the day after fish have been hauled to the test site. Branding of 3,600 fish will take from 1 to 2 days. After branding, we will hold fish in separate containers for 48 hours to 72 hours to allow the brand to set and the fish to acclimate. We will record branding information on a branding form.

We will dye the control groups of fall chinook fry for the screen leakage test with bismark.brown dye to differentiate them from the test group. Fish will be placed in an aerated container with the dye mixture for one hour to allow time for the dye to set.

Holding and Water Supply System: We will hold all 36 separate groups for the injury tests in appropriate-sized containers. These containers will be specifically labeled with the brand mark, fish species and number. The containers will be in large tanks supplied with pumped river water from the canal, will be perforated to allow flow through of water, and covered with netting to prevent fish escape but permit sunlight penetration. We will record mortalities, temperature, and other observations during periodic checks.

Two electric submersible pumps will be used to pump water from the WEID Canal into the large holding tanks through a regulated manifold system of PVC pipes and valves (Figure 5). Each sump pump will have a maximum pumping capacity of 170 gallons per minute (gpm) at a 10-ft head which will supply approximately 55 gpm of inflow water to each of the 6 large tanks. A gas centrifugal pump will be available in case of submersible pump failure. Pumped water will circulate around the tank, providing inflow to the holding containers, and drain out a stand pipe back into the canal. Standpipe length will regulate water depth.

We will use the auxillary inflow water supply at the bypass collection facility for holding fish in containers in this area. Water from the traveling screen spray water pump will also be used for miscellaneous operations (Figure 5). We will use floating net pens to hold fish in the canal headworks area or in the river, if necessary.

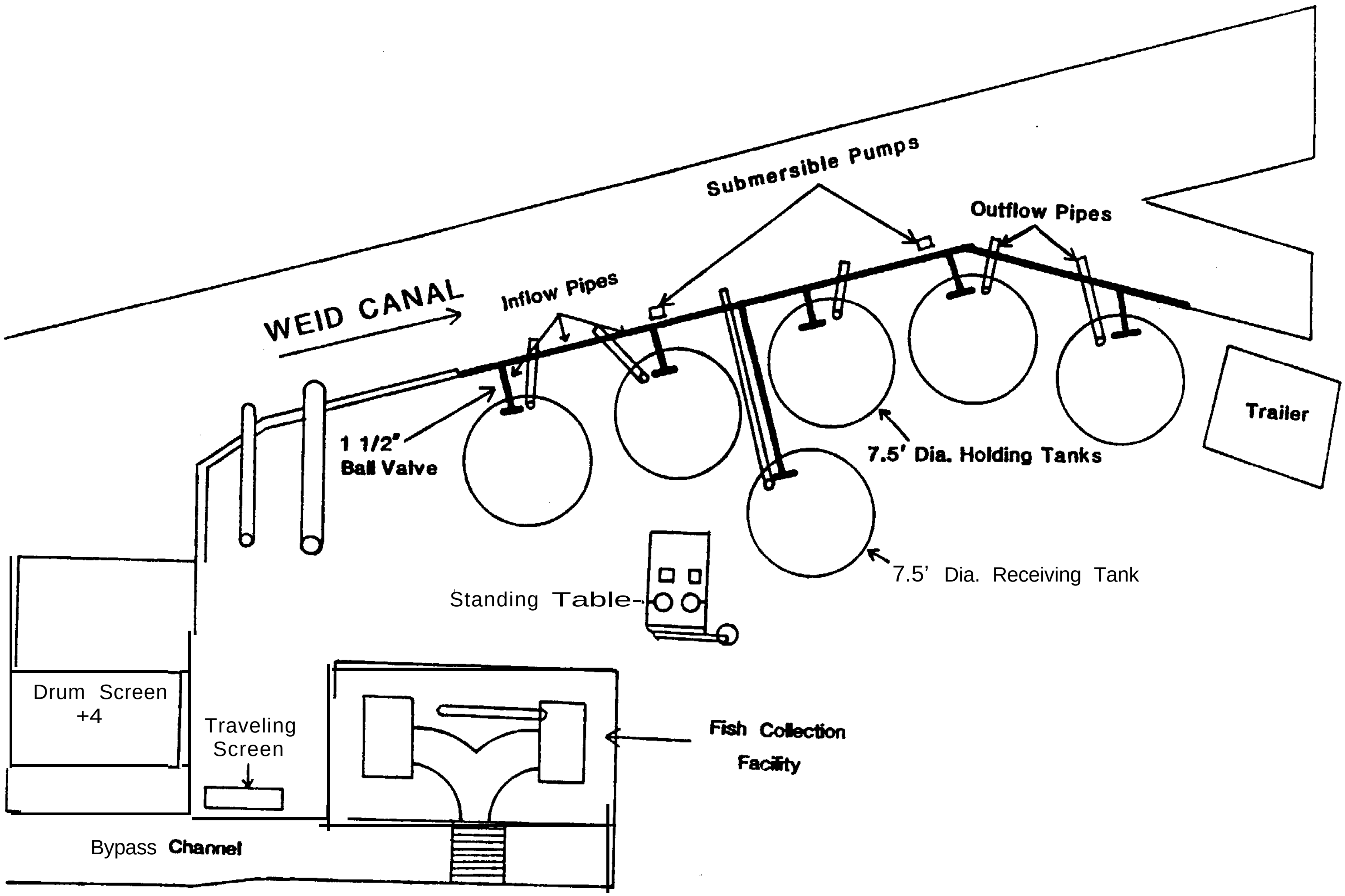
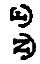


Figure 5. Schematic of fish holding facilities and test set-up at the WEID Canal facility, Three Mile Falls Dam, Spring 1991.

Table 2. Patterns and locations of freeze-brands used on fish released at the juvenile fish bypass facility in the West Extension Irrigation District Canal, Three Mile Falls Dam, Spring 1991.

		Treatment			Control		
Brand	Test, replicates	Group brand position			Group brand position		
	Screen Injury Day:	1	2	3	1	2	3
	1	LA	RA	LD	RD	RD	RD
	2	LA	RA	LD	RD	RD	RD
	3	LA	RA	LD	RD	RD	RD
	Screen Injury Night:						
	1	LA	RA	LD	RD	RD	RD
	2	LA	RA	LD	RD	RD	RD
	3	LA	RA	LD	RO	RD	RD
	Bypass Injury 25 cfs:						
	1	LA	RA	LD	RD	RD	RD
	2	LA	RA	LD	RD	RD	RD
	3	LA	RA	LD	RD	RD	RD
	Bypass Injury 5 cfs:						
	1	LA	RA	LD	RD	RD	RD
	2	LA	RA	LD	RD	RD	RD
	3	LA	RA	LD	RD	RD	RD

LA=Left Anterior, RA=Right Anterior, LD-Left Dorsal, RD-Right Dorsal

Data Analysis:

Injury Estimates: We will compute mean and 95% confidence intervals for the proportion of juvenile spring and fall chinook salmon and summer steelhead that are descaled (and killed), partially descaled (and injured) or that remain healthy during passage past the screens (screen injury treatment) and passing from the collection facilities to the outfall (bypass pipe and outfall injury treatment). We will also compute mean and 95% confidence intervals for the proportion of juvenile salmon that are descaled, injured, partially descaled or are healthy in the corresponding control groups for each test. We will use analysis of variance (ANOVA) to test for significant difference ($P<0.10$) between the respective treatment and control groups. We will transform the data as appropriate to meet the assumptions of ANOVA.

Relative fish condition will be determined by dividing the number of descaled, partially descaled or healthy fish in a sample by the total number sampled and multiplying by 100.

We will estimate the 95% confidence interval for descaled, partially descaled or healthy fish from "x" number of replicates for each species as

$$\bar{n} \pm ts/\sqrt{N}$$

where

$\bar{n}$ = mean percent of fish descaled, partially descaled or healthy from x number of replicates

t = student's t distribution value at x degrees of freedom and $\alpha = 0.05$.

s = sample standard-deviation

N = number of replicates

Screen Efficiency Estimates: We will test the null hypothesis that no fish pass the drum screens and enter the irrigation canal and all fish that encounter the drum screens are guided into the bypass. We will estimate screen efficiency for each test and overall.

We will correct estimates of screen efficiency for sampling efficiency. The sampling efficiencies computed to estimate screen efficiency will be: bypass collection efficiency (EFF_{bc}) and net capture efficiency (EFF_{nc}). We will assume net retention to be equal to net efficiency, giving it a value of 1. The formula for estimating screen efficiency (EFF_{sc}) will be

$$EFF_{sc} = 1 - \frac{Xnet}{EFF_{nc}N}$$

where

X_{net} = number of fish released upstream of the screens and caught in the nets, and

N = an estimate of the total number of fish encountering the screens.

$$N = \frac{X_{net}}{EFF_{nc}} + \frac{X_{bc}}{EFF_{bc}}$$

where

X_{bc} = the number of fish released upstream of the screens and caught in the bypass collection facility.

$$EFF_{nc} = \frac{n_{nc}}{N_{nc}}$$

$$EFF_{bc} = \frac{n_{bc}}{N_{bc}}$$

where

n_{nc} = the number released in the net mouth and caught in the net,

N_{nc} = the number released in the net mouth,

n_{bc} = the number of fish released in the bypass channel and caught in the bypass collection facility, and

N_{bc} = the number released in the bypass channel.

We will compute an overall efficiency estimate by combining all data from the various tests. In this way, the varying N values will be incorporated and differences in test size will be compensated.

Trave7 Time Estimates: We will determine test fish travel time from the headgates to the bypass collection facility by estimating the time to recapture 50% (median travel time) and 95% of the released test fish. We will estimate travel time through the lower bypass by determining recapture rates for released test fish at a 5-cfs and 25-cfs bypass flow.

Preparatory Activities

Holding: We calculated required holding container capacity for the various sizes of test fish using a 2 pound per cubic foot formula. Based on this capacity, the number of fish per pound, and the number needed for a test, we determined the amount of containers required. For the smaller test fish, we acquired 36 6-gallon buckets. We drilled 1/4-inch holes in the upper portion of the pails to allow water to flow through. We fabricated mesh covers and straps to hold the covers in place. We tested the degree of water exchange with a dye to assure sufficient inflow and water exchange.

We acquired 72 20-gallon containers for the larger fish and similarly perforated the upper portion with holes. We also cut out horizontal slots and covered these with mesh. These containers were also tested.for circulation using a dye. We cut out the center portion of the lid and covered the opening with mesh to allow sunlight penetration.

We tested the stability of the containers in water and discovered that weights would be needed to eliminate buovancv. We acquired lead weights,-and affixed wire hooks to secure the-weights On the container handles.

We used 5 large 800-gallon plastic tanks, 7.5 ft in diameter, to hold the needed number of 6-gallon and 20-gallon containers. These were old fertilizer tanks that we cut in half and repaired, using the bottom 3-ft deep portion. A sixth tank was cut lower to accommodate unloading of fish from the tanker. we determined the number of containers that each tank would hold, and divided this number into the total number of containers to determine the required number of tanks.

We measured available space at the site to design a workable layout for the holding system. We plumbed the water inflow and outflow systems, set in the pumps, and tested the system (see Figure 5).

We designed small and large net pens for use in the canal or river. We contacted a vendor to fabricate the mesh cages, and fabricated the frames ourselves. The 10 small net pens were 18 inches square and 18 inches deep. The one large net pen was 4,ft x 4 ft x 2 ft. deep (Figure 6). Net pens were made from 3/16-inch knotless nylon netting and contained a zipper in the top mesh for access. Frames were constructed of l-inch PVC pipe and nets were attached with plastic cable ties.

Branding and Harking: We constructed a branding table for use at the site which included a side trough for transferring fish to a holding container. We acquired the necessary branding equipment, tools, and supplies and arranged to have the liquid nitrogen stored at the Irrigon Hatchery. We observed branding operations at the hatchery to become familiar with branding techniques.

We consulted with other biologists to determine a method for dyeing fall chinook fry and decided to use Bismark Brown Y dye. Before using

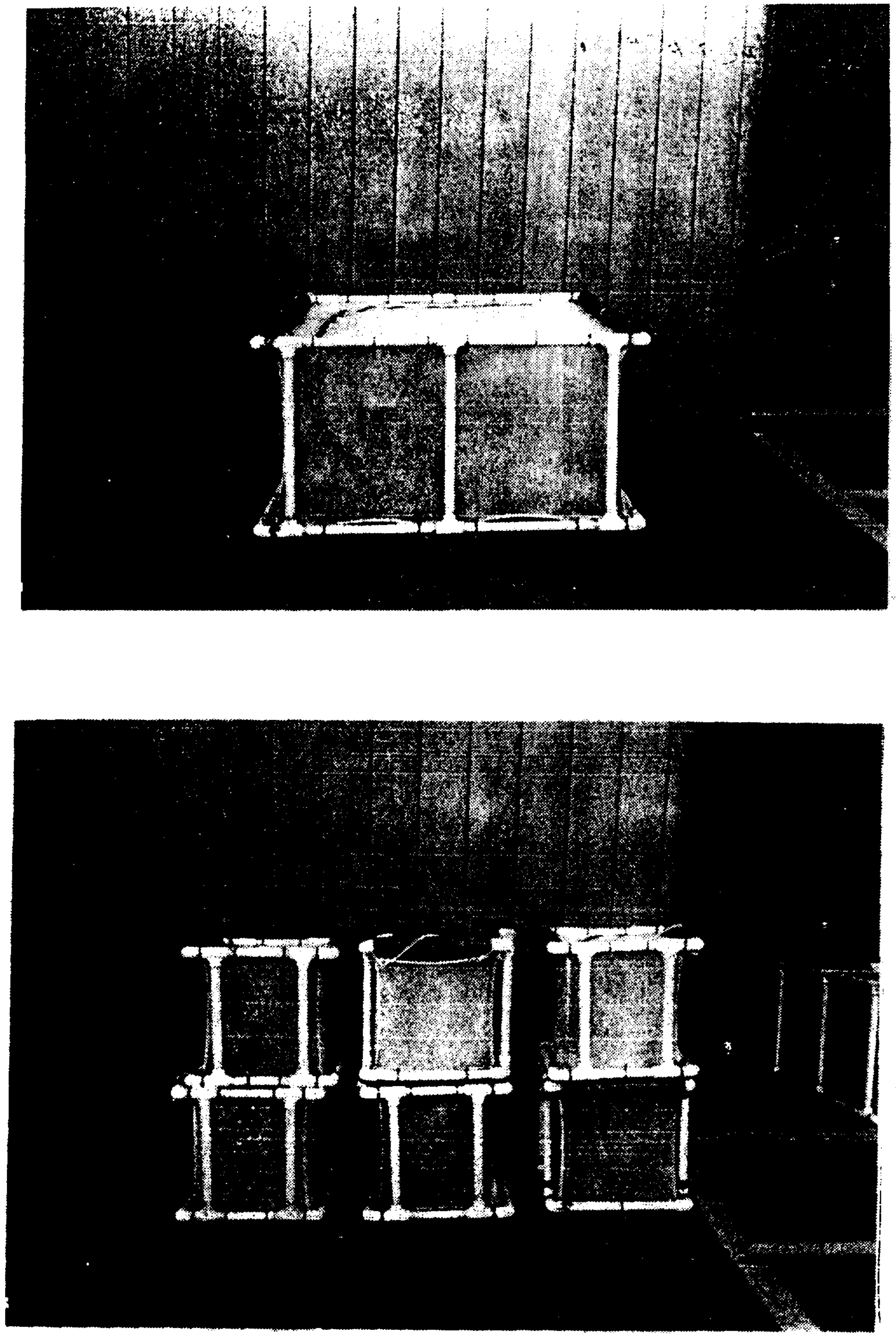


Figure 6. Large (upper) and small (lower) net pens for use in WEID Canal facility evaluation activities, Three Mile Falls Dam, Spring 1991.

the dye for the evaluation, we tested the dye with fry to determine proper procedures and concentrations.

Trap Design: We designed fyke nets for the screen leakage test to fit in the stoplog guides behind each drum screen and conform to the available space and directional current (Figure 7). We contacted vendors for fabrication of the nets and the fyke net frames. Net dimensions included a mouth opening of 7.25 ft long by 12 ft wide tapering to a 1-ft square cod end 1.5 ft in depth. Net lengths varied depending on their respective drum screen position. A zipper was installed in the cod end to access contents and an aluminum square frame was incorporated at the net-cod end transition to add support. The nets were fabricated of l/8-inch delta knotless nylon mesh with opening edges encased in 8-oz nylon. One-quarter inch grommets were applied around the edging, spaced 6 inches apart.

Fyke net frames measured 12.7 ft wide by 8 ft long and were constructed of 3-inch by 3-inch steel angle iron (Figure 8). The 8-ft length of the frames allowed for a 0.5-ft clearance above the normal operating water level in the WEID Canal. Lifting brackets were welded onto the top edge of the frame. Additional 1.5-inch by 1.5-inch steel angle iron pieces were.welded to the inside edge of the frame and drilled with l/4-inch holes spaced 6 inches apart. Fyke nets were bolted onto this inner frame. Four Z-inch by lo-inch boards were bolted inside each main frame to make a solid panel with a one-foot gap at the bottom to flush out silt. To assist in net deployment and retrieval with the gantry crane, we requested modified cable slings from the Bureau of Reclamation.

We designed a fyke net for the river return drain pipe to evaluate fish leakage through the traveling screen (Figure 9). The fyke net opening was 2 ft x 2.5 ft, and encased in 8-oz nylon. The net was fabricated from l/8-inch delta knotless nylon netting. A zipper was included in the cod end for content removal. The 2.3-ft by 2.8-ft net frame was constructed of 2-inch x 2-inch angle iron. The net was bolted to the frame through drilled holes, spaced 6 inches apart. To install the net and frame, we secured angle iron brackets to the concrete retaining wall on each side of the pipe opening. This required pumping out the water from the drain pool to lower the water level.

Equipment Needs: We purchased supplies for all aspects of the evaluation after accessing what our sampling and safety needs were for each specific activity.

We acquired additional vehicles for transportation needs to and from the site for all shift rotations. We borrowed a trailer from the U.S. Fish and Wildlife Service to use for office space and gear storage at the test site.

We assisted CTUIR in constructing a crowder and divider for the Minthorn acclimation pond where our test fish were to be held. The crowder was to be used during the loading process.

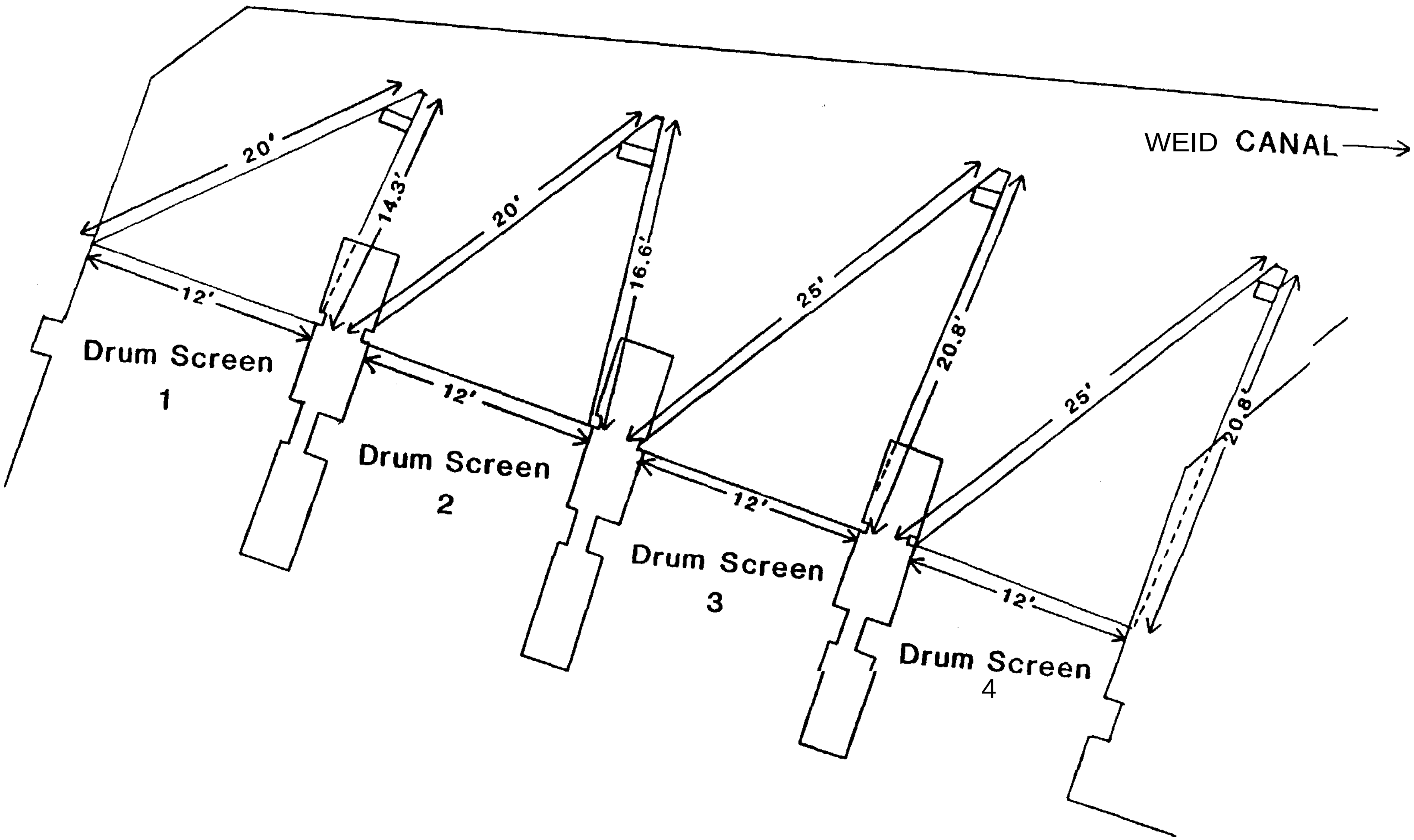


Figure 7. Drum screen fyke nets for screen leakage test at the WEID Canal facility, Three Mile Falls Dam, Spring 1991.

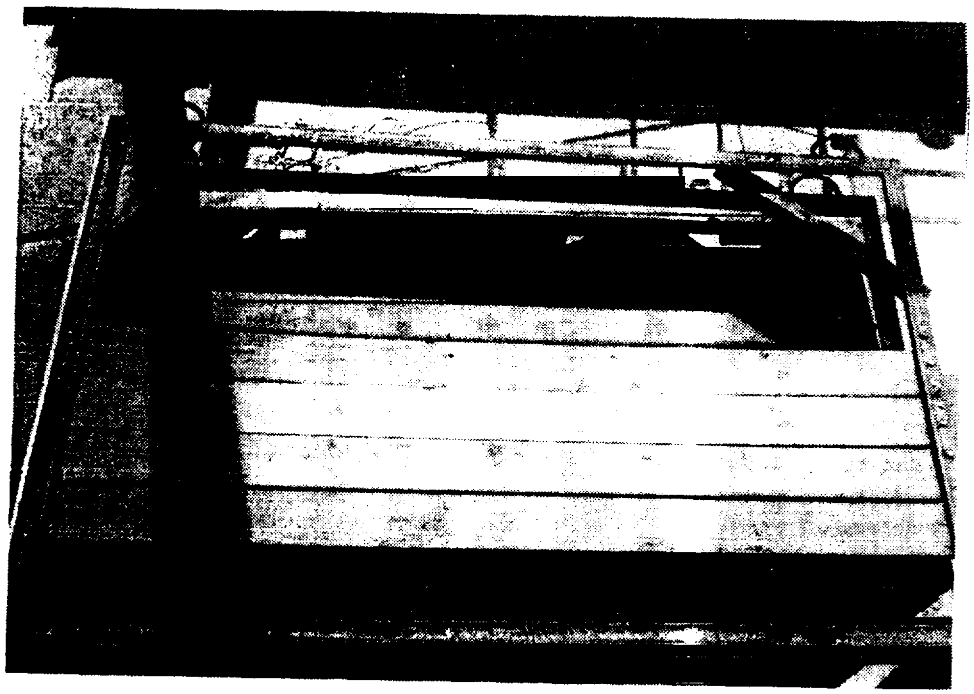


Figure 8. Fyke net frames for screen leakage test at the WEID Canal facility, Three Mile Falls Dam, Spring 1991.

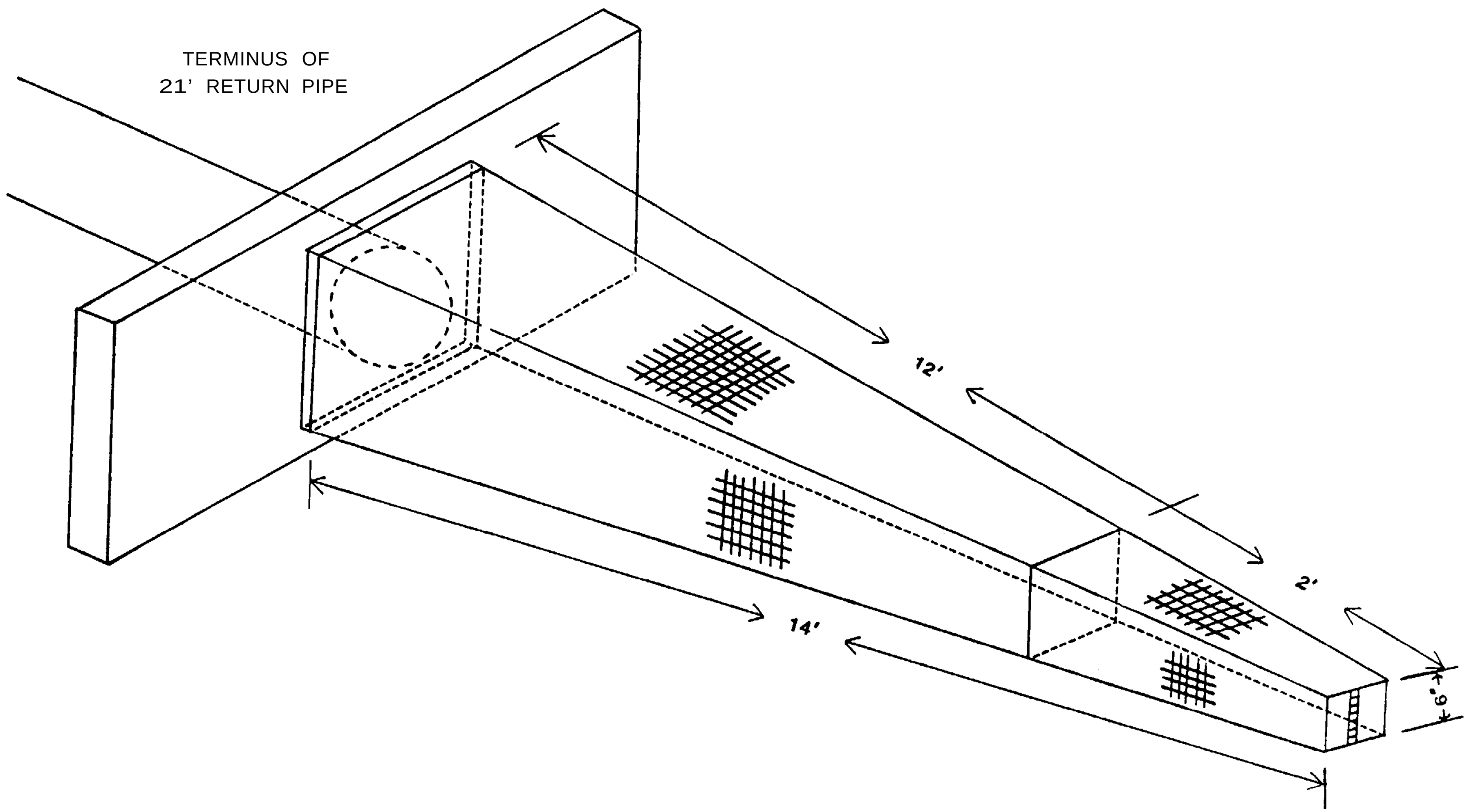


Figure 9. Fyke net for traveling screen leakage test at the WEID Canal facility, Three Mile Falls Dam, Spring 1991.

Facility and Gear Modifications: Modifications to the facility included the installation of additional lighting at the site to enhance nighttime evaluation activities and improve safety. We were assisted by the Bureau of Reclamation in installing quartz lamps on the gantry crane and near the holding tanks. We also developed a portable lighting system to facilitate nighttime releases in non-illuminated areas.

Upon request, the Bureau of Reclamation modified an existing electrical outlet on the motor control center to accommodate the voltage of our two submersible pumps.

At the collection facility, we modified the sampling tank by eliminating gaps around the cover to prevent fish escape. We installed hose splitters and hoses for holding fish in auxillary containers. We fabricated a slide gate for the fish separator to prevent fish from entering the transfer flume during sample tank crowding.

We modified the large floating net pen to be used in the bypass outfall test by replacing deteriorated plastic cable ties with hose clamps to more securely hold the net to the frame, and applied enamel paint to the frame for sun protection. After testing the net pen in a 25-cfs outflow, we realized the need for winches to facilitate deployment and securement of the net. We installed two small winches on hand railings above and adjacent to the bypass outfall. We labeled net pen ropes to facilitate proper connections and positioning.

In the bypass outfall plunge pool, we removed large boulders, wood and miscellaneous debris to reduce potential damage to the net pen during use. We marked 1-ft increments on the adjacent concrete wall as a modified staff gauge to determine plunge pool depth. We also cleared the shoreline of debris and brush to improve access during our tests.

Personnel: We hired 5 additional seasonal personnel in late March to assist in the evaluation activities, for a total of 7 staff members. This allowed us to conduct the evaluation on a 24-hour basis, 7 days-a-week.

Upriver Activities at Maxwell and Westland Diversion Dams

Trap Design

We used an inclined plane trap design for the bypass trap at Maxwell Dam'(Figure 10). Our design was patterned after the type used by Battelle, Pacific Northwest Laboratories in their evaluations of fish screening facilities in the Yakima River Basin. The inclined plane was 3.8 ft wide by 4 ft long with 2.5-ft high sidewalls serving as splash guards. A 1.3-ft wide by 2.5-ft long by I-ft deep live box (24.3 gal. capacity) was welded to the downstream end of the trap. We designed a pivot-rod front entrance assembly to permit leverage capabilities in adjusting the flow of water reaching the live box. The trap frame was solid 3/16-inch aluminum sheeting supported on sections of l-inch by l-

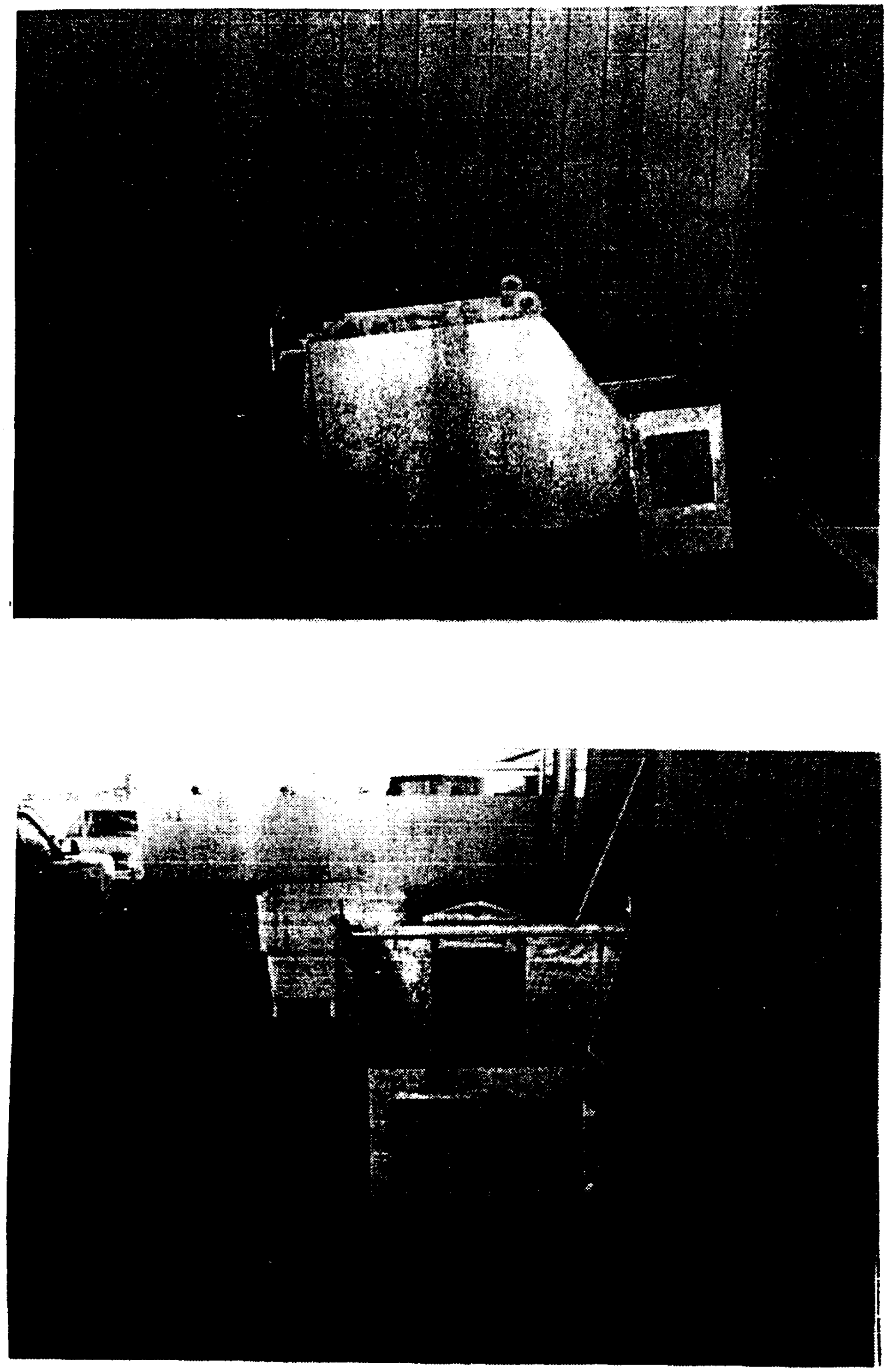


Figure 10. Inclined plane fish trap, Maxwell Dam fish bypass channel, Spring 1991.

inch angle iron welded to 2-inch aluminum strap cross pieces. Perforated sheeting containing 1/8-inch diameter, staggered holes (40% open) was used for the floor of the trap and lined the live box walls for eliminating excess water. Lifting brackets were welded into the side walls and a lifting eye was incorporated into the front entrance assembly for raising and lowering the trap with hoists. The surface area of the perforated plate was designed to eliminate a IO-cfs bypass flow.

We designed a fyke net and floating live box assembly for use in the juvenile fish holding pond at the Westland Dam fish facility (Figure 11). The 12.3-ft long fyke net measured 4 ft by 3.6 ft at the entrance and tapered to a conical 'I-inch diameter end which was attached to a live box. Three aluminum rings were incorporated along the tapering portion of the net to hold its shape. The front edge of the fyke net was encased in 8-oz nylon with grommets applied. The 1.5-ft by 3-ft by 2-ft live box was supported on a frame of l-inch PVC pipe encased in foam pipe insulation for flotation. The bottom portion of the frame was perforated to allow water inflow for added weight and stabilization. The entire fyke net and live box assembly was fabricated of l/8-inch delta knotless nylon netting. The fyke net frame was constructed of 2-inch by 4-inch lumber fastened together with metal brackets, and measured 4.17 ft wide by 5.25 ft long. Two 3/8-inch eye bolts secured to the top edge of the frame allowed for deployment and retrieval.

Other Activities

We inspected the wastewater overflow channel at Maxwell Dam. We found the dirt channel to be occluded with debris at the entrance (Figure 12). The remainder of the channel was clear and rocky, and emptied into a small pool leading to the river. We considered the relatively low gradient to be conducive to fish stranding during abatement of overflow periods.

DISCUSSION

We encountered relatively few major problems in our efforts to meet study objectives. Noteworthy concerns or challenges that did arise are presented in this discussion.

In our initial coordination with the ODFW Liberation Program to haul test fish from the hatcheries to the temporary holding site at Minthorn, our test fish were to be hauled in conjunction with scheduled liberations. However, concerns arose on how our evaluation fish were to be segregated from the remainder of the load. If hauled in the large tanker, test fish could not be transported or unloaded separately from the main load of fish. This situation required that an extra tanker be used and extra trips made to specifically haul our test fish.

Although we had requested unmarked fish for use in the test and were assured all fish were unmarked, we later discovered that 25% of the spring chinook from the Carson National Fish Hatchery were AD+CWT. This

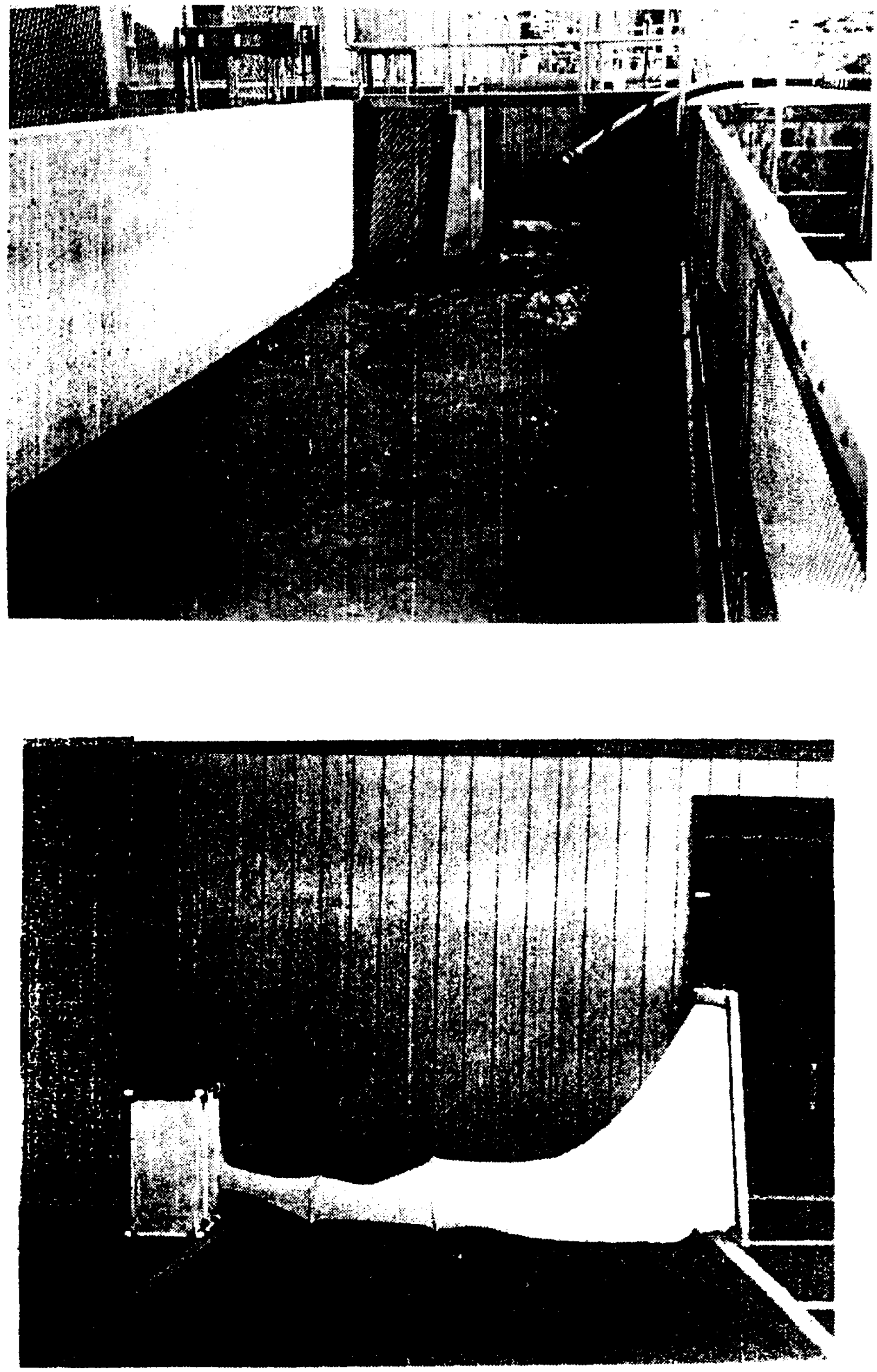


Figure 11. Westland Dam juvenile fish holding pond (upper) and fish collection fyke net (lower), Spring 1991.

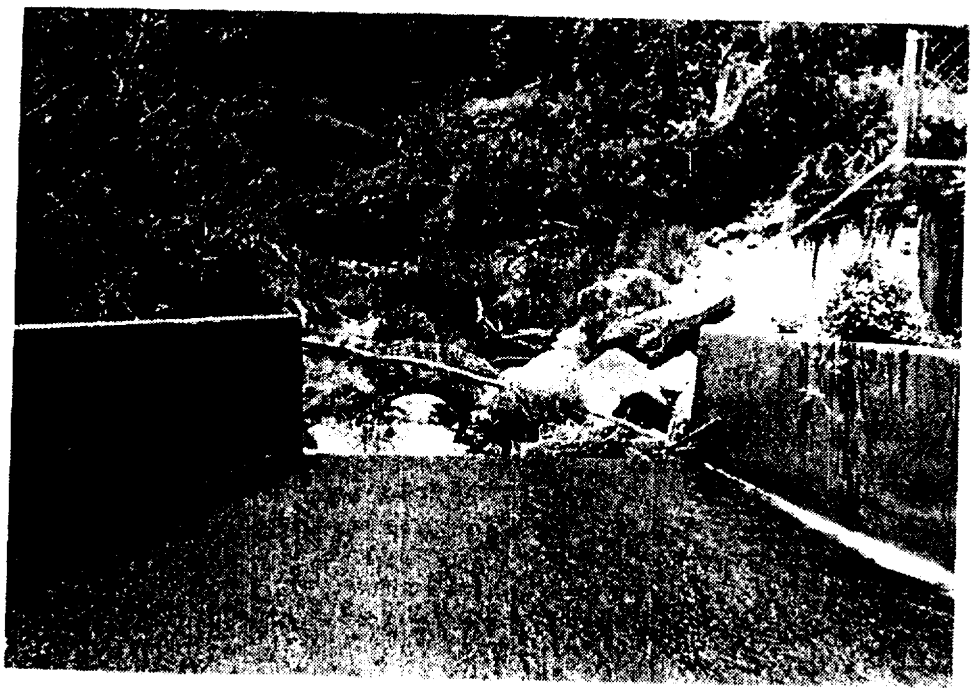


Figure 12. Entrance to wastewater overflow channel at Maxwell Dam canal, Spring 1991

discovery required additional investigation to determine the reason for the mark and determine whether our use of these fish would affect any monitoring or evaluation study.

Our patterning of the basic fyke net frame design after frames installed by the Bureau of Reclamation to help flush out silt behind the drum screens had a glitch. Apparently, lifting brackets on the Bureau frames were not properly designed for the gantry crane at the WEID facility (i.e. they were positioned too far apart). Thus, our lifting brackets were in error also. We remedied this problem by designing a new cable sling to lift the frames.

During assembly of the fyke nets to the frames, we discovered that the spacing of the grommet holes in the net edging did not precisely match the bolt holes in the frame. This error was caused by the placement of bolt holes close to the frame corners which was not accounted for in the spacing of net grommet holes. To fasten the nets adequately to the frames, we either had to drill new holes in the frames or punch in new grommets in the net edging.

Our prolonged efforts in designing the various fyke nets needed for the evaluation at Three Mile Falls Dam resulted in a reduced amount of available time for fabrication. We did not receive fyke nets for the screen leakage test until one day before the scheduled start of the test. This created a two-day delay in initiating the test to allow time for assembly. We also received the drain pipe fyke net later than anticipated, which delayed our ability to test for traveling screen leakage.

After acquiring the submersible pumps for providing inflow water during the evaluation, we discovered that an existing 240-volt outlet on the motor control center at the WEID facility needed to be modified to accommodate the two 230-volt submersible pumps. To rectify this situation required additional effort from Bureau personnel.

We originally thought staffing needs for the evaluation would be satisfied with 4 research personnel. However, in the preparation process, it became apparent that extra personnel would be needed; a total of 7 employees were needed to cover the operation 24 hours-a-day, 7 days-a- week. Three of these employees were hired immediately prior to the evaluation.

Our initial plans for designing bypass traps did not include the Westland facility due to the thought that we could use the juvenile fish holding pond as a collection system. However, it became apparent that we needed to design a more effective and efficient sampling system due to intrinsic inadequacies of the holding pond. Our concerns were further compounded when we discovered that it would be very difficult to place a trap in the bypass channel due to the shallowness of the downwell and the absence of a structure to secure or mount the trap. Therefore, we needed to devise a system for collecting fish as they entered into the holding pond for use in future screen injury tests. This part of the evaluation will be limited to low river flow periods when fish are being collected in the holding pond.

Our ability to evaluate the Westland facility at maximum design flow may be constrained due to bypass operational restrictions at high and low river flows. The design constraint at this facility was due to a low gradient in elevation from the facility to the river. During high river flows, river water will back up into the bypass system precluding efficient bypassing of fish and requiring the bypass to be shut down. In essence, different segments of an evaluation may need to be performed at different flows due to structural and operational constraints on where we can collect and sample fish.

To perform an effective evaluation of a juvenile bypass facility, consideration must be given to the designed operation of the irrigation canal. To mesh the occurrence of canal operations at maximum design flow with test fish availability can be a major obstacle. The two may not necessarily go hand-in-hand. Tests may have to be run prior to full canal waterup if test fish are only available in a certain period of time. If possible, all aspects of a normal operation must be adhered to during an evaluation to get the full benefit of the evaluation. We attempted to coordinate evaluation activities at Three Mile Falls Dam with operation of the diversion facility at maximum design flow as much as possible.

RECOMMENDATIONS

Based on this year's experience in preparing for the evaluation of the WEID Canal juvenile fish bypass facility at Three Mile Falls Dam, developing the evaluation sampling plan, and conducting preliminary pre-evaluation activities at upriver dams, we offer the following suggestions for future evaluations.

1. Capture facilities should be designed well in advance of their intended use to provide sufficient time for fabrication. Delays in fabrication and other unforeseen problems need to be taken into account in the estimation of total time required.

2. In determining staffing needs to conduct an evaluation, a liberal and realistic approach should be used to ensure that the study is adequately staffed.

3. Installation of fyke net grommets should be performed in the field to more precisely align grommet holes with frame bolt holes. The elimination of all edge gaps is of paramount importance in conducting an effective screen leakage test.

4. Activity coordination and information dissemination with various affected agencies and individuals should be a priority task prior to an evaluation. This should eliminate confusion and potential conflicts during the evaluation, and ensure a smoother operation.

5. Information needs of other agency personnel should be determined prior to the evaluation to ensure appropriate information is collected and compiled in the field.

6. Collection traps should be tested at designed operating levels at their respective locations to properly evaluate trap design for effectiveness and efficiency. During the design process, detailed planning and consultation should be undertaken to avoid design flaws.

7. All equipment needs should be adequately assessed to avoid conducting an evaluation with insufficient equipment and supplies. Backup gear and alternative methods should be devised to be prepared for unplanned emergencies.

8. Intraagency and interagency personnel affiliated with an evaluation should be notified in advance of the study schedule and be invited to observe evaluation operations.

9. Sampling plans for future evaluations should be circulated for detailed peer review and critique.

10. Site inspections should be performed in detail to assure compatibility with equipment needs and study activities.

11. A full scale evaluation should be performed at Maxwell and Westland Dam juvenile fish bypass systems in 1992 to determine specific

deficiencies in design, construction, and operation and to ensure that the systems function as intended. The Study objectives should be similar to those for the Three Mile Falls Dam juvenile fish bypass facility evaluation conducted in 1991.

12. Results of the 1991 juvenile fish bypass facility evaluation at Three Mile Falls Dam should be presented in a 1992 interim progress report. Activities conducted to prepare for evaluations of the juvenile fish bypass systems at Maxwell and Westland diversion dams should also be presented.

13. Wastewater channels at Maxwell and Westland diversion dams should be evaluated to ensure safe fish passage during periods of high river flow. Potential for juvenile fish passage, stranding, and injury, and adult fish attraction should be investigated.

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REPORT B

1. Evaluation of the juvenile fish bypass facility in the West Extension Irrigation District Canal at Three Mile Falls Dam.

2. Documentation of passage of juvenile salmonids through the bypass facility and east-bank adult fish ladder.

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CONTENTS

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We extend our appreciation to Jay Marcotte and Jerry Bauer of the Bonneville Power Administration for their assistance with contracting of funds. We thank Mary Buckman and Emery Wagner for their critical review of the manuscript.

ABSTRACT

We report on our effort from April through September 1991 to evaluate the juvenile fish bypass facility in the West Extension Irrigation District Canal at Three Mile Falls Dam on the Umatilla River. We also report on juvenile salmonid outmigration through the east-bank adult fish ladder in 1990 and through the bypass facility in 1991. We include information on preliminary activities to prepare for future evaluations at Maxwell, Westland, and Cold Springs diversion dams. Tests at Three Mile Falls Dam showed that races of spring and fall chinook salmon (Oncorhynchus tshawytscha) and summer steelhead (Oncorhynchus mykiss) were not injured during passage through the entire fish bypass facility. We also observed no significant leakage of chinook salmon fry through the drum screen system with screening efficiency approaching 100%. Some impingement of fry and subyearlings was observed on the secondary traveling screen because of unfavorable hydraulics and insufficient spray water at one location. Fish moved freely through the upper screening facility and generally moved more rapidly during nighttime tests. Fish movement was delayed in the lower bypass outfall at flows of 5 cubic feet per second (cfs), but quickened when flows were increased to 25 cfs. Although movement of fish in the facility was more rapid at night, the migration of river-run salmonids (probably coho and chinook salmon) showed a distinct diurnal peak. Passage through the east-bank ladder showed that some fish movement was correlated with higher river flows. We offer recommendations for structural and operational improvements in the West Extension Irrigation District Canal juvenile fish bypass facility at Three Mile Falls Dam. We fabricated and partly tested collection systems for-the juvenile fish bypass facilities at Maxwell, Westland, and Cold Springs diversion dams to be used in future evaluations. The primary problem encountered with the Maxwell trap was a backwash eddy that stranded fish. Preliminary monitoring of fyke net operation at the Westland Diversion Dam showed that the net worked well and only required minor modifications. During 1992, we will continue tests at Three Mile Falls Dam and prepare for evaluation activities at Westland Dam in 1993.

INTRODUCTION

Background

The Northwest Power Planning Council's (NPPC) Columbia River Basin Fish and Wildlife Program (1987) called for the improvement of anadromous fish passage facilities at irrigation diversion projects in the Umatilla River Basin in the form of passage improvements (Section 1403, Measure 4.2). Under contract with the Bonneville Power Administration (BPA) and in cooperation with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and fish and wildlife agencies, the U.S. Bureau of Reclamation (USBR) developed and carried out a program to improve fish passage facilities at Umatilla River diversion dams. State-of-the-art passage facilities at Three Mile Falls Dam were the first to be constructed, followed by Maxwell and Cold Springs diversion dams. Westland Diversion Dam passage facilities were reconstructed under the direction of the Oregon Department of Fish and Wildlife (ODFW). Passage facilities at Stanfield Diversion Dam are currently in the design phase by ODFW staff. New screening facilities are intended to prevent juvenile salmonids from entering the irrigation canals by guiding them unharmed back to the river from which they were diverted. Evaluation of the passage improvement projects at the five major diversion dams on the Umatilla River was suggested in *A Comprehensive Plan for Rehabilitation of Anadromoos Fish Stocks in the.Umatilla River Basin* (Boyce 1986).

Construction of similar fish passage and protection facilities at major (Phase I) irrigation diversions in the Yakima River Basin, Washington, has also been funded by BPA and USBR under Section 803 (b) of the NPPC's Columbia River Basin Fish and Wildlife Program (NPPC 1987). Evaluations of the effectiveness of these fish screening facilities on the Yakima River have been carried out by Neitzel et al. (1985, 1987, 1988, 1990a, 1990b) and Hosey & Associates (1988, 1989, 1990a). We considered their experiences when designing evaluations of fish screening facilities in the Umatilla River Basin.

We began the first year of our evaluation of juvenile fish bypass facilities in the Umatilla River at Three Mile Falls Dam in November 1989. During this period, we operated and evaluated the efficiency of the juvenile fish bypass system in the West Extension Irrigation District (WEID) Canal. Improvements were made to the fish bypass collection facilities, a system was developed to collect juvenile salmonids at the bypass outfall, and preliminary information on juvenile fish passage conditions was collected (Knapp and Ward 1990). Report A of this report describes our approach to and preparatory activities for conducting second year study objectives.

In Report B we present results from our efforts toward addressing second year study objectives. These study objectives were to (1) evaluate the passage of juvenile salmonids through the bypass system in the WEID Canal facility at Three Mile Falls Dam, including the evaluation at design flow of injury and mortality rates, and passage of juvenile salmonids through and over the screens, and (2) perform preliminary activities that would facilitate passage evaluations at the Maxwell, Westland, and Cold Springs diversions dams in coming years.

Study Sites

A description of the Three Mile Falls Dam and associated WEID Canal and fish screening facilities is in our first annual progress report (Knapp and Ward 1990). A description of the Maxwell and Westland diversion dams is included in Report A of this report. Cold Springs Diversion Dam is located at River Mile 29.2; reconstruction of the old juvenile fish screening facility was completed in 1990. Components of.the new facility and associated canal structure include a trashrack, 10 rotary drum screens, a bypass chamber and outlet, and a canal check and wasteway structure. All sites are located on the lower Umatilla River (Figure 1). A schematic diagram illustrates the fish bypass facility at Three Mile Falls Dam (Figure 2).

METHODS

Three Mile Falls Dam Juvenile Fish Bypass Facility Evaluation

The evaluation of the juvenile fish bypass facility at Three Mile Falls Dam consisted of several different tests to evaluate various components of the facility at designed operating criteria and flow. The primary tests conducted were the screen injury, bypass pipe and outfall injury, and drum screen leakage tests. Secondary tests evaluated headgate injury and traveling screen leakage. We conducted these tests with different species or races (sizes) of chinook salmon *(Oncorhynchus tshawytscha)* and summer steelhead *(Oncorhynchus mykiss)* in April and May of 1991. Methods are described in detail in Report A.

We conducted all injury tests using yearling spring chinook salmon and summer steelhead and subyearling fall chinook salmon. For the headgate injury test, we used fish saved from previous tests that were in good condition. Drum screen leakage was tested with fall chinook salmon fry. These species were selected because they are present in the Umatilla River system. All fish used in the screen injury tests were freeze-branded with a unique group brand and held in separate containers for 48 hours to 72 hours to allow the brand to set and the fish to acclimate. For the screen leakage test, control fall chinook salmon fry were marked with bismark brown dye to differentiate them from the treatment groups and placed in an aerated container for one hour to allow the dye to set. Marked groups were held in large tanks supplied with pumped river water from the canal. In addition, floating net pens were used to hold fish in the canal headworks area or in the river when necessary. More detailed information on test fish, branding, and the holding system is available in Report A.

We determined fish condition for all injury tests using descaling criteria developed by the U.S. Army Corps of Engineers (Neitzel et al. 1985) and described in Report A. Fish condition was based on the percentage of scale loss in each of five designated sections per side of fish. Fish were classified as "healthy" (scale loss $\leq$ 3% per section), "partially descaled" (scale loss > 3%, but < 40% per section), or "descaled" (cumulative scale loss 2 40% in any two sections). We also recorded observations of other injury types such as cuts, bruises, eye or head injuries, and torn operculums.

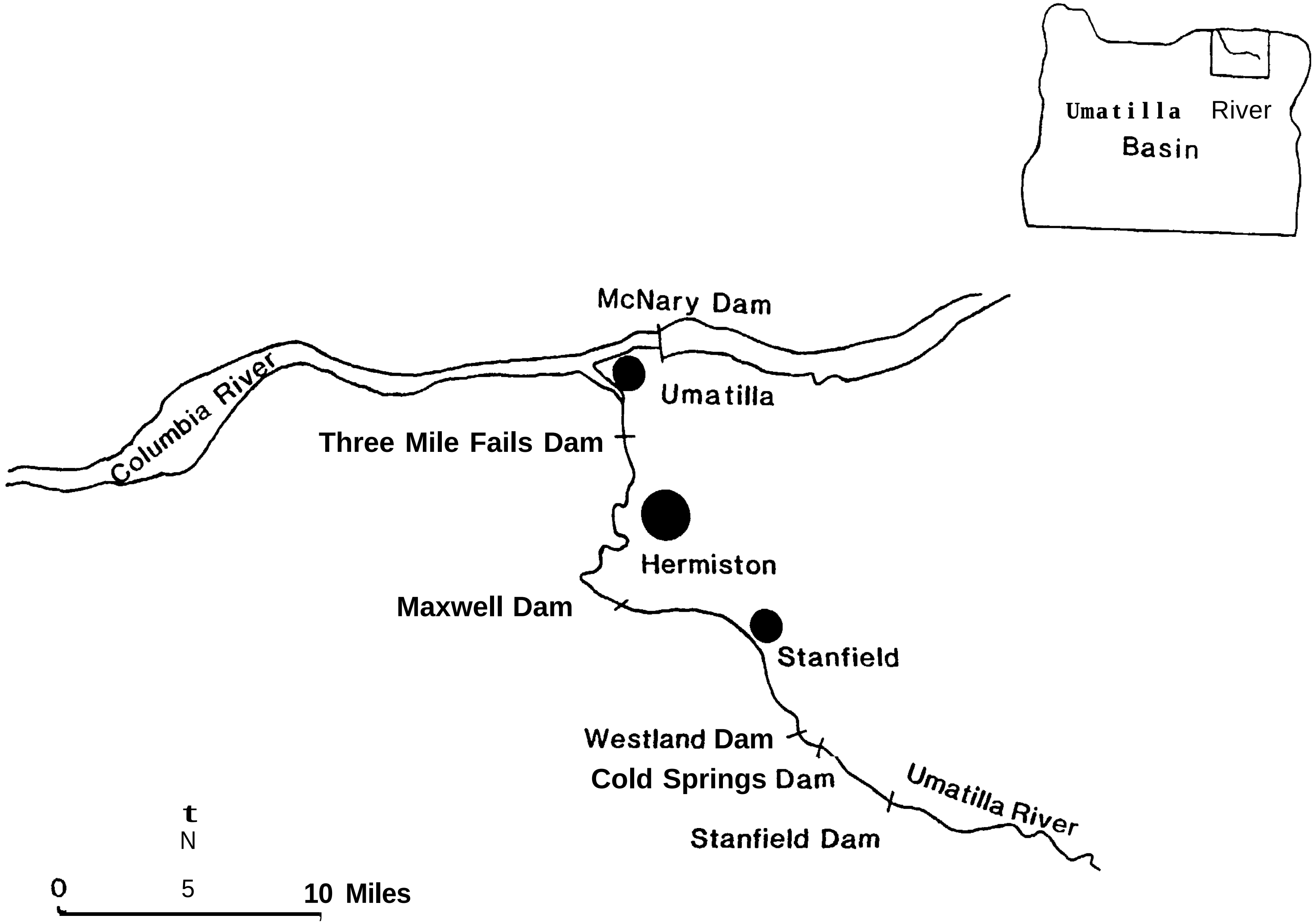
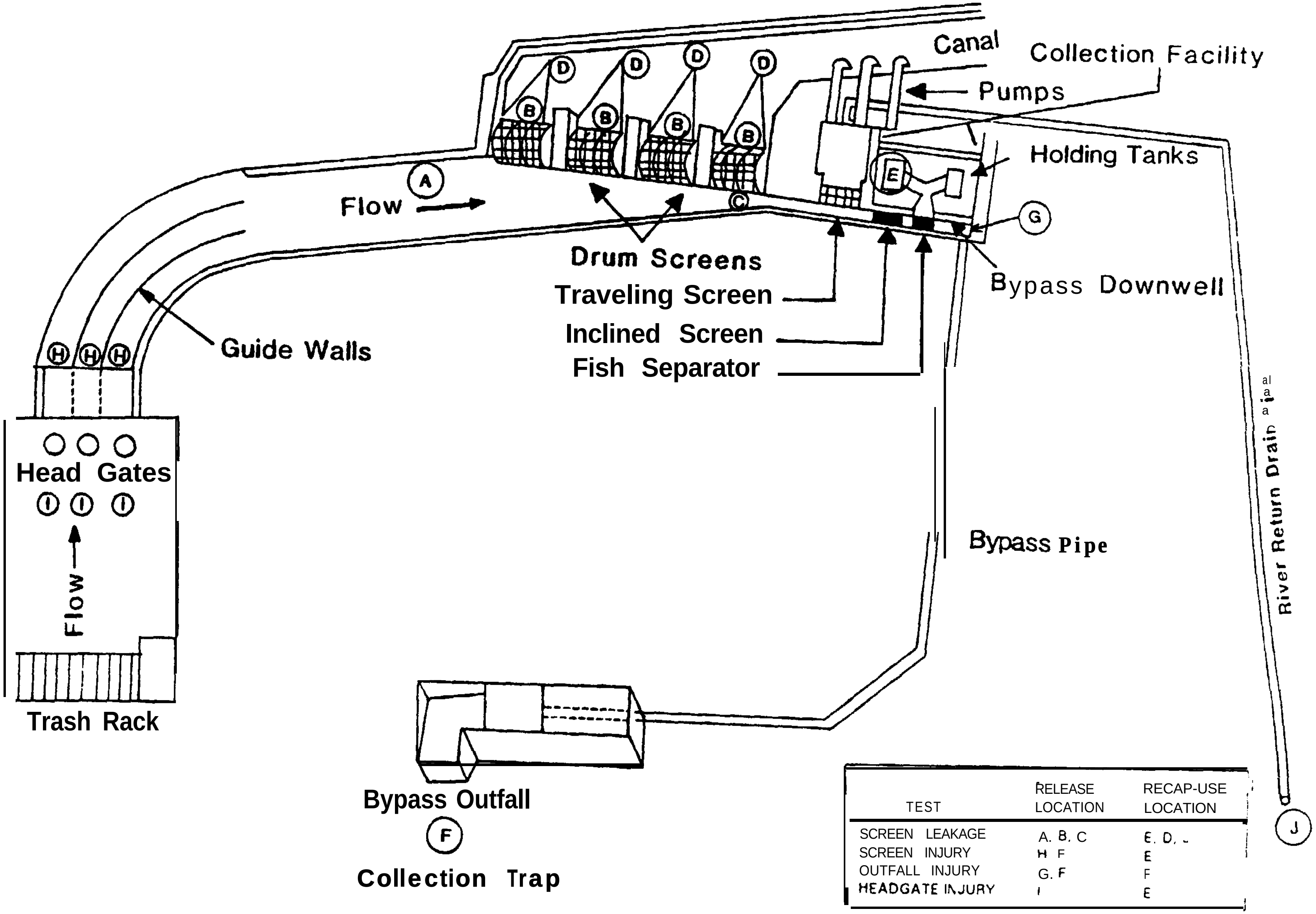


Figure 1. Locations of diversion dams on the lower Umatilla River, Oregon.



TEST	RELEASE LOCATION	RECAP-USE LOCATION
SCREEN LEAKAGE	A. B. C	E. D. J
SCREEN INJURY	H F	E
OUTFALL INJURY	G. F	F
HEADGATE INJURY	I	E

Figure 2. Schematic of the WEID Canal juvenile fish bypass facility at Three Mile Falls Dam including sampling locations for release and recapture of fish.

Screen Injury

To evaluate injury and mortality rates associated with the drum screens, we released replicate groups of healthy, freeze-branded fish upstream of the drum screens and recaptured them at the bypass collection facility (treatment). We also released replicate groups of healthy fish (control) directly into the collection facility (sample tank) to allow us to evaluate injury caused by the collection and handling process. All recaptured fish were examined for descaling and other injuries.

We conducted tests with spring and fall chinook salmon during the day and at night and with summer steelhead during the day from 23 April to 9 May 1991. We conducted tests on three different dates with up to three replicates tested each day. Treatment and control fish were released on the same day. Each test consisted of approximately three 100-fish groups for each species or race of test fish. We released treatment groups at approximately 0900 hours and 2100 hours, respectively, for three consecutive 24-hour periods. Treatment groups were released immediately following the release of the control groups into canal flows ranging from 116 cubic feet per second (cfs) to 149 cfs (77 - 99% of maximum design canal flow). Occasionally, control groups were pooled, creating only one group per day. A 10% subsample from each replicate group was examined for condition before release to ascertain pre-release condition. These subsample fish were not returned to their groups.

Treatment groups were released immediately below the headgates in each of three flume sections in the canal headworks (see Figure 2). Groups of control fish were released directly into the collection facility sample tank and handled during examination in the same manner as the treatment fish. We followed operation criteria for a sampling mode when capturing released test fish in the collection facility. This included the installation of sampling equipment (orifice plate, inclined screen, fish separator), and operation of the traveling screen and pumpback pumps, and the proper setting of weir gate positions and headworks water levels (USBR 1989). On occasion, we partially opened the 21-inch diameter drain pipe gate to return water to the river in lieu of pump operation.

We recaptured treatment fish in the sample tank at the bypass collection facility (see Figure 2). Fish were crowded and removed from the tank every hour to determine travel time and prevent tank crowding. Treatment fish were captured for at least 96 hours after release to allow sufficient time for a 95% recovery. Fork lengths were taken from a random selection of control and treatment fish.

River-run fish collected during the evaluation were separated from test fish and returned to the river. If necessary, we anesthetized all fish to separate test from river-run fish. We examined test fish immediately upon recapture or transferred them to the holding containers for later processing. Anesthetized river-run and test fish were placed in a holding tank to recover from the anesthetic and then released into the bypass downwell. All test fish were placed in an anesthetic trough and anesthetized with Finquel (MS222). Fish condition was determined and recorded on descaling forms. We examined fish for descaling in the collection facility, which included an overhead canopy for protection from the weather and a high pressure sodium light to maintain consistent lighting conditions. Fish in good condition were retained for use in secondary tests.

Bypass Pipe and Outfall Injury Test

To evaluate injury and mortality rates associated with the bypass pipe and bypass outfall, we released replicate groups of freeze-branded healthy fish into the bypass downwell, recaptured them in the bypass outfall collection trap (floating net pen), and examined the fish for descaling and other injuries (treatment). We also released replicate groups of fish directly into the bypass outfall collection trap to allow us to evaluate injury caused by the collection and handling process (control).

We conducted tests from 16 April to 31 May 1991. Generally, we conducted tests on three different dateS for each species or race of test fish and at bypass flows of 5 cfs and 25 cfs. Each test consisted of three, approximately 100-fish groups. A 10% subsample from each treatment and control group was examined prior to release to ascertain pre-release condition. These subsampled fish were not returned to their groups.

The operation criteria for bypass flow were adhered to when performing the tests. This included the installation of the restrictive orifice plate for 5-cfs flow and the concurrent operation of the traveling screen and pumpback pumps (USBR 1989). Weir gate positions for both flow regimes were also properly set according to operating criteria. During the 25-cfs tests, we installed a bypass channel stoplog to reduce flows during control releases and subsequent net positioning. The stoplog was removed to achieve a full 25-cfs flow before releasing the treatment groups.

We released control fish into the net pen immediately before releasing treatment fish at the bypass channel weir crest upstream of the downwell. Therefore, both groups were in the net pen simultaneously during the recapture interval. To capture the majority of the test fish, the net pen remained in position for about one hour. We retrieved the net pen after the prescribed interval, and retrieved control fish and test fish, placing them in containers for immediate examination. River-run fish were released to the river. We examined fish for injury in the same manner as in the screen injury test. Fish were allowed to recover from the anesthetic in net pens placed in the river prior to release.

Headgate Injury Test

To evaluate injury and mortality associated with passage through the headgates, we released groups of previously used, good condition fish upstream of the headgates, recaptured them at the collection facility, and examined them for injury or descaling. We used the results from treatment fish in the screen injury tests that were released downstream of the headgates as a control. During testing, we followed normal canal operations and operating criteria for a sampling mode at the collection facility (USBR 1989). All three headgates were fully open.

We conducted three daytime tests and two nighttime tests for spring chinook salmon from 30 April to 2 May 1991, and two daytime tests and two nighttime tests for fall chinook salmon on 7 and 8 May 1991. The number of fish released in each test ranged from 77 to 190. We did not subsample test fish to determine pre-test fish condition, but, for purposes of analysis, we assumed that all fish began the test in good condition. Fish were released in separate groups in front of the headgates (see Figure 2).

Fish were recaptured in the bypass collection facility at hourly intervals, and examined for descaling and other injury following the same procedure used in the screen injury test. We recorded fish condition, and time of release and recapture. After processing, we released the fish back to the river.

Drum Screen Leakage Test

To evaluate passage of juvenile salmonids through (leakage) and over (impingement) the drum screens, we released treatment groups of fall chinook salmon fry upstream from the screens and recaptured them either in fyke nets placed immediately behind the screens in the WEID Canal or in the bypass collection facility (see Figure 2). We also released groups of bismark-brown-dyed control fish in the fyke net mouth to obtain an estimate of net collection and retention efficiency. An estimate of bypass collection efficiency was obtained by releasing groups of control fish in the bypass channel and recapturing them in the sample tank at the collection facility. We also monitored fish passage over the screens during tests to estimate rollover caused by impingement. Because salmonid fry are not a normal contingent of the juvenile outmigration, our test fry were easily discernable.

We performed tests at a canal flow of 74 cfs to 78 cfs from 5 April to 10 April 1991. Three tests were made, each during midmorning and separated by 48-hour periods. The 48-hour interval was necessary to allow fish from one group to clear the system before release of the next group, since test fish groups could not be differentiated.

Because of our inability to designate separate groups for each test, we released a single 300-fish treatment group upstream of the screens, and a single 300-fish control group in the bypass channel on each test day. Control fish were also released behind each of the four screens in the net mouth in separate 75-fish groups. Each test was designed to comprise 900 fish for three days, for a total of 2,700 fry.

To capture test fish in the collection facility, we followed the operation criteria for sampling. This included the installation of bypass channel sampling equipment, operation of the traveling screen, opening of the river return drain pipe (pumpback pumps could not be operated with fyke nets in place), and proper setting of weir gate positions and headworks water levels (USBR 1989).

Fyke nets were placed behind the screens before releases. The fyke nets were monitored for approximately 48 hours after release to capture control fish and any test fish that leaked past or rolled over the screens. At 4-hour to 6-hour intervals during this 48-hour period, we examined the contents of the fyke net by individually raising the nets, removing the contents of the cod end, and placing the contents in buckets. The nets were cleaned with water supplied from the traveling screen spray water pump and immediately lowered back into place. We collected fry from the sample tank in the bypass collection facility every hour. Data on river-run fish collected in the sample tank were recorded, and then the fish were returned to the river.

We recorded the numbers of fry retrieved (treatment and control) from each fyke net and from the hourly sample tank crowding. During the tests, we monitored the drum screens for any indication of fry impingement and documented numbers of rollover fish. We recorded lengths of all treatment fish that passed through or over the screens. We recorded lengths from subsamples of treatment and control.fish.

Traveling Screen Leakage Test

To determine if leakage was occurring at the secondary traveling screen, we installed a fyke net at the terminus of the river return pipeline (see Report A). Any fish leaking past the screen when the sluice gate to the river return drain pipe was open would be eventually captured in the fyke net. We planned to retrieve the contents of the fyke net on a hourly basis.

We were unable to devise a method to capture fish impinged on the traveling screen during pumpback pump operation. However, we made two fish releases in the bypass channel to determine if we could directly observe impingement of fall chinook salmon fry on the traveling screen. On 24 April, we released 110 fry into the bypass channel. The two IO-cfs pumpback pumps were in operation with the sluice gate closed. On 2 May we made another release of fry into the bypass channel with the river return drain pipe opened more than 12 inches on the pipe stem. We adjusted the pipe stem down to 9 inches to reduce turbulence; hydraulic conditions appeared similar to conditions during pumpback pump operation.

Travel Time

We examined fish movement during the screen injury and bypass outfall tests to determine if the fish bypass facility could delay fish migration. The time of release and recapture was recorded to ascertain movement rates through the facility. In the screen injury test, we estimated travel time through the screen facility by calculating the time to recapture 50% (mean travel time) and 95% of the test fish. In the bypass outfall test, we estimated fish travel time through the lower bypass and outfall by computing the total number of test fish recaptured in one hour.

Juvenile Passage

Fish passage information on wild and hatchery-reared salmonids released upstream from Three Mile Falls Dam was obtained during tests from 5 April to 10 April, and from 23 April to 9 May 1991. We sampled hourly all fish entering the fish bypass facility and recorded the numbers of wild and hatchery fish present. Because of the large number of fish moving through the facility, species of fish were combined.

The numbers of juvenile salmonids moving through the eastbank fish ladder at Three Mile Falls Dam were documented in the spring of 1990 using video cameras placed in the east ladder viewing window to record adult passage. Video tape information was monitored periodically from 23 March to 7 June 1991. These video tapes were reviewed to determine the number and timing of downstream migrating juvenile salmonids using the east-bank ladder. Individual species could not be determined.

Data Analysis

We used analysis of variance (ANOVA) to test the hypothesis that the relative condition of control and treatment fish were equal in all injury tests. Sources of variation tested in each ANOVA were treatment versus control, and time of day (day or night) or flow (5 cfs or 25 cfs). We chose as our significance level a *P* value of <0.10. All testing was completed using the General Linear Model Procedure in the SAS program for personal computers (SAS Institute Inc. 1990).

Injury Estimates: For purposes of analysis, we calculated the pre-test condition (from subsamples) and post-test condition (from control or treatment test fish) of fish observed as percentages of recaptured injured fish (the sum of partly descaled, descaled, and other injured fish). We then calculated net injury rate as the difference between pre-test and post-test condition.

We computed a 95% confidence interval about the net injury rate for each treatment and control group. In the headgate injury test, no subsamples to measure pre-test condition were obtained. Therefore, we assumed the condition of treatment fish was equal to zero, meaning that no injured fish were present.

Screen Efficiency Estimates: We evaluated the ability of the drum screens to prevent fish from entering the irrigation canal and guide fish that encounter the drum screens into the bypass. We estimated screen efficiency for each test and for all tests combined. We combined all data from the various tests to compensate for differences in test size and, theoretically, in the number of fish encountering the screen.

Estimates of screen efficiency were corrected for bypass collection efficiency (EFF_{bc}) and net capture efficiency (EFF_{nc}). We assumed net retention to be equal to net efficiency, giving it a value of 1. The formula for estimating screen efficiency (EFF_{sc}) was

$$EFF_{sc} = 1 - \frac{x_{net}}{EFF_{nc}N}$$

where

X_{net} = number of fish released upstream of the screens and caught in the nets, and

N = an estimate of the total number of fish encountering the screens (it may be less than the actual number of fish released)

$$N = \frac{X_{net}}{EFF_{nc}} + \frac{X_{bc}}{EFF_{bc}}$$

where

X_{bc} = the number of fish released upstream of the screens and caught in the bypass collection facility

$$EFF_{nc} = \frac{n_{nc}}{N_{nc}}$$

$$EFF_{bc} = \frac{n_{bc}}{N_{bc}}$$

where

n_{nc} = the number released in the net mouth and caught in the net

N_{nc} = the number released in the net mouth,

n_{bc} = the number of fish released in the bypass channel and caught in the bypass collection facility, and

N_{bc} = the number released in the bypass channel.

Activities at Maxwell, Westland, and Cold Springs Diversion Dams

Maxwell Diversion Dam

We fabricated a bypass trap for the Maxwell Dam facility using an inclined plane design (see Report A). We subsequently used the bypass trap at the Maxwell screening facility on 6 June 1991 to test for suitability and effectiveness in capturing fish without injury. Before testing, we constructed a 4- x I-inch wooden frame and installed two l/2-ton hoists to lift and lower the trap in place in the bypass downwell. We positioned the trap and channel weir boards so that approximately a IO-cfs bypass flow entered the trap. The trap angle was adjusted with the use of the pivot-rod front entrance assembly to achieve a suitable, non-turbulent water flow into the live box without impinging fish.

We released one 25-fish group of marked subyearling fall chinook salmon upstream of the bypass near the middle drum screen, .and three 25-fish groups in the bypass channel. We retrieved the fish from the trap live box, examined them for condition, and documented observable problems with trap operation. Bypass channel releases were retrieved in 2 minutes; the drum screen release was retrieved in 30 minutes.

Westland Diversion Dam

We fabricated a fyke net and floating live box assembly for use in the juvenile fish holding pond at the Westland Dam fish facility (see Report A). During mid-June, we deployed the modified fyke net in the holding pond to test the efficiency and effectiveness of the net in capturing fish. We installed the fyke net in stoplog grooves at the upstream end of the pond. A 2- x 12-inch board was placed across the pond to access the live box. The pond inflow was adjusted to 4 cfs. We released one 35-fish replicate of dyed subyearling fall chinook salmon downstream of the bypass weir and a second 17-fish replicate upstream of the weir. Subyearlings were retrieved from the live box 5 minutes to 10 minutes after release and examined for condition. We documented operation and design deficiencies for future modifications.

Cold Springs Diversion Dam

We designed and fabricated an aluminum inclined plane trap for the bypass at Cold Springs Dam. The design incorporated features of the bypass channel, bypass downwell, maximum design bypass flow, and available structure for trap alignment and deployment. The inclined plane was 7.6 ft long by 2.5 ft wide with 3-ft sidewalls that served as splash guards and incorporated a go-degree turn at the outlet. The entrance width was 3.9 ft tapering to an outlet width of 2.5 ft. A 2.5-ft long by 1.3-ft wide by 2-ft deep live box (47 gal capacity) was welded to the downstream end of the trap. Perforated sheeting containing 1/8-inch diameter, staggered holes (40% open) was used for part of the floor and live well to dissipate 18 cfs. Two sets of 1/2-inch thick lifting brackets were welded to the side walls, and the entire trap was constructed of 3/16-inch solid aluminum supported on sections of 1-inch angle iron. This trap will be tested in 1992; testing of the Cold Springs juvenile fish bypass facility will occur in 1993-94.

RESULTS

Three Mile Falls Dam Juvenile Fish Bypass Facility Evaluation

Lengths of fish used were similar for control and treatment fish in all tests (Figures 3 and 4). The summer steelhead used were gradeouts that increased the range of fish lengths tested. Summer steelhead lengths averaged 150 mm (fork length) and ranged from 35 mm to 225 mm.

Injury

Screen Injury: Fish injury rates of juvenile salmonids moving past the drum screens and into the bypass channel during day and night tests were not significantly greater than control fish for spring chinook salmon (F=0.63,

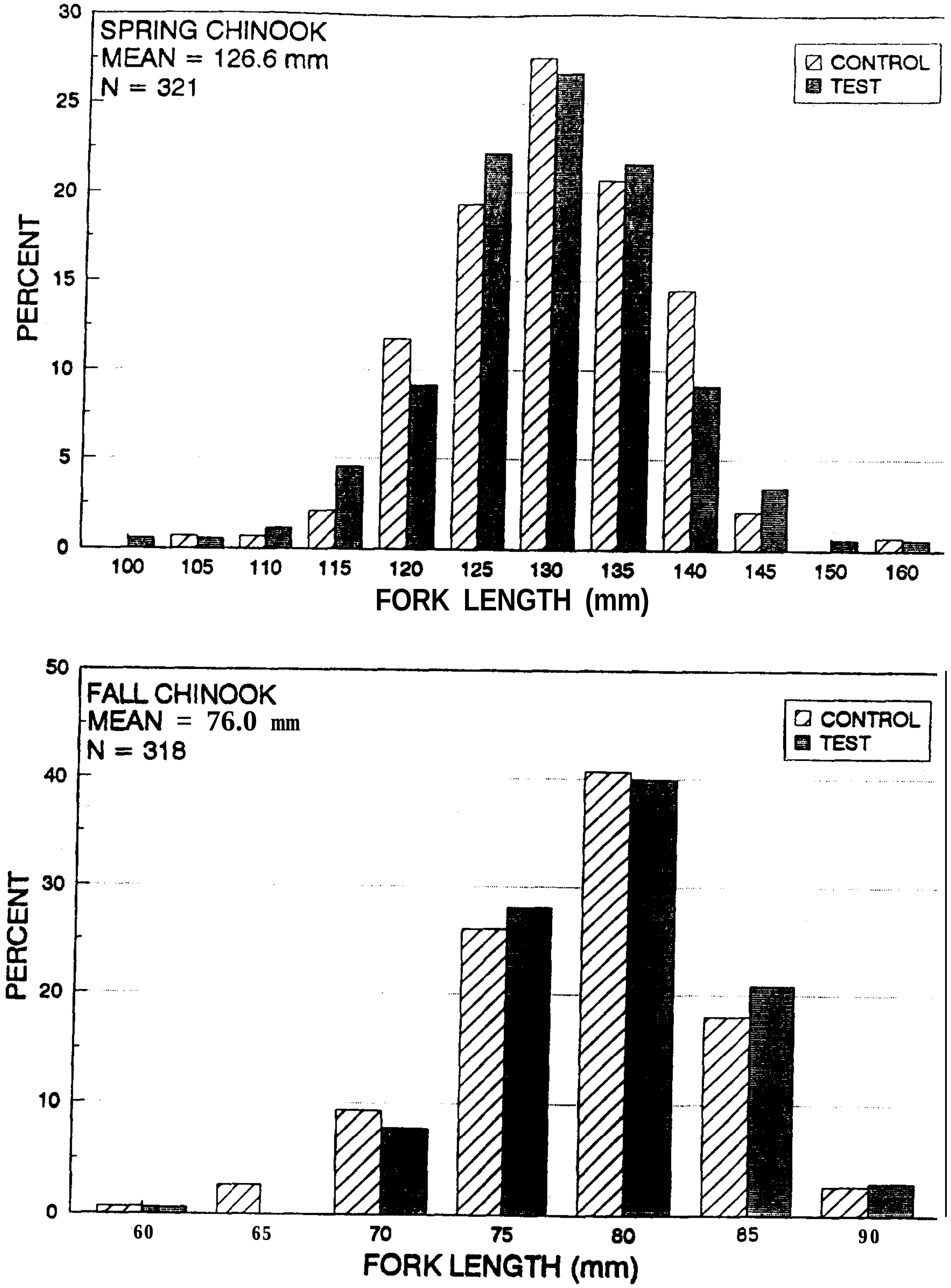


Figure 3. Length frequency distribution of spring chinook salmon and fall chinook salmon used in injury tests at the WEID Canal facility, Three Mile Falls Dam, Umatilla River, Spring 1991.

P>0.77), fall chinook salmon (F=1.12,P>0.42), or summer steelhead (F=1.91, P>0.28; Table 1). The highest mean net injury percentages were found for spring chinook salmon daytime controls (8.7%) and summer steelhead daytime controls (7.2%). Most "other" injuries to fish consisted of eye or head damage.

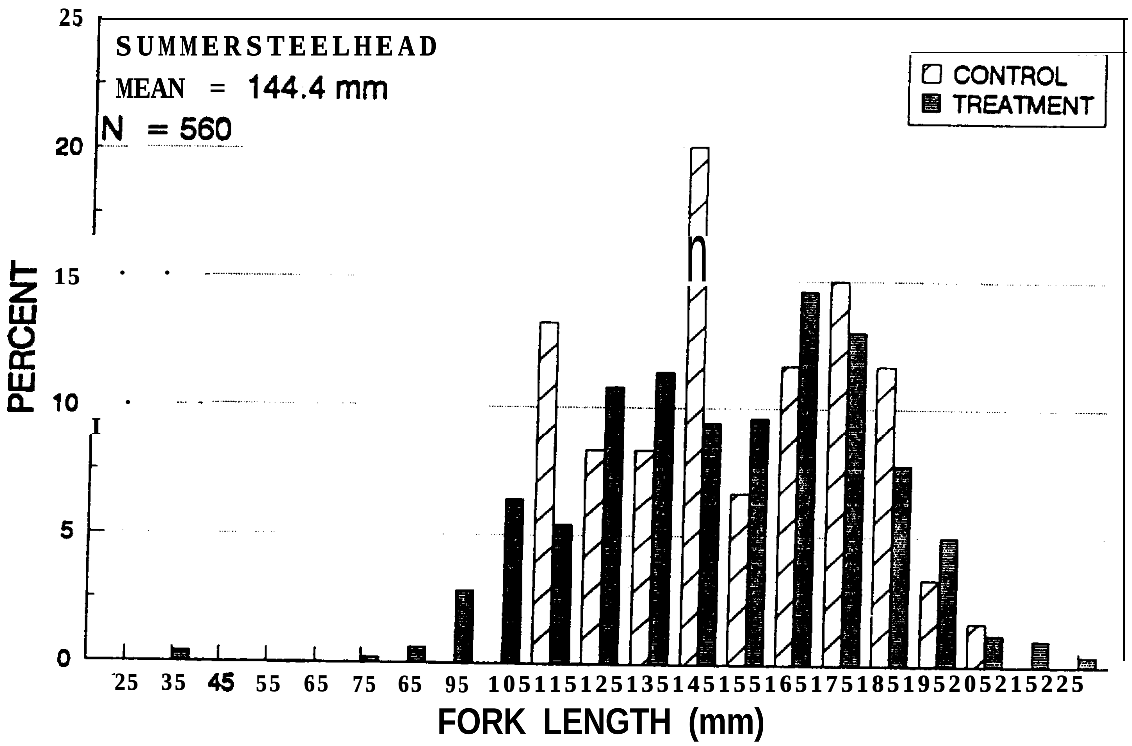


Figure 4. Length frequency distribution of summer steelhead used in injury tests at the WEID Canal fatility, Three Mile Falls Dam, Umatilla River, Spring 1991.

Table 1. Mean percentages of partly descaled, descaled, and other injured fish; net injury rate; and 95% confidence intervals for the WEID Canal screen injury test, Three Mile Falls Dam, Umatilla River, Spring 1991 (subsample values are in parentheses; N = number of test replicates).

Species	Control /test	Time	Number released	Number recaptured	Partly Descaled	Descaled	Other	Net injury rate	95% Confidence Interval LowerCI	UpperCI	N
Spring	Control	Day	809	797	14.0 (5.6)	0.0(0.0)	0.7(0.0)	8.7	-4.1	21.4	5
Chinook	Test	Day	799	757	20.6(20.0)	0.1(0.0)	0.8(1.1)	0.4	-9.1	9.9	9
	Control	Night	813	811	6.9(12.2)	0.0(0.0)	0.0(0.0)	-5.4	-21.9	11.0	3
	Test	Night	807	638	18.9(26.?)	0.7(0.0)	0.3(0.0)	-6.8	-16.3	2.7	9
Fall	Control	Day	006	803	7.2 (3.0)	0.0(0.0)	O.l(O.0)	4.3	1.5	10.1	5
Chinook	Test	Day	700	513	7.2 (1.3)	0.0(0.0)	O.O(O.0)	5.9	1.4	10.5	8
	Control	Night	798	795	3.2 (8.0)	0.0(0.0)	O.O(O.0)	-4.9	-12.3	2.6	3
	Test	Night	808	715	5.6 (2.2)	0.0(0.0)	0.2(0.0)	3.7	-0.6	8.0	9
Sumner	Control	Day	324	321	28.7(21.5)	0.0(0.0)	0.7(0.0)	7.2	-13.0	27.4	4
Steelhead	Test	Day	322	145	35.5(32.1)	0.0(0.0)	0.0(0.0)	3.2	-13.4	19.7	6

Bypass Outfall Injury: Condition of fish returning to the river through the bypass pipe and outfall at flows of 5 cfs and 25 cfs was not significantly different than control fish for spring chinook salmon ($F=1.71$, $P>0.19$). There was a higher probability of a significant difference for fall chinook salmon ($F=1.79$, $P>0.11$) and summer steelhead ($F=1.86$, Pt0.10; Table 2). However, the major source of variation was caused by a day effect ($F=4.47$, Pt0.02) for fall chinook and a day/flow interaction ($F=5.42$, Pt0.01) for steelhead, and was not attributable to the bypass outfall. Generally, the spring chinook salmon treatment and control groups showed higher net injury rates (range of 12-30%) than either fall chinook salmon or summer steelhead. The percentage of "other" injuries for fall chinook salmon were higher in this test than for all other tests and species, and ranged from 4% to 13%. The majority of these injuries were from predators and parasites or were stress-induced mortalities and were not caused by the testing procedure. These mortalities comprised approximately 80% of the "other" category for both flow regimes, and were a result of holding fish for a prolonged period during flooding in late May.

Treatment fish in the outfall injury test were recaptured with less success than in the screen injury test. Generally, less than 60% of the released fish were recaptured. For summer steelhead, the recapture percentage was less than 30%.

Headgate Injury: Limited testing suggested that injury rates of juvenile salmonids that traveled past the headgates were not significantly different than control fish for spring chinook salmon ($F=1.00$, $P>0.49$) or fall chinook salmon ($F=0.50$, $P>0.85$; Table 3).

Leakage

Drum Screen Leakage: The overall mean efficiency rate of fish passing the drum screens without leaking into the canal was estimated at 99.8% (Table 4). Estimated mean efficiency rates for each of the four drum screens showed little variability and ranged from 99.6% to 99.9%. In addition, screen efficiency estimates for an individual drum screen were similar among days. Efficiency.of the bypass collection system averaged 77.0%, while net efficiency averaged 82.3%. Of 900 fish released upstream of the screens, only 6 fish passed through the screens. Because we observed one rollover impinged fish, we suspected that rollover may have been the cause for the net capture of the other five fish. During the test period, canal flows were approximately 50% of maximum design flow and ranged from 74.0 cfs to 78.0 cfs.

The lengths of fish released upstream of the screens and caught in the fyke nets were 60 mm, 60 mm, 62 mm, 64 mm, and 66 mm. These lengths were near the average length of fall chinook salmon used for both control and treatment tests (Figure 5).

Table 2. Mean percentages of partly descaled, descaled, and other injured fish; net injury rate; and 95% confidence intervals for the WEID Canal outfall injury test, Three Mile Falls Dam, Umatilla River, Spring 1991 (subsample values are in parentheses; N = number of test replicates).

Sped es	Control /test	Flow	Number released	Number recaptured	Partly descaled	Descaled	Other	Net injury rate	95% Confidence Interval LowerCI	UpperCI	N
Spring Chinook	Control	5	589	576	55.8(36.2)	0.0(0.0)	0.0 (0.0)	19.7	3.8	35.6	7
	lest	5	624	355	69.1(40.5)	0.4(0.0)	0.4 (0.0)	29.5	13.6	45.4	7
	Control	25	352	302	48.3(36.8)	0.0(0.0)	0.0 (0.0)	11.6	-9.5	32.6	4
	Test	25	330	173	63.9(41.5)	3.5(0.0)	0.9 (0.0)	26.9	5.8	48.0	4
Fall Chinook	Control	5	693	673	55.0(58.3)	2.1(2.6)	4.0 (0.0)	0.2	-11.5	11.9	9
	lest	5	748	357	46.8(61.8)	1.8(0.0)	8.6 (0.0)	-4.5	-16.2	7.2	9
	Control	25	637	601	33.1(15.3)	1.3(0.0)	6.6(18.2)	7.3	-4.4	19.0	9
	Test	25	688	487	24.1(17.8)	2.1(0.0)	12.7(17.8)	3.4	-8.3	15.1	9
Sumner Steelhead	Control	5	810	823	27.7(31.1)	0.1(0.0)	0.0 (0.0)	-3.3	-12.5	5.9	9
	Test	5	538	152	20.6(28.9)	0.0(0.0)	0.0 (0.0)	-8.3	-17.6	0.9	9
	Control	25	810	723	15.8(20.0)	0.0(0.0)	0.0 (0.0)	-4.2	-13.5	5.0	9
	Test	25	801	240	32.1(26.7)	0.0(0.0)	0.4 (0.0)	5.8	-3.4	15.0	9

Table 3. Mean percentage of partly descaled, descaled, other injured fish; net-injury rate; and 95% confidence intervals for the WEID Canal headgate injury test, Three Mile Falls Dam, Umatilla River, Spring 1991 (subsample values are in parentheses; N = number of test replicates).

Species	Control /test	Time	Number released	Number recaptured	Partly descaled	Descaled	Other	Net injury rate	95% Confidence Interval LonerCI	UpperCI	N
Spring Chinook	Control	Day	799	757	20.6(20.0)	O.l(O.0)	0.8(1.1)	0.4	-9.9	10.8	9
	Test	Day	478	372	5.5 (0.0)	O.O(O.0)	O.O(O.0)	5.5	-12.5	23.5	3
	Control	Night	807	638	18.9(26.7)	0.7(0.0)	0.3(0.0)	-6.8	-17.	23.6	9
	Test	Night	238	204	23.1 (0.0)	0.4(0.0)	0.4(0.0)	23.9	1.9	45.9	2
Fall Chinook	Control	Day	700	513	7.2 (1.3)	O.O(O.0)	O.O(O.0)	5.9	0.9	10.9	8
	Test	Day	257	232	10.4 (0.0)	O.O(O.0)	0.4(0.0)	10.8	0.7	20.9	2
	Control	Night	808	715	5.6 (2.2)	O.O(O.0)	0.2(0.0)	3.7	-1.0	8.4	9
	Test	Night	174	152	4.3 (0.0)	O.O(O.0)	O.O(O.0)	4.3	-5.7	14.4	2

Table 4. Estimates of drum screen passage efficiency of fall chinook salmon fry at the WEID Canal juvenile fish bypass facility, Three Mile Falls Dam, Umatilla River, April 1991.

	Bypass		Net		Test Fish					
	Released1	Caught	Released	Caught	Released1	Caught In net	Caught In bypass	Bypass effldency	Net efficiency	Screen efficiency
DRUM SCREEN 1										
1	300	246	75	69	300	2	158	0.820	0.920	0.989
2	300	280	75	51	300	0	264	0.933	0.680	1.000
3	300	167	75	73	300	1	198	0.551	0.973	01997
TOTAL	900	693	225	193	900	3	620	0.770	0.858	0.996
DRUM SCREEN 2										
1	300	246	75	70	300	0	1%	0.820	0.933	1.000
2	300	280	75	70	300	0	264	0.933	0.933	1.000
3	300	167	75	75	300	1	198	0.557	1.000	0.997
TOTAL	900	693	225	215	900	1	620	0.770	0.956	0.999
DRUM SCREEN 3										
1	300	246	75	72	300	0	158	0.820	0.960	1.000
2	300	280	75	56	300	0	264	0.933	0.747	1.000
3	300	167	75	41	300	1	198	0.557	0.547	0.995
TOTAL	900	693	225	169	900	1	620	0.770	0.751	0.998
DRUM SCREEN 4										
1	300	246	75	67	300	0	158,	0.820	0.893	1.000
2	300	280	75	71	300	1	264	0.933	0.947	0.996
3	300	167	75	26	300	0	198	0.557	0.347	1.000
TOTAL	900	693	225	164	900	1	620	0.770	0.729	0.998
GRAND TOTAL	900	693	900	741	900	6	620	0.770	0.823	0.998

1 A 300-fish group was released upstream of the drum screens (test) and in the bypass channel (control) for each replicate test.

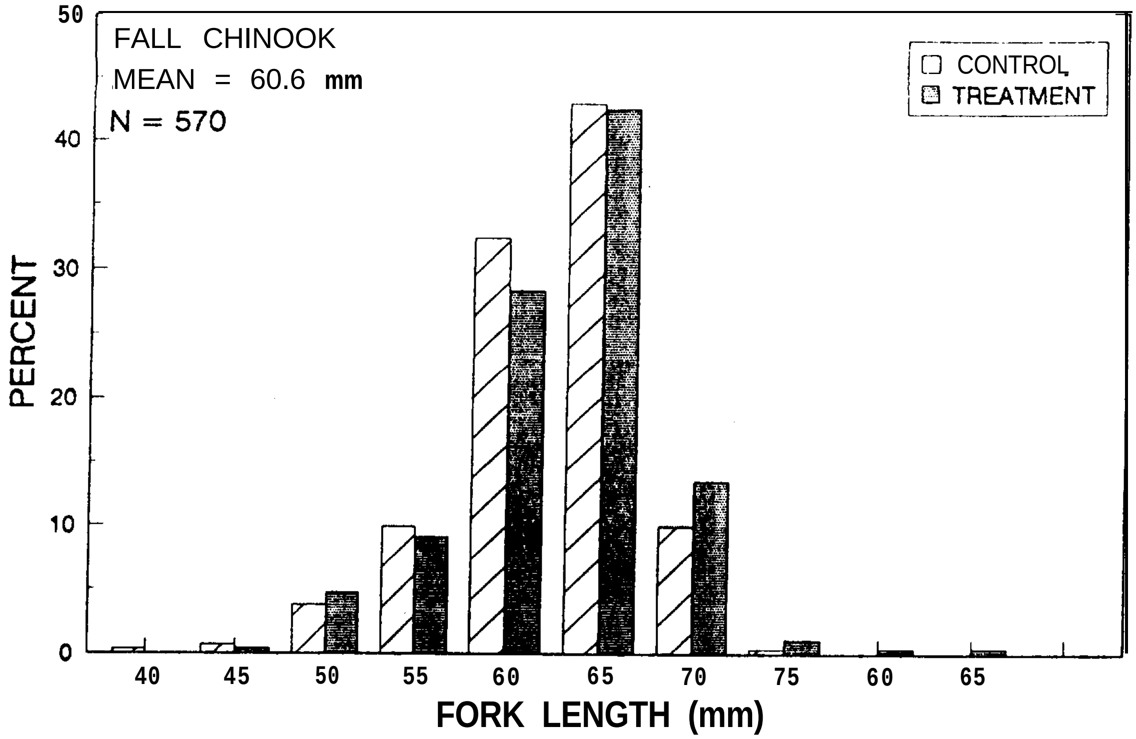


Figure 5. Length frequency distribution of fall chinook salmon used in screen leakage tests at the WEID Canal facility, Three Mile Falls Dam, Umatilla River, Spring 1991.

Traveling Screen Leakage and Fish Impingement: An attempt to capture leakage fish on 9 April was thwarted as the net was torn by the force of the discharge. The net was subsequently repaired and reinstalled on 15 May during the fall chinook outmigration. We captured one fall chinook subyearling (85 mm) after one hour of sampling. Further sampling was abandoned as the net tore again after reinstallation.

During the drum screen leakage test, we observed 108 fall chinook salmon impinged on the secondary traveling screen (Table 5). These fry were test and control fish from the leakage test. Some of the fry were impinged in debris piles falling behind the screen. During the drum screen leakage test, the sluice gate to the El-inch river return drain pipe was fully open.

We observed some impingement on the traveling screen of fry released in the bypass channel when we operated the pumpback pumps and when we opened the river return drain pipe. During pumpback pump operation, some fry were observed to "fight" the current pull through the screen and become temporarily impinged before falling off the screen from the force of the spray water. When the river return drain pipe was open, turbulent conditions existed. These conditions were unfavorable for fry when the pipe was opened more than 12 inches, but were improved when the pipe was opened only 9 inches.

As fall chinook salmon subyearlings migrated through the screening facility in May, we observed occasional impingement on the screen, discovered

Table 5. Observations of traveling screen impingement of fall chinook salmon fry at the WEID Canal juvenile fish bypass facility, Three Mile Falls Dam, Umatilla River, Spring 1991 (ND = no data).

Date	Time	Number of subyearlings	Number of fry	Headworks elevation	Sluice gate	Pumps
7 Apr 91	2205	0	20	404.0	open	off
9 Apr 91	0900	0	87	404.1	open	off
24 Apr 91	1015	0	1	403.9	closed	on
8 May 91	0430	1	0	404.0	closed	on
9 May 91	1820	1	0	404.4	closed	on
10 May 91	0700	2	0	404.4	closed	on
11 May 91	0630	2	0	401 .o	closed	on
12 May 91	0730	1	0	ND	closed	on
13 May 91	0640	2	0	ND	closed	on

fish in debris piles behind the screen, and captured fish in a bucket placed adjacent to the screen (Table 5). During the flood in late May, the sluice gate was fully opened to clear silt in the pump embayment area. We discovered numerous organisms, including fall chinook salmon subyearlings, in the debris piles behind the secondary screen. Impingement was not observed during a full bypass mode when all bypass flow (25 cfs) was routed directly back to the river with no traveling screen, pump, or sluicing operation.

Travel Time

Screen Facility: Fish travel times past the drum screens varied by species and time of day. Spring chinook salmon travel times showed little difference between day and night tests with approximately 3 hours required to capture 50% of the test fish and 58-67 hours to catch 95% of test fish (Figure 6). Fall chinook salmon traveled past the screens more quickly at night with 50% of the fish caught in one hour compared to 5.5 hours for daytime tests. Summer steelhead moved considerably more slowly than spring or fall chinook salmon, requiring 10.5 hours and 162.0 hours to capture 50% and 95% of the day test fish, respectively. No nighttime tests were conducted with summer steelhead.

Lower Bypass: In the 5-cfs test, 25% of spring chinook salmon and 27% of fall chinook salmon moved through the outfall system at the end of the first hour. Summer steelhead moved much more slowly through the outfall

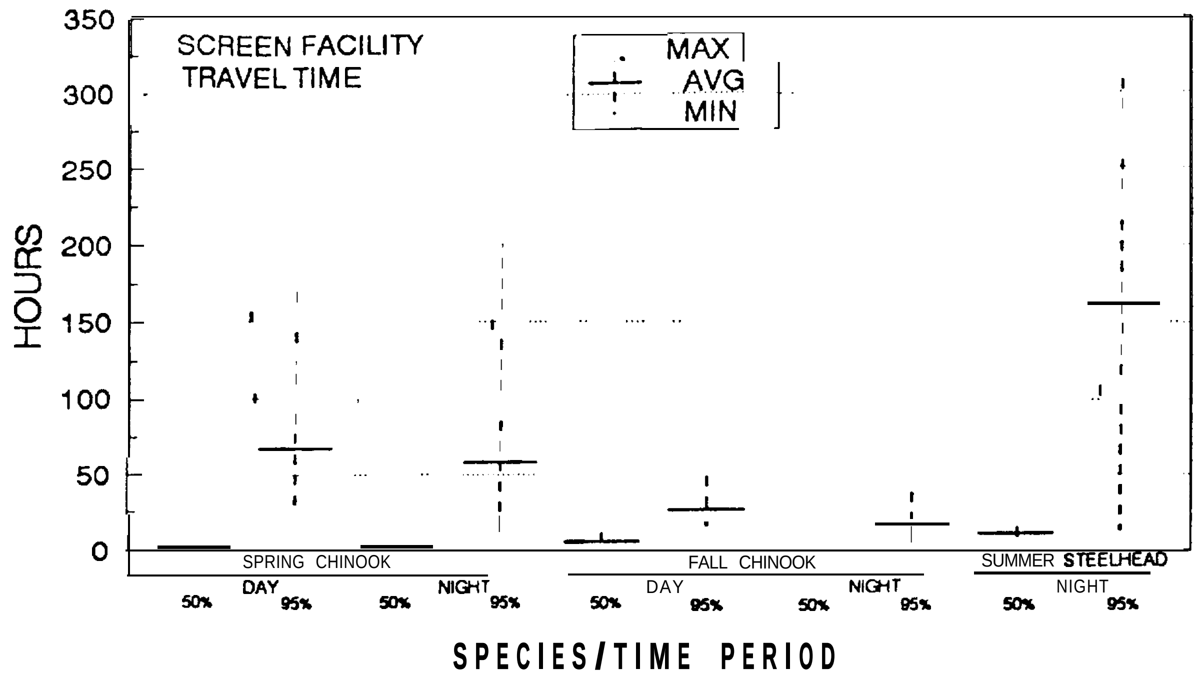


Figure 6. Mean number of hours required to capture 50% and 95% of fish released in the screen injury test at the WEID Canal facility, Three Mile Falls Dam, Umatilla River, Spring 1991.

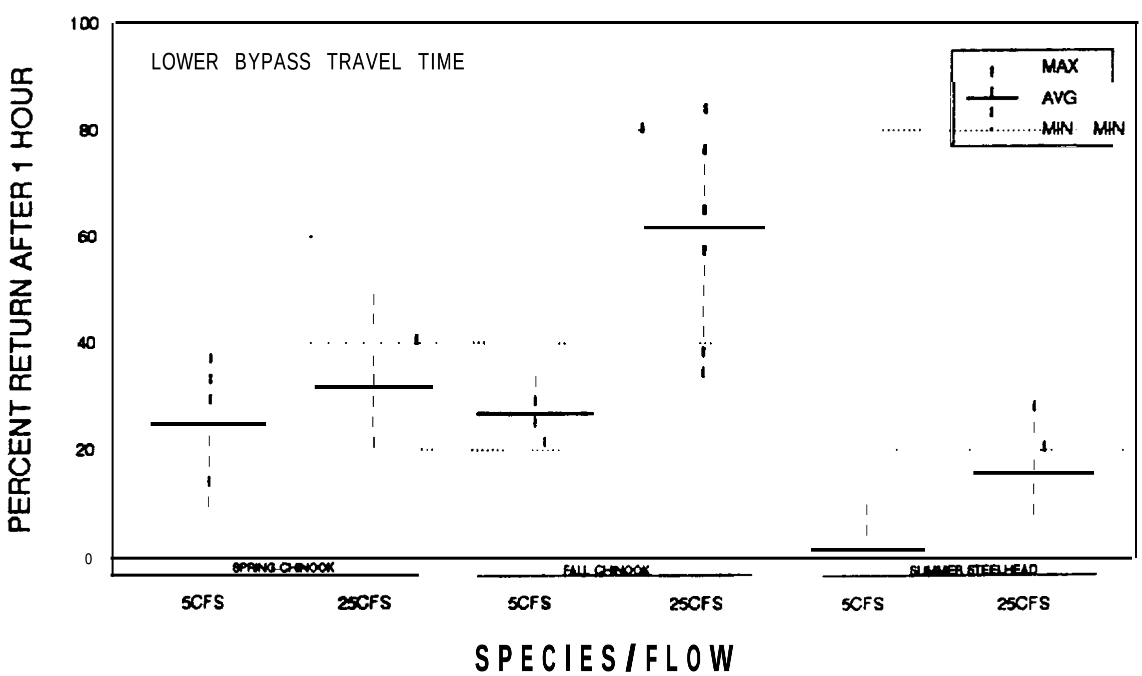


figure 7. Percent of released fish recaptured at the end of a l-hour sampling period during the outfall injury test at the WEID Canal facility, Three Mile Falls Dam, Umatilla River, Spring 1991.

bypass than chinook salmon with 2% captured in the first hour (Figure 7). Flushing the system with 25 cfs 2-4 hours after testing increased the total percentage of spring chinook salmon captured to 56%. Flushing the system with 25 cfs after the first hour increased capture rates for three groups of summer steelhead by 41%. An unknown number of fish returned to the river when the net pen was not in place.

When flows in the bypass were 25 cfs, mean capture rates were 62% and 16% for fall chinook salmon and summer steelhead, respectively. Mean capture rate of spring chinook salmon after one hour of testing at a bypass flow of 25 cfs was 32%.

Passage

Fish Bypass Facility: We observed a distinct pattern of diurnal passage of hatchery and wild juvenile salmonids through the bypass facility at Three Mile Falls Dam from upstream locations in the Umatilla River (Figure 8). In most cases, movement through the facility was greatest from sunrise through sunset. The highest hourly number of juvenile salmonids counted was 1,800 on 24 April and approximately 2,000 on 8 May 1991. Total river-run passage through the fish bypass facility from 5 April to 10 April and from 23 April to 9 May 1991 was 41,318 fish. River flows during this period ranged from 400 cfs to 1,000 cfs. Included in our sample of river-run fish on 2 May was a sockeye salmon measuring 164 mm long.

1990 Ladder Passage: Juvenile fish counts peaked through the east-bank fish ladder from 10 to 13 days after Umatilla River flows reached their highest point (Figure 9). During this time, approximately 30,000 juvenile salmonids were observed moving past the viewing window. The highest daily count was 3,787 fish in early April and the lowest count was 89 on 4 May. Other distinct peaks occurred in mid-May, late May, and early June (end of observation period). Fish ladder flow data during the observation period was not available.

Activities at Maxwell, Westland, and Cold Springs Diversion Dams

During testing of the Maxwell incline plane bypass trap, we recovered all 75 subyearling chinook salmon from releases made in the bypass channel. Only 7 of the 25 fish released in front of the middle drum screen were recaptured. Most of the fish collected were in good condition, with only seven showing signs of partial scale loss.

Our tests of the modified fyke net used at the Westland Dam juvenile fish holding pond resulted in recapture rates of 97% and 94% for the first and second release groups, respectivelv. All fish in the second group were in good condition.- Eighty-two percent of the fish in the first release group were in good condition, with six fish showing partial scale loss.

No trap testing was conducted at Cold Springs Dam. The design of the inclined plane bypass trap is described in the methods section.

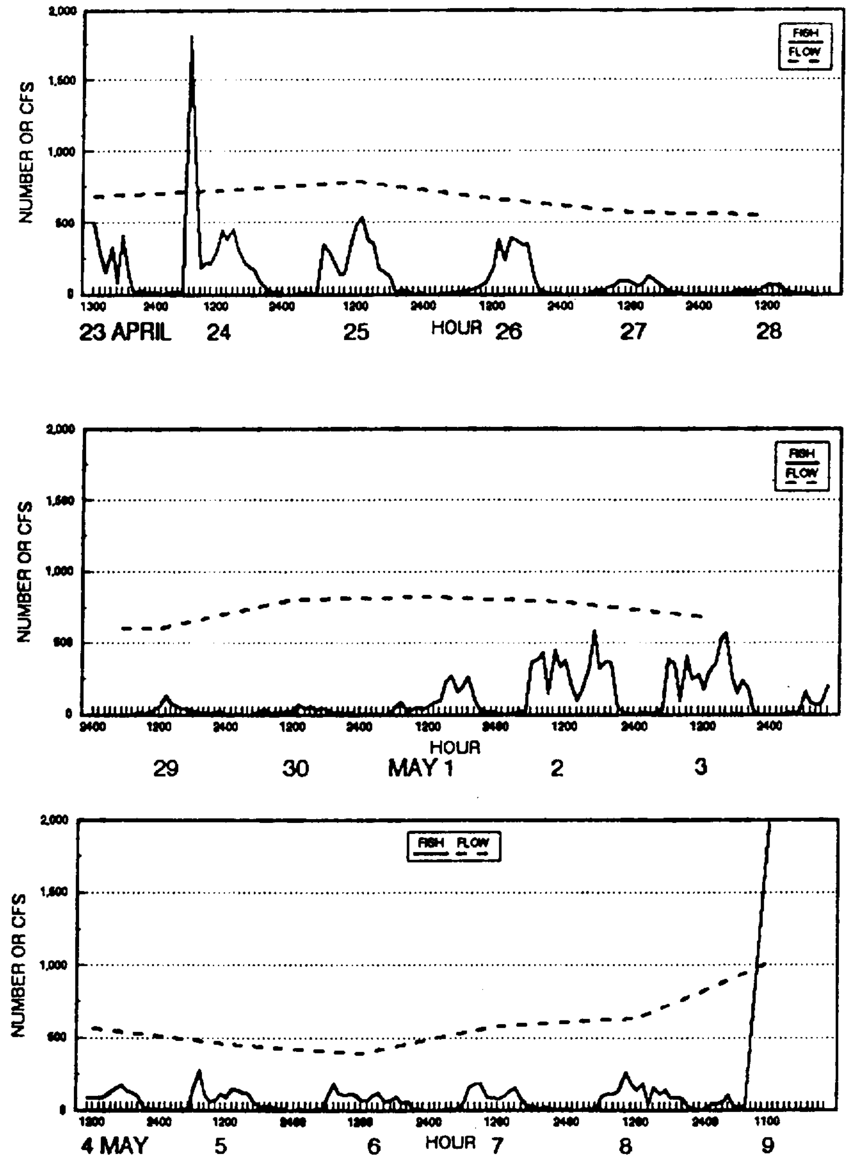


Figure 8. Number of river-run juvenile salmonids passing through the WEID Canal fish bypass facility at Three Mile Falls Dam and Umatilla River flows (cfs) near Umatilla, OR, 23 April - 9 May 1991.

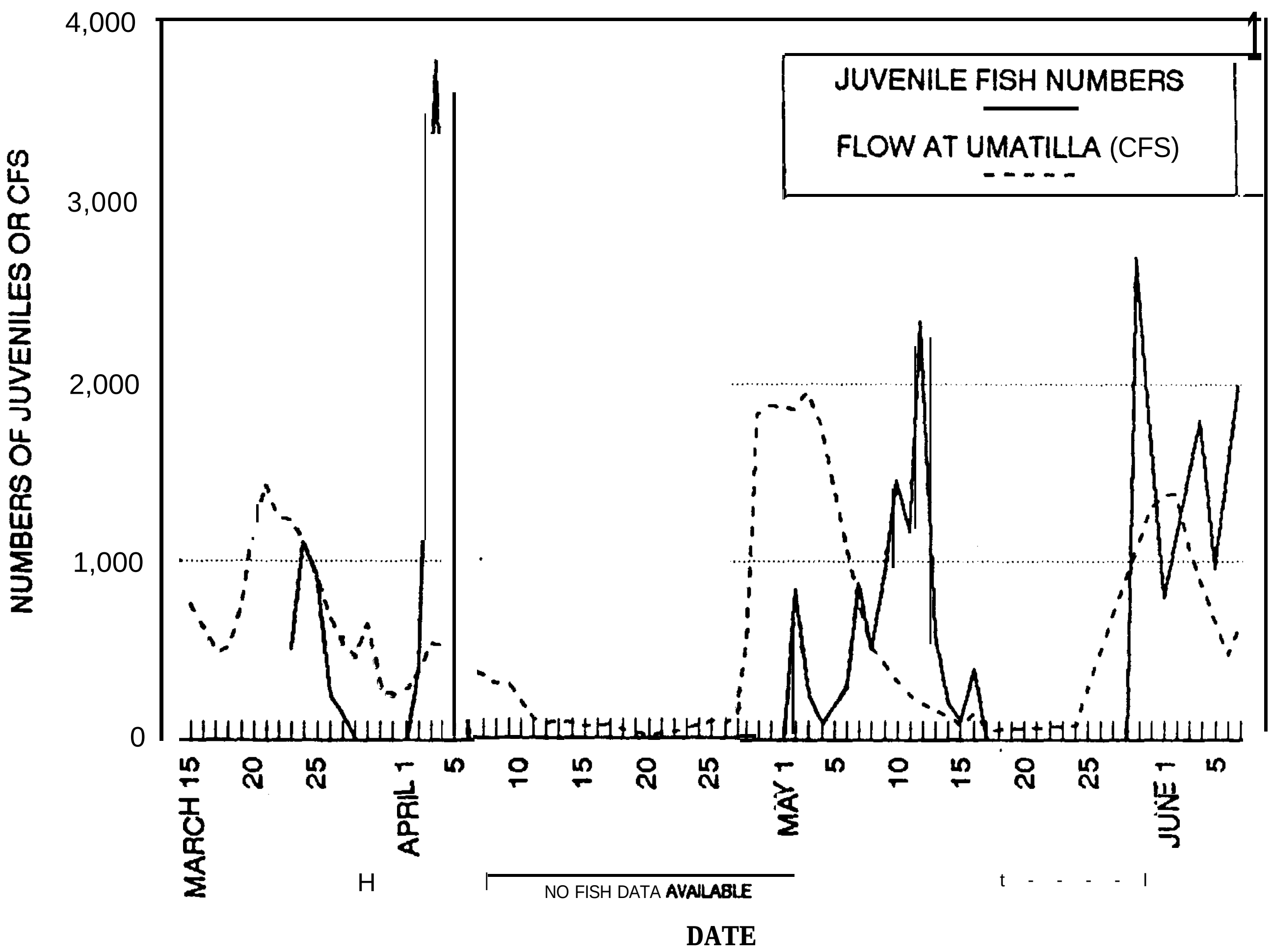


Figure 9. Video tape counts of-river-run juvenile salmonids at the eastbank fish ladder at Three Mile Falls Dam and Umatilla River flows (cfs) near Umatilla, OR, 15 March - 7 June 1990.

DISCUSSION

Three Mile Falls Dam Juvenile Fish Bypass Facility Evaluation

Injury

Small sample sizes may have confounded some of our results. We observed that negative net injury rates were obtained in the screen injury, bypass outfall and headgate injury tests, indicating the condition of post-test fish was better than pre-test fish. Besides the effects of small numbers of fish used to determine pre-test condition, these negative values were also a result of inherent variability in the descaling evaluation.

The results of the headgate injury test were also affected by small sample sizes and uncertainties about the condition of pre-test fish. Since few fish were available, no subsamples were evaluated for pre-test condition and the assumption that their condition was good may not have been valid. More thorough testing will be attempted in 1992.

Based on our tests at Three Mile Falls Dam and a review of other studies evaluating anadromous fish passage facilities in Northwestern rivers, it is unlikely that any significant injury of fish in the Umatilla River can be attributed to the WEID Canal fish bypass facility. Most of the high injury rates that occurred in our tests were part of the sampling procedure and were not caused by the facility. The low fish injury rates encountered during testing of fish passage through the fish bypass facility, past the screens, and through the outfall pipe at Three Mile Falls Dam were similar to results in the Yakima River, Washington. Evaluation at Yakima River screening facilities to determine passage injury to salmonids showed injury rates of less than 5% (Hosey & Associates 1990b). Similar tests at other facilities on the Yakima River also showed low injury rates, generally less than 2% (Neitzel et al. 1985, 1987, 1988, 1990a, 1990b).

Leakage

The screening efficiency of the rotary screens at Three Mile Falls Dam was high and similar to the performance of screens at Yakima River facilities (Neitzel et al. 1988, 1990a, 1990b). The only poor passage efficiency reported during that study was at the Westside Ditch (Neitzel et al. 1990b). In one test, 25% of river-run chinook salmon fry passed through the screens, but the poor screen efficiency was believed to be caused by small fish size or behavioral differences. Generally, most evaluations of rotary screens have shown screening efficiencies greater than 99% and summary reports have suggested that angled screens are "highly effective" (Taft 1986) in preventing fish leakage. Continued maintenance of the WEID Canal facilities at Three Mile Falls Dam, emphasizing upkeep of the seals and adherence to operating criteria, will ensure that juvenile fish are efficiently screened from the canal and returned to the Umatilla River.

Travel Time

Since canal flows were not altered during the screen injury test and we did not have detailed information on the movement of river-run fish, we could not directly determine if the upper bypass had the potential to delay fish migration. However, in most cases, at least 50% of the test fish moved through the WEID Canal screening facility in less than 11 hours and it did not appear that fish movement was delayed. Our results were similar to the range of salmon and steelhead travel times reported in Yakima River screen facility evaluations (Hosey and Associates 1990b; Neitzel et al. 1985, 1987, 1988, 1990a, 1990b). In both river systems, chinook salmon were found to move through the bypass facilities much more quickly than summer steelhead. Similarly, we found that salmon movement was affected by time of day with fish usually moving more rapidly at night.

Our analysis of travel times through the lower bypass during daylight hours indicated that fall chinook salmon and summer steelhead moved more slowly through the bypass outfall pipe at low flows than at high flows. Much of the slower movement in our tests was caused by fish holding in a pocket of water at the end of the bypass pipe to the outfall structure. We observed groups of fish holding in the outfall structure on several occasions, and this corroborated observations made in 1990 (Knapp and Ward 1990). Hosey and Associates (1990a) found that for salmonids released in the early evening, movement through a Yakima River outfall bypass pipe was rapid. However, the flow volume in the WEID Canal is generally smaller than Yakima River canals and, in combination with time of day variables, may partially account for the differences observed in our tests. Although Nietzel et al. (1985, 1987, 1988, 1990a, 1990b) did not directly test transit times through outfall pipes, they reported slower fish movement during low flows at several sites on the Yakima River and suggested that fish could be flushed through some facilities. We were able to flush fish through the bypass system when flow was 5 cfs by increasing flow to 25 cfs for a short period of time. Changes in the outfall design should be considered to reduce this problem and pass fish more rapidly at low flows. The operating guidelines at Three Mile Falls Dam (USBR 1989) that require a 25-cfs bypass flow when the drum screens are installed and operating appear to be validated and show the importance of providing higher bypass flows during critical migration periods to quickly return fish to the river.

It is likely that a wide range of fish migration behaviors will be observed during this study and the causes for different patterns will be difficult to ascertain. Several variables are involved that differ from river to river and could affect passage times, including size of fish, smolting stage, local flow conditions, stream history, and individual characteristics of the facility. Future testing may help to describe fish migration through the fish bypass facility and determine if it is any different from migration patterns in the river.

Passage

It appears that most juvenile salmonids move through the Umatilla River and into the Columbia River during short windows of opportunity. We stopped monitoring fish passage in early May 1991 and failed to separate fish species or strain. Therefore, we could not determine how species-specific activity affected the counts. Fish counts in the WEID Canal fish bypass facility increased in magnitude at daybreak. During our monitoring period, most scheduled hatchery releases in the Umatilla Basin were coho and chinook salmon (CTUIR 1990) and we assumed that these species comprised the bulk of daylight migration activity. This assumption was corroborated by data from Neitzel et al. (1987) where coho and chinook salmon in the Yakima River migrated at daybreak while steelhead migratory activity increased at sundown.

Although a clear relationship between fish passage and river flow was not established, it is probable that flow was important. Movement on 24 April may have been triggered by a peak flow of 1,020 cfs on 15 April. The count on 8 May coincided with flows greater than 1,000 cfs, but was not preceded by high flow. A combination of factors including river flow, fish size and condition, stocking locations and dates, and year-to-year seasonal variability will determine the exact timing of fish passage. Since a primary goal for the basin is to re-establish naturally producing salmonid populations (NPPC 1989), it is essential to accurately document the periods when peak migration occurs to ensure optimal operation of the WEID Canal fish bypass facility for efficient fish passage.

1992 Tests

Some of the tests completed in 1991 will be repeated in 1992 to improve on inconclusive or uncompleted tests. Several aspects of the evaluation can be improved to increase the confidence in our test results. An accurate analysis of fish injury caused by the facility depends on starting the tests with fish in good condition. In several cases, a significant portion of fish used in 1991 were in poor condition prior to testing. In addition, an attempt will be made to ensure more uniform size distribution within each test species group. It is probable that the wide size range of summer steelhead used added to the variability of the test results.

We will implement an improved statistical design in 1992 to provide more balance between treatment and control tests. Occasionally in 1991, we pooled controls thereby reducing the sample sizes for testing. We will also attempt to subsample a larger number of fish to determine the pre-test condition. The appearance of negative numbers in the computation of the net-injury rate may have been the result of subsampling a small number of fish. Our plans for 1992 at Three Mile Falls Dam are described in our statement of work (APPENDIX A). Work at Maxwell Dam will be discontinued because of plans by the Bureau of Reclamation to cease operation of this facility in the near future.

Operational and Structural Problems at Three Mile Falls Dam

Sampling Equipment

We experienced great difficulty in our efforts to remove and deploy the bypass channel sampling equipment (inclined screen and separator sample box) during our evaluation. The equipment was cumbersome to maneuver and difficult to align properly. We also had difficulty changing from a full bypass mode to a sampling mode when fish were in the bypass channel. Unless fish were removed from the bypass channel between the weir gate and orifice plate before the inclined screen was deployed, they would become trapped underneath the inclined screen and be ultimately flushed through the auxiliary inflow system. Occasionally this occurred and created blockages in the auxiliary inflow lines. To effectively drain and remove fish from this area, a stoplog was installed downstream of the traveling screen and fish were netted out.

There is no easy and efficient means to deploy the inclined screen, nor are operating instructions included in the designer's operating criteria for the facility (USBR 1989). We inserted an eye bolt into the top edge of the screen to permit lifting and maneuvering with the crane. The inclined screen needed to be in the correct location and proper position when lowered to attach it to the support frame. The side and bottom rubber seals tended to curl under the screen during deployment and extra effort was required to keep them properly aligned. future operators of this equipment will need to be aware of the problems to ensure efficient and effective use.

Juvenile salmonids continued to escape into the bypass downwell instead of being diverted into the sampling trapping area during the sampling mode. Although loss of fish was reduced with the installation of a E-inch neoprene barrier at the downstream end of the separator in 1990 (Knapp and Ward 1990), some fish were still lost when fish entered the separator too rapidly or at a perpendicular orientation to the separator bars. Continued losses may require that the separator be redesigned or that another modified barrier device be installed. These losses primarily occurred when water flows and canal water levels were normal or somewhat high. At low river flows and a headworks water elevation below 404.1 ft, water and fish trickle onto the separator and fish loss at the end is not a problem. The concern in this scenario is the need to prevent water loss through the separator top perforated plate, a recommendation that was made previously (Knapp and Ward 1990).

During sampling, we observed that fish became trapped behind a perforated plate on the back side of the sample box, Closer inspection revealed that a gap existed along the edge of the transfer chute that led from the separator sample box to the transfer flume. This gap probably resulted from bypass inflow water pressure distorting the separator assembly and leaving a gap on the upstream edge. Fish diverted into the transfer flume apparently swam back up the current, located the side gap, and swam behind the perforated plate, only to become trapped and die. This problem was most pronounced during the fall chinook outmigration because of the small average size of the chinook salmon subyearlings.

We documented several other fish-related structural problems that will require annual inspection and maintenance to correct or prevent, including an unsecured rubber seal at the bottom of the inclined screen. The primary concern is leakage or escape of fish, reducing diversion effectiveness. The fact that one fall chinook salmon subyearling (86 mm long) was captured in the fyke net at the terminus of the river return drain pipe indicates possible traveling screen leakage. Apparently operational and structural problems pose the greatest threat to small fall chinook salmon subyearlings.

Traveling Screen

Fish impingement on the secondary screen (traveling screen) during the sampling mode was the primary biological problem observed at the facility. During the sampling mode, 20 cfs is taken through the traveling screen and pumped into the canal or returned to the river through the 21-inch diameter river return pipeline. The remaining 5 cfs passes through a bypass orifice plate at the downstream end of the secondary screen. When the sluice gate to the river return pipeline was opened rather than the pumps operating, we observed increased impingement rates of fry.

Contributing factors to this impingement problem may have included the presence of a hydraulically inefficient transition of a 25-cfs flow from the bypass entrance to a 5-cfs flow through the orifice plate. Because of an abrupt momentum loss upstream of the orifice plate, an unstable flow condition at the screen face was created that resulted in surging and instantaneous high velocity hot spots at the screen face. Depending on the degree of sluice gate opening, the flow through the traveling screen when excess bypass flow is being returned to the river can exceed 30 cfs (letter dated 10 October 1991 from W.S. Rainey, National Marine Fisheries Service, to J. Marcotte, Bonneville Power Administration).

As fish became impinged on the screen, they would "rollover" to the back side of the screen because of insufficient spray water in the impingement location. Our observations were that impingement occurred entirely in the northeast corner of the rotating screen, an obvious "hot spot" area that did not receive sufficient flushing with spray water. Apparently frequent plugging of the terminal spray nozzle on the spray water bar occurred because of river debris.

There exists a need to remedy the impingement problem with structural or operational modifications. A recommendation has been made to operate only one pump to reduce the bypass entrance flow from 25 cfs to 15 cfs, and reduce flow through the secondary screen by 50%. This approach would likely reduce surging near the secondary screen and allow more efficient hydraulic conditions for fish passing through the bypass orifice plate. This could be implemented if 15 cfs provides enough flow to efficiently return fish to the river. In addition, it was recommended that use of the sluice gate should be limited to short periods during daylight hours, when juvenile passage rates are presumed to be at the lowest levels, and throttled back as impingement is observed (letter dated 10 October 1991 from W. S. Rainey, National Marine Fisheries Service, to Jay Marcotte, Bonneville Power Administration). In light of our findings on die1 passage of river-run fish in which passage rates were highest during daylight hours, a nighttime operation of the sluice gate may be preferable. This would be particularly important during future high water events, when heavy river silt loads and sedimentation problems at the facility would require intensive sluicing efforts.

Operating Criteria

Fluctuations in headworks water level above or below the normal operating criteria of 404.1 ft are a concern because they affect bypass operations. At levels greater than 404.1 ft, fish and debris may roll over at the drum screens. These situations may occur when river flow rises suddenly, as during the flood in late May 1991. More than 80% of the drum screens were submerged during this high flow event. At levels less than 404.1 ft (403.9), sampling efforts are hampered because minimal water flows across the top of the inclined screen. This problem was reported previously (Knapp and Ward 1990) and may be a concern when trapping and hauling juvenile salmonids during low river flow.

Activities at Maxwell, Westland, and Cold Springs Diversion Dams

We encountered very few problems during testing of traps at Maxwell and Westland dams. At Maxwell Dam, the primary operational problem encountered was the formation of a backwash eddy in the front corners of the trap that stranded fish entering this area. It was necessary to push these fish into the main water flow for recapture in the live box. We subsequently modified the trap by riveting aluminum plates diagonally across the front corners to prevent stranding of fish. We also recovered less than 30% of subyearling chinook salmon released in front of the middle drum screen. These fish were observed schooling in the screen forebay. At Westland Dam, the net appeared to work well and the only modification made was the inclusion of additional floatation material on the live box. Our plans for 1992 at Westland Dam are described in our 1992 statement of work (APPENDIX A).

RECOMMENDATIONS

Based on our efforts during the evaluation, we recommend the following improvements to ensure safe and effective fish passage through the juvenile fish bypass facility at the WEID Canal.

1. The headgates and checkgates to the WEID Canal should be automated to ensure proper water level elevations in the forebay and headworks area at all times. A normal operating water surface elevation of 404.1 ft at the drum screens should be maintained whenever possible to ensure effective operation of the facility components.

2. All equipment seals should be annually inspected and regularly replaced to prevent fish loss. This would include the secondary traveling screen, the primary drum screens, and bypass channel sampling equipment. Apparently, structural deficiencies pose the greatest threat to small fish (fry and subyearlings).

3. The operating criteria for the left-bank fish facilities at Three Mile Falls Dam should be amended to include specific guidelines for operating the sluice gate to the 21-inch river return drain pipe, and for deploying sampling equipment. We recommend that the sluice gate not be operated during daylight hours when fish passage is most prevalent. Operators need to be made aware that their actions may cause injury to and loss of fish.

4. A mechanism to control the amount of water eliminated through the fish separator perforated plate is needed during low flow periods, particularly when trapping or sampling is occurring unattended. Fish can be stranded on the perforated plate, and in the sample box and transfer flume if little water reaches these areas.

5. In concurrence with the National Marine Fisheries Service, we recommend that only one pump be operated during modes other than a full bypass mode to reduce the bypass entrance flow from 25 cfs to 15 cfs. This would reduce by half the flow through the secondary screen and decrease surging in the separation chamber.

6. The operating criteria for the WEID Canal, as amended, should be followed in the effort to protect fish that move through the system. Operating guidelines and criteria should be made readily available for all users of the facility. Staff gauges should be installed at all critical locations to determine compliance with the operating criteria.

7. A means to prevent fish from leaving the transfer chute and entering behind the back perforated plate in the sample box should be investigated.

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APPENDIX A

1992 Planned Activities for the Umatilla River Passage Study

Goals and Objectives

Our study goal is to evaluate the passage of juvenile salmonids at diversions in the Umatilla River and make recommendations to improve passage, if applicable. We will investigate effects facility operation and structure have on juvenile fish and their ability to bypass diversions. Our efforts from 1989 through 1990 included modification and operation of the juvenile bypass system in the WEID Canal at Three Mile Falls Dam to obtain preliminary information on facility efficiency and juvenile salmonid condition and passage. In 1991, we prepared for and conducted a full-scale evaluation of juvenile passage at the WEID Canal facility, and designed and fabricated some fish capture facilities for Maxwell, Westland,-and Cold Springs dams to enhance our ability to conduct future evaluations of these facilities.

The three objectives for the 1991-92 project period are to (1) determine if problems exist with passage of summer steelhead, and spring and fall races of chinook salmon through the headgates and the bypass system in the WEID Canal and through the east-bank adult fish ladder at Three Mile Falls Dam; (2) conduct a feasibility study at Westland Dam to ensure readiness for a 1993 evaluation; and (3) determine if flow characteristics at defined locations in the screening facilities at Three Mile Falls and Westland dams meet design specifications. Evaluation efforts at Maxwell Dam will be abandoned due to planned termination of canal and facility operation in the near future as a result of Phase II completion of the Flow Enhancement Project.

Definitions

Evaluation efforts will be accomplished in the context of specific task parameters. For clarity in the purpose of this study, these parameters are defined as follows.

Passage: The movement of fish through the components of a fishway or diversion screening facility from their entrances to their river return outlets. Passage will also refer to "leakage" of juvenile fish through or over a screening structure.

Passage Success: The ability of fish to pass or navigate through a fishway or diversion bypass system and be returned to the river without incurring injury or mortality, or experiencing impediments to natural movement or, for juvenile fish, loss into the canal.

Diversion Rate: The cumulative percent of released juvenile fish that enter a diversion system.

Travel Time: Average time for released fish to travel from a release point to a recovery point.

Injury: Fish incurring body injuries or scale loss during passage from a release point to a recovery point.

Hortality: Fish not surviving passage from a release point to a recovery point as a result of injuries.

Document: To observe presence or absence.

Estimate: To determine percent of fish in a release and recovery test.

Test Fish: Fish used in a mark and recapture study.

River-Run Fish: Non-test fish that are part of the adult fish migration or juvenile fish outmigration.

Evaluation: The synthesis of estimates, observations, and determinations to determine the synergistic effects of a system in the overall context of passage success.

Specifically, we will repeat several injury and leakage tests and take additional velocity measurements at Three Mile Falls Dam because we were unable to satisfactorily complete these tests in 1990 and 1991. We will also (1) document passage and estimate injury of juvenile fish moving through the east-bank ladder at Three Mile Falls Dam, (2) take velocity measurements at specific locations in the Westland Canal screening facility, (3) operate the Westland Canal facility bypass and associated structures, and (4) design and fabricate all collection traps to carry out an evaluation at Westland Dam in 1993.

We will estimate injury and mortality of fish associated with the Three Mile Falls Dam passage facilities by releasing groups of marked fish at various locations in the ladder and diversion canal, recapturing them at downstream sites, and inspecting them for mortality, descaling or other injury. We will make corresponding releases in the recapture facilities to assess and compare injury caused by the collection and handling process. We will estimate travel time by determining the difference between time of release and time of recapture. We will estimate diversion rates by the proportion of fish entering a diversion system from the total number of fish released in front of the headgates. We will estimate fish loss into the canal through the traveling screen by releasing groups of fish upstream from the screens and recapturing them in a fyke net set downstream from the screen. We will determine if velocity patterns adhere to design criteria by measuring approach and sweep velocities in front of the drum and traveling screens, and at the entrances to the bypass channel and the fish return during various phases of operation.

Juvenile fish to be used in the evaluations will be held at hatchery or acclimation facilities and hauled to study sites prior to the tests for freeze branding or dyeing and acclimation. Fall chinook fry will be dyed. Freeze-branded fish will be held in separate containers approximately 48 hours before release.

A survey of velocity patterns at the Three Mile Falls and Westland screening facilities will be accomplished using an electromagnetic water current meter. We will pattern our surveys after those performed by previous researchers (Abernethy et al. 1989, 1990). We will take measurements during low, normal and high diversion flows to ascertain adherence to screening facility design criteria.

Objectives

Objectives and corresponding tasks for 1991-92 are as follows.

Objective 1 Determine the passage success of summer steelhead, and spring and fall races of chinook salmon through the bypass system in the WEID Canal and the east-bank fish ladder at Three Mile Falls Dam.

Task 1.1 Estimate travel time, injury and mortality of summer steelhead associated with the drum screens at design flow.

To estimate travel time, injury and mortality associated with the drum screens, we will release replicate groups of healthy, freeze-branded fish upstream of the screens; recapture them at the bypass collection facility; and examine the fish for descaling and other injuries (treatment). We will also release replicate groups of healthy, freeze-branded fish directly into the collection facility to allow us to evaluate injury caused by the collection and examination process (control). We will conduct tests during the day and at night and will repeat each day and night test on three different dates at design flow. -Each treatment and control, day and night release will consist of three loo-fish replicate groups. We will examine a 30% subsample from each replicate group for condition prior to release to ascertain pre-release condition. These subsample fish will not be returned to their groups. We will determine travel time from the release location upstream of the screens to the collection facility by estimating the time to recapture 50% (median travel time) and 95% of the released test fish.

We will use the method of Neitzel et al. (1985) to determine fish condition. The condition of recaptured fish will be categorized as healthy, partially descaled, descaled (or dead), and injured (Hosey & Associates 1988). We will use analysis of variance (ANOVA) to test.the hypothesis that the relative condition of control and treatment fish in the various tests are equal in all releases. Sources of variation tested in the ANOVA will be (1) treatment versus control, and (2) time of day (day or night). We will transform the data as appropriate to meet the assumptions of ANOVA. For purposes of analysis, we will calculate pre-test condition (from subsamples) and post-test condition (from control or treatment fish) of fish observed as percentages of recaptured injured fish (the sum of partly descaled, descaled, and other injured fish). We will then calculate net injury rate as the difference between pre-test and post-test condition. We will compute a 95% confidence interval about the difference in the net injury rate between corresponding treatment and control groups.

Rationale: We were not able to satisfactorily complete the screen injury test for summer steelhead in 1991 because of accidental loss of test and control fish.

Products: We will compute mean and 95% confidence intervals for the total proportion of summer steelhead .injured, descaled or killed during.passage past the screens. We will use analysis of variance to test for significant difference in injury rates between the respective treatment and control groups. We will compute travel time for 50% and 95% of the recaptured test fish.

Schedule: Test preparation will be completed during winter 1991-92. Fish will be procured, branded and released during April 1992. Data analysis and a report of results will be completed by 30 September, 1992 (Appendix Table A-1).

Task 1.2 Estimate travel.time, injury and mortality of fall chinook subyearlings associated with the bypass pipe and bypass outfall at a 5-cfs and 25-cfs outfall flow.

To estimate injury and mortality rates associated with the bypass pipe and bypass outfall, we will release replicate groups of healthy, freeze-branded fish at the entrance of the bypass pipe, recapture them at the bypass outfall to the river, and examine the fish for descaling and other injuries (treatment). A floating net pen placed directly beneath the outfall will be used to recapture treatment fish. We will also release replicate groups of healthy, freeze-branded fish directly into the floating net pen to allow us to evaluate injury caused by the collection and handling process (control). We will repeat each test on three different dates and at flows of 5 cfs and 25 cfs. Each treatment and control, 5-cfs and 25-cfs release will consist of three 100-fish groups. We will examine a 30% subsample from each treatment and control replicate subgroup for condition prior to release to ascertain pre-release condition. These subsample fish will not be returned to their groups. We will determine if fish movement from the bypass downwell to the bypass outfall is impaired by computing the percentage of fish recaptured after a one-hour interval for 5-cfs and 25-cfs bypass flows.

We will examine fish for condition and analyze the data the same as discussed in Task 1.1.

Rationale: We conducted the bypass pipe and bypass outfall injury test in 1991 with subpar fall chinook subyearlings due to a protracted holding period caused by flooding and high flows.

Products: We will compute mean and 95% confidence intervals for the total proportion of fall chinook subyearlings injured, descaled or killed during passage from the entrance to the bypass pipe to the bypass outfall at the WEID Canal facility. We will use analysis of variance to test for significant difference in injury rates between the respective treatment and control groups. We will compute the percentage of test fish recaptured after a one-hour interval at operating conditions of 5-cfs and 25-cfs bypass flow to determine if fish movement through the lower bypass system is impaired.

Schedule: Test preparation will be completed during winter 1991-92. Fish will be procured, branded and released during May 1992. Data analysis and a report of results will be completed by 30 September, 1992.

Task 1.3 Estimate diversion rate, travel time, injury, and mortality of Summer steelhead, and spring and fall races of chinook salmon associated with operating the canal headgates at less than full headgate opening.

To estimate injury and mortality associated with passage through'a reduced headgate opening, we will release groups of healthy, freeze-branded fish upstream of the three headgates; recapture them at the collection facility; and examine them for descaling or other injury (treatment). We will set the headgate openings at approximately 1 ft (l/3 of normal operation opening). We will follow the same procedures outlined in Task 1.1 to complete the test for each species or race of fish. Travel time will be estimated from the release location upstream of the headgates to the collection facility, as in Tasks 1.1 and 1.2. We will statistically compare mean travel time with travel time estimated in Task 1.1 for summer steelhead. Diversion rate will.be estimated from the cumulative percentage of released fish entering the canal and arriving at the collection facility over time. We will examine fish for condition and analyze the data as discussed in Task 1.1.

Rationale: We observed velocity increases caused by reduced opening size of the headgates. Submergence of a reduced entrance opening may subject fish to non-favorable hydraulics and encounters with debris piles.

Products: We will compute mean and 95% confidence intervals for the proportion of summer steelhead, spring chinook and fall chinook subyearlings injured, descaled or killed during diversion through reduced headgate openings into the WEID Canal. We will use analysis of variance to test for significant difference in injury rates between treatment and control groups. We will compute travel time for 50% and'95% of the recapture test fish to determine if fish diversion is impeded by a reduction in the headgate opening.

Schedule: Fish will be procured, branded and released during April and May 1992. Data analysis and a report of results will be completed by 30 September, 1992.

Task 1.4 Document passage (leakage) and impingement of fall chinook fry and subyearlings associated with the traveling screen when operating pumpback pumps in tandem or individually and varying gate openings of the river return drain pipe.

To document the extent of passage around and over the traveling screen in the WEID Canal of smaller-sized fish we will install a fyke net at the terminus of the 21-inch diameter river return drain pipe. The drain pipe will be in operation during the sampling mode when the traveling screen is functioning, but the pumpback pumps are not. All fish that pass through or over the operating traveling screen will eventually be diverted through the drain pipe and recaptured in the fyke net. We will count fish impinged on the traveling screen or fish that have leaked around the screen and into the fyke net at varying openings of the river return drain pipe. When river flow drops and bypass flow needs to be diverted back to the canal, the drain pipe will be closed and the pumpback pumps will be put into operation. We will count fish impinged on the traveling screen when operating the pumpback pumps in tandem or individually. Leakage cannot be detected due to the inability to recapture fish during pump operation. To make counts and observations, we will release groups of fall chinook fry upstream of the traveling screen. We will also observe leakage and impingement during tests using fall chinook subyearlings and during the subyearling outmigration.

Rationale: In 1991, we observed some impingement of fall chinook fry and subyearlings on the traveling screen in the WEID Canal during pumpback pump operations and at varying levels of river return drain pipe gate openings. We collected a fall chinook subyearling in a fyke net placed at the terminus of the river return drain pipe.

Products: We will document the presence or absence of leakage or impingement of fall chinook fry and subyearlings around or on the traveling screen associated with the operation of the pumpback pumps in varying combinations and with a full and throttled river return drain pipe gate opening.

Schedule: Fabrication of a new river return drain pipe fyke net will be completed during the fall of 1991. We will observe leakage and impingement of fall chinook fry in early April and of fall chinook subyearlings in May. A report of our observations will be completed by 30 September, 1992.

Task 1.5 Estimate injury of spring chinook salmon at varying degrees of turbulence in the bypass downwell caused by changes in flow and water level.

To estimate injury of spring chinook in the bypass downwell, we will release fish at the weir crest in the-bypass channel and recapture them at the bypass outfall in the floating net pen. We will vary the bypass channel flow and water height in the downwell to test injury levels against varying turbulence conditions in the downwell. We will also release fish directly in the 24-inch bypass pipe to serve as our control.' We will perform similar test procedures, examine fish and analyze data as discussed in Task 1.1.

Rationale: General observations of poor condition of spring chinook in the bypass pipe and outfall test conducted in 1991 indicate that turbulence in the bypass downwell may be causing injury.

Products: We will compute mean and 95% confidence intervals for the proportion of spring chinook that are injured or descaled during passage into the downwell at varying degrees of turbulence caused by changes in flow and water level. We will determine if injury rates of treatment fish are significantly different from control fish using ANOVA.

Schedule: See-Appendix Table A-l.

Task 1.6 Document passage, injury and mortality of summer steelhead, and spring and fall races of chinook salmon associated with the east-bank fish ladder during the juvenile outmigration.

To document the extent of passage of outmigrating juvenile salmonids through the east-bank fish ladder, and possible injury and mortality associated with this passage, we will enumerate smolts passing by the fishway viewing window from video tapes of adult passage recorded by CTUIR. We will also visually observe movement of juvenile fish through the various components of the ladder, including the attraction water weir and the entrance pool and other diffusers. We will collect and brand good-condition fish at the bypass facility, release them in the upper portions of the ladder, and collect them at the base of the ladder to estimate injury incurred as fish pass through the ladder structure. Fish condition will be ascertained as described in previous tasks. We will release fish in our capture facilities to evaluate injury caused by collection and handling (control).

Rationale: We observed juvenile fish passage through the east-bank ladder in 1990 and recorded passage counts from video tapes of adult passage in'the spring of 1990. Relative passage rates through the east-bank ladder appeared to be similar to passage through the west-bank juvenile fish bypass facility during the same time period, indicating that smolts use the ladder as a means to bypass the dam even when the bypass is in operation.

Products: We will document numbers of juvenile summer steelhead, and spring and fall races of chinook salmon passing through the east-bank adult fish ladder at Three Mile Falls Dam in 1991 and 1992. We will estimate injury levels of juvenile salmonids passing through the ladder to preliminarily ascertain if ladder passage occurs in an effective and non-injurous manner.

Schedule: We will conduct visual observations and test releases at the east-bank.ladder during the spring-summer outmigration from mid-April to mid-June 1992. We will read 1991 adult passage video tapes in the fall and winter of 1991-92.

Objective 2 Ensure efficient operation of the juvenile salmonid bypass and collection system in the canal at Westland Diversion Dam, and design, fabricate, and test all necessary capture facilities in preparation for passage evaluation activities,in 1993.

Tasks 2.1 Operate the bypass and holding pond facilities at Westland Dam.

We will operate the bypass and holding pond facilities in concert with irrigation district and trap and haul personnel to familiarize ourselves with the overall operation and ensure that the facilities operate as designed. We will test operate all systems and structures, including gates, pumps, fish separator, bypass inflow and outflow, the juvenile holding pond and associated sampling system, and the drum and traveling screens. All aspects of the day-to-day operation of the facility will be monitored. We will test operate the bypass facility when juvenile salmonids are migrating past Westland Dam. We will test operate the juvenile collection and holding system during trap and haul operations when river flow is low.

Rationale: We were not able to gain a thorough understanding of facility operation through extensive hands-on experience in 1991 because of limited staff and time constraints. Ability to conduct a successful evaluation is contingent on operational expertise due to the complexity and uniqueness of the Westland Canal system and juvenile facility.

Products: We plan to gain thorough knowledge of facility operation at Westland Dam and assurance of an efficient and properly functioning system that will be ready to evaluate after 1 October, 1992.

Schedule: We will familiarize ourselves with the system through hands-on operation during the 1992 spring, summer, and fall juvenile outmigration. A report of activities and findings will be completed by 30 September, 1992.

Task 2.2 Design, fabricate and test capture facilities necessary for conducting evaluation activities in 1993 at Westland Dam.

We will design and fabricate collection facilities to be used at the bypass outlet, downstream of the drum and traveling screens, and in the bypass channel in the Westland Canal. These capture facilities will be used in various injury and leakage tests in 1993. Traps will be similar in design to those used in evaluations at Three Mile Falls Dam.

We will test operate the collection facilities during the migration period of juvenile salmonids. We will release and recapture marked fish to evaluate the efficiency of the traps in capturing the majority of fish, and to ensure that the trapping process does not result in excess injury or mortality. A modified fyke net with floating live box has been fabricated and tested and will be used for capturing test fish in the juvenile holding pond. We will collect samples of river-run fish in these traps to determine if injury or mortality levels are obviously high.

Rationale: We were not able to satisfactorily complete bypass channel and bypass outlet capture facility design and fabrication due to structural complexities of the bypass system and "flood-caused" alteration of the river channel at the outlet.

Products: We will gain the ability to efficiently and effectively collect fish at defined locations in the canal and bypass system at Westland Dam; and to conduct tests to determine passage success of juvenile salmonids through the bypass system in the Westland Canal after 1 October, 1992. We will document high levels of injury or mortality of river-run fish.

Schedule: Traps will be designed and fabricated during spring 1992. Traps will be test operated during summer and fall 1992. A report of results will be completed by 30 September, 1992.

Objective 3 Determine if velocities at defined locations in the bypass systems at Three Mile Falls and Westland dams meet design criteria.

Task 3.1 Measure approach velocity in the bypass channel, and approach and sweep velocities through the traveling screen at Three Mile Fal Is Dam.

We will use an electromagnetic water current meter and record velocities (feet per second) at 0.2%, 0.5%, and 0.8% of water depth. Measurements will be taken at centerline and at the upstream and downstream edges of the traveling screen, and at the entrance to the bypass channel. The probe will be positioned parallel to the screen pointing upstream for recording sweeping velocities and pointed perpendicularly away from the screen for recording approach velocities. We will measure velocities at the traveling screen and at the entrance to the bypass channel during operation of the pumpback pump in tandem or individually and at varying gate openings of the river return drain pipe. We will also measure velocities in the bypass channel during a 25-cfs flow. Headwork elevation, canal flow and operating conditions, water depth, and time to measure will be noted.

Products: We will determine if velocity patterns meet design criteria at the bypass channel entrance and at defined locations in front of the traveling screen during varying operations of pumpback pumps and river return drain pipe gate in the WEID Canal at Three Mile Falls Dam.

Schedule: We will measure velocity patterns at defined locations in the WEID Canal during April and May 1992.

Task 3.2 Measure approach and sweep velocity at the drum screens, traveling screens, and entrance to the bypass channel at Westland Dam.

We will follow the same procedure as described in Task 3.1. We will take measurements during low, medium and high canal flows to determine if velocity patterns meet criteria at all operations. Drum screen velocity measurements will be taken close to the screens and at the centerline perimeter of the screens. Headworks elevation, canal flow and operating conditions, drum screen submerged depth, and traveling screen operations will be recorded.

Products: We will determine if velocity patterns meet design criteria at the drum screens, traveling screens and at the entrance to the bypass channel at Westland Dam at low, medium and high canal flows.

Schedule: We will measure velocity patterns at defined locations in the Westland Canal from April to June 1992.

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Appendix Table A-l. Activity schedule summary for evaluating juvenile salmonid passage facilities at Three Mile Falls and Westland dams, October 1991 through September 1992.

	Month											
Activity	**Ott**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Gear Preparation	—	—	—	—	—	—						
Study Design	—	—										
Task 1.1							—					
Task 1.2								—				
Task 1.3							—	—				
Task 1.4							—	—				
Task 1.5												
Task 1.6			—	—	—	—	—	—				
Task 2.1						—	—	—	—	—	—	—
Task 2.2				—	—	—	—	—	—	—	—	—
Task 3.1							—	—	—	—		
Task 3.2							—	—	—	—	—	—
Data Analysis									—	—		
Report Writing										—	—	—

REPORT C

1. **Examine the passage of adult salmonids at Three Mile Falls Dam**

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CONTENTS

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ABSTRACT

The confederated Tribes of the Umatilla Indian Reservation (CTUIR) monitored . river conditions (flow, water temperature, and turbidity) at Three Mile Falls Dam on the Umatilla River, from October, 1990 through June 1991; sampled adult and jack salmon from the east bank holding pond; installed, operated and reviewed video tapes from video recording equipment located at the east bank ladder viewing window and visually observed adult salmon movement through the ladder.

A total of 333 adult, 107 jack and 621 subjack fall chinook salmon, Oncorhvnchus tshawvtscha, 410 adult and 512 jack coho salmon, Oncorhvnchus kisutch, 1,291 adult and 39 jack spring chinook salmon, and 1,110 steelhead, Oncorhvnchus mykiss, were enumerated at Three Mile Falls Dam on the Umatilla River during the period October 1, 1990 through June 30, 1991. Variation in comparison of numbers of adult fall chinook and coho salmon enumerated with video equipment vs. counted through the holding pond exceeded 100%. Advanced maturation made species identification based on video tape difficult and/or impossible. The amount of movement back and forth in front of the video camera indicated that fish were having difficulty finding the entrance to the holding pond. This is not a serious problem unless fish are being injured during their search. Blocking of a one to two foot section of the lead gate (fish barrier grate) nearest the steep pass, which would separate the flows from the steep pass and lead gate, should permit salmonids to enter the steep pass more rapidly. The problem will not occur when Three Mile Falls Dam is operated in the by-pass mode.

Migration of fall chinook and coho salmon did not correlate with increasing flows, probably because flow levels remained low (150-250 CFS) throughout the period of migration. Increasing numbers of spring chinook salmon adults were enumerated after high flow events as the river flow dropped.

INTRODUCTION
BACKGROUND

Lack of water for upstream migration of adult salmonids in the Umatilla River has been documented as far back as 1902. The East Oregonian newspaper quoted "Present conditions of the Umatilla River (at Umatilla) are unprecedented. Scarcely any water is visible at this point. Private irrigation enterprise are blamed." Another report by F. B. Holbrock reports "fish hogs are killing off salmon running in the Lower Umatilla River by the thousands. The water is so low the fish are handicapped in moving upstream." The construction of Three Mile Falls Dam by the Bureau of Reclamation (BOR) in 1914 to divert water for irrigation appeared to be another major factor in the extinction of Umatilla River spring and fall chinook and coho salmon. Although a fish ladder was constructed, serious operational problems such as false attraction flows, channel obstruction and sedimentation of the ladder caused a barrier to salmonid migration at most water levels. Only indigenous steelhead have survived, probably because they were able to wait long periods of time until optimal water conditions permitted upstream migration to spawn. Construction of mainstem Columbia River hydroelectric dams, over fishing and degradation of spawning and rearing habitat have exacerbated the decline of salmonids migrating to and from the Umatilla River,

An aggressive program to reestablish spring and fall chinook salmon and coho salmon and supplement the steelhead population began approximately 10 years ago.

Modification to the Umatilla riverbed below Three Mile Fall8 Dam were made in 1984 and 1985 to aid passage at low water. The adult fish ladder at Three Mile Falls Dam was improved in 1987 and 1988 and included modified entrances, increased attraction flows, a ladder designed to prevent stranding and delays in the ladder steps and modified exit structures. Fish ladders have also been constructed at Westland and Cold Springs irrigation diversions.

The study reported here was designed to evaluate the passage of adult salmonids at Three Mile Dam Falls to ensure that adult passage facilities are operated as designed and any mortality that results from injury or delay due to the facility is documented and corrective actions recommended.

The major objective of the Adult Passage Evaluation Project was to examine the passage of adult salmonids through Three Mile Falls Dam at various water flows and to examine adult salmonid passage with the lead gate open and the denil steep pass turned off (camera enumeration'when salmonid are by-passed and not trapped and hauled).

A secondary objective was to determine passage of adult salmonids in the area up to 500 feet below Three Mile Falls Dam and the Maxwell, Westland, and Cold Springs irrigation diversions.

STUDY SITE

The Umatilla River in northeast Oregon drains an area of approximately 2290 square miles and discharges its flow into the mainetem Columbia River below McNary Dam. Average flow, based on monthly average flows from 1935-1978 at Umatilla are 428 CFS and range from 23 CFS during July to 1,096 CHF during April (CTUIR and ODFW 1990).

Major tributaries of the Umatilla River are Meacham, McKay, Birch, and Butter Creeks. Two storage reservoirs, McKay (73,800 AF) and Cold Springs (50,000 AF) were constructed primarily for irrigation, but also have value in flood control, fish, wildlife and recreation. Five irrigation diversion dams, Stanfield, Westland, Dillon, Maxwell and Three Mile Falls Dam were constructed to channel water to various irrigation districts.

Three Mile Falls Dam, constructed by the United States Bureau of Reclamation (USBR), in 1914 has a crest height of 24 feet and crest length of 915 feet. Construction of new fish passage facilities were completed in 1988 and included reconstruction of the east and west bank fish ladders to improve upstream migration of adult salmonids and construction of adult trapping and viewing facilities.

METHODS

Flow, turbidity and water temperature were monitored from October 1, 1990 though June 30, 1991 at Three Mile Falls Dam on the Umatilla River. Water temperature was recorded in degrees centigrade at the right bank facility at hourly intervals with a digital recording Ryan Tempmentor. Turbidity was determined with a secchi disk to the nearest one-tenth of a meter. Discharge date (preliminary) was obtained from the United States Geological *Survey*, who monitored and record flows (in cubic feet per second) at the Umatilla gage, approximately 1.5 km below the dam.

All salmonids passing upstream through the right bank (east) fish ladder at Three Mile Falls Dam were captured, enumerated, examined for marks, a portion sampled for age, sex and fork length and the remainder hauled upstream to be released in river or held for broodstock in conjunction with the Umatilla River trap and haul and artificial production projects.

Fall chinook salmon were categorized at Three Mile Falls Dam as adult if greater than 24" fork length, jack if between 18" and 24" fork length or subjack if less than 18" fork length. Coho salmon were classified as adult if 20" fork length or larger and jack if less than 20" fork length. Spring chinook salmon were classified as age 5 if 31" fork length or greater, age 4 if 24" to 30 7/8" fork length and age 3 if less than 24" fork length for sampling purposes, based on length vs. age data on spring chinook salmon collected at Bonneville Dam (Schwartzberg and Fryer, 1990).

Video equipment and techniques used to record salmonid migration at Three Mile Falls Dam were similar to those described by Kutchine (1990).

Carcass and prespawning mortality surveys were conducted below Three

Mile Falls Dam, from Westland to Maxwell diversions and above McKay Creek (partly conducted as a tribal and state general fisheries management activity).

RESULTS

Salmonid Enumeration

A total of 333 adult, 107 jack and 621 subjack fall chinook salmon, 410 adult and 512 jack coho salmon, 1,110 steelhead and 1,291 adult and 39 jack spring chinook salmon were enumerated at Three Mile Falls Dam trapping facility between October 1, 1990 and June 30, 1991 (Appendix 1). The adult fall chinook salmon returned from October 10 through December 6, 1990 with 89.5% of the migration being enumerated from October 29 through November 13. The adult coho salmon returned from October 15 through February 15 with 86.6% of the migration being enumerated between October 29 through November 13. Timing of adult fall chinook and coho salmon returning to Three Mile Falls Dam was similar in 1989 (Tables 1 & 2). The steelhead adult spawning migration through Three Mile Falls Dam occurred from October 19, 1990 through June 11, 1991 with 75.2% of the escapement being enumerated between February 1, 1990 and April 15, 1991. The timing of the 1989-1990 steelhead return to Three Mile Falls Dam was earlier as 74.8% of the return occurred from January 10 through March 31 (Table 3). The return of spring chinook salmon occurred from April 11 through June 24 and 82.5% of the fish returned from April 25 through May 29, 1991. Return timing was similar in 1990 (Table 4).

River Conditions

During 1990, as observed by Kutchins in 1989, there is not a correlation between stream flow and fall salmonid migration (Figure 1). The majority of the fall chinook and coho salmon migrated to Three Mile Falls Dam when flows were between 150-250 CFS and flows did not exceed 255 CFS during this period.

It appears that even at low flows salmonids would have little problem migrating up the Umatilla River to Three Mile Falls Dam. A much more serious consequence of low flow is that little attraction water is available for homing in the Umatilla River from the mainstem Columbia River. For example, average flows at the Umatilla gage are often less than 100 CFS in early October compared to lOO,OOO+ CFS on the mainstem Columbia River near Umatilla. It has been documented that adult fall chinook salmon have strayed from Umatilla juvenile releases (Rowan, 1991), even after short term acclimation at Bonifer or Minthorn. It appears that the low flows observed in the Umatilla River during October to mid-November (25-250 CFS) are probably the major factor in the straying observed for fall chinook salmon.

Peak movement of spring chinook salmon generally occurred as water levels declined after high flow events (Figure 2). A range in flow levels of 500-1,000 CFS during the spring chinook migration appears adequate to permit fish to home with a high degree of reliability. Little straying of adult spring chinook salmon has been documented (Rowan, 1991) from juveniles released in the Umatilla River.

Table 1. Return of adult fall-&i&ok. salmon to Three Mile Falls Dam' by week, 1989 and 1990

	1990				1989			
DATE	N	%	Accum %	X CFS	N	%	Accum %	X CFS
Oct. 8-14	1	.3	.3	68.6	28	10.0	10.0	196
15-21	5	1.5	1.8	118.9	12	4.3	14.3	236
22-28	1	.3	2.1	139.6	88	31.5	45.8	221
29-04	170	51.1	53.2	150.7	30	10.8	56.6	161
Nov. 05-11	53	15.9	69.1	232.0	47	16.8	73.4	153
12-18	81	24.3	93.4	220.	65	23.3	96.7	188
19-25	6	1.8	95.2	113.4	8	2.9	99.6	141
26-02	16	4.8	100	226.3	1	.4	100	102
Total	333				279			

Table -2.. Return of adult coho salmon to Three Mile Dam Falls by week 1989-1990.

	1990				1989			
Date	N	%	Accum %	X CFS	N	%	Accum %	X CFS
Oct 8-14	0	0	0	68.6	168	4.1	4.1	196
15-21	8	2.0	2.0	118.9	56	1.4	5.5	236
22-28	6	1.5	3.5	139.6	1171	28.5	34.0	221
29-4	212	51.7	55.2	150.7	161	3.9	37.9	161
Nov 5-11	48	11.7	66.9	232.0	651	15.9	53.8	153
12-18	110	26.8	93.7	220.0	1503	36.6	90.4	188
19-25	4	1.0	94.7	113.4	116	2.8	93.2	141
26-2	18	4.4	99.1	226.3	60	1.5	94.7	102
Dec 3-9	3	.7	99.8	206.3	124	3.0	97.7	107
< 10	1	.2	100.0		92	2.2	99.9	
Total	410				4102			

Table 3 . Return of Steelhead to Three Mile Falls Dam by two week period 1989-i 991.

	1990-1991				1989-I990			
Date	N	%	Accum %	X CFS	N	%	Accum %	X CFS
Oct 1-15	2	.2	.2	59.1	30	1.8	1.8	156
16-31	13	1.2	1.4	133.8	88	5.3	7.1	217
Nov 1-15	28	2.5	3.9	211.7	40	2.4	9.5	162
16-30	19	1.7	5.6	177.1	20	1.2	10.7	139
Dec 1-15	37	3.3	8.9	178.6	9	.5	11.2	106
16-31	9	.8	9.7	gage broken	2	.1	11.3	98
Jan 1-15	0	0	9.7	508.1	132	7.9	19.2	331
16-31	59	5.3	15.0	853.1	352	21.1	40.3	193
Feb 1-15	268	24.1	39.1	488.9	36	2.2	42.5	374
16-28	173	15.6	54.7	1261.5	185	11.1	53.6	598
Mar 1-15	104	9.4	64.1	788.3	217	13.0	66.6	835
16-31	89	8.0	72.1	610	326	19.5	86.1	755
Apr 1 -15	202	18.2	90.3	862	114	6.8	92.9	280
16-30	76	6.8	97.1	713	75	4.5	97.4	333
May 1-15	26	2.3	99.4	638	42	2.5	99.9	1064
16-31	7	.6	100.0	3214	0	0	99.9	
Totals	1112				1668			

Table 4. Return of adult spring chinook salmon to Three Mile Falls Dam by week, 1990-199i.

	1991				1990			
DATE	N	%	Accum %	X CFS	N	%	Accum %	X CFS
April 11-17	19	1.5	1.5	1068	4	.2	.2	77
18-24	44	3.4	4.9	695	2	.1	.3	38
25-01	219	17.0	21.9	689	182	8.4	8.7	961
May 02-08	147	11.4	33.3	589	888	41.1	49.8	137 6
09-15	391	30.3	63.6	658	499	23.1	72.9	246
16-22	107	8.2	71.8	5308	53	2.5	75.4	53
23-29	201	15.6	87.4	1868	130	6.0	81.4	48
30-05	81	6.3	93.7	513	311	14.4	95.8	981
June 06-12	56	4.3	98.0		69	3.2	99.0	545
13-19	24	1.9	99.9		18	.8	99.8	145
20-26	2	.2	100.1		2	.1	99.9	12

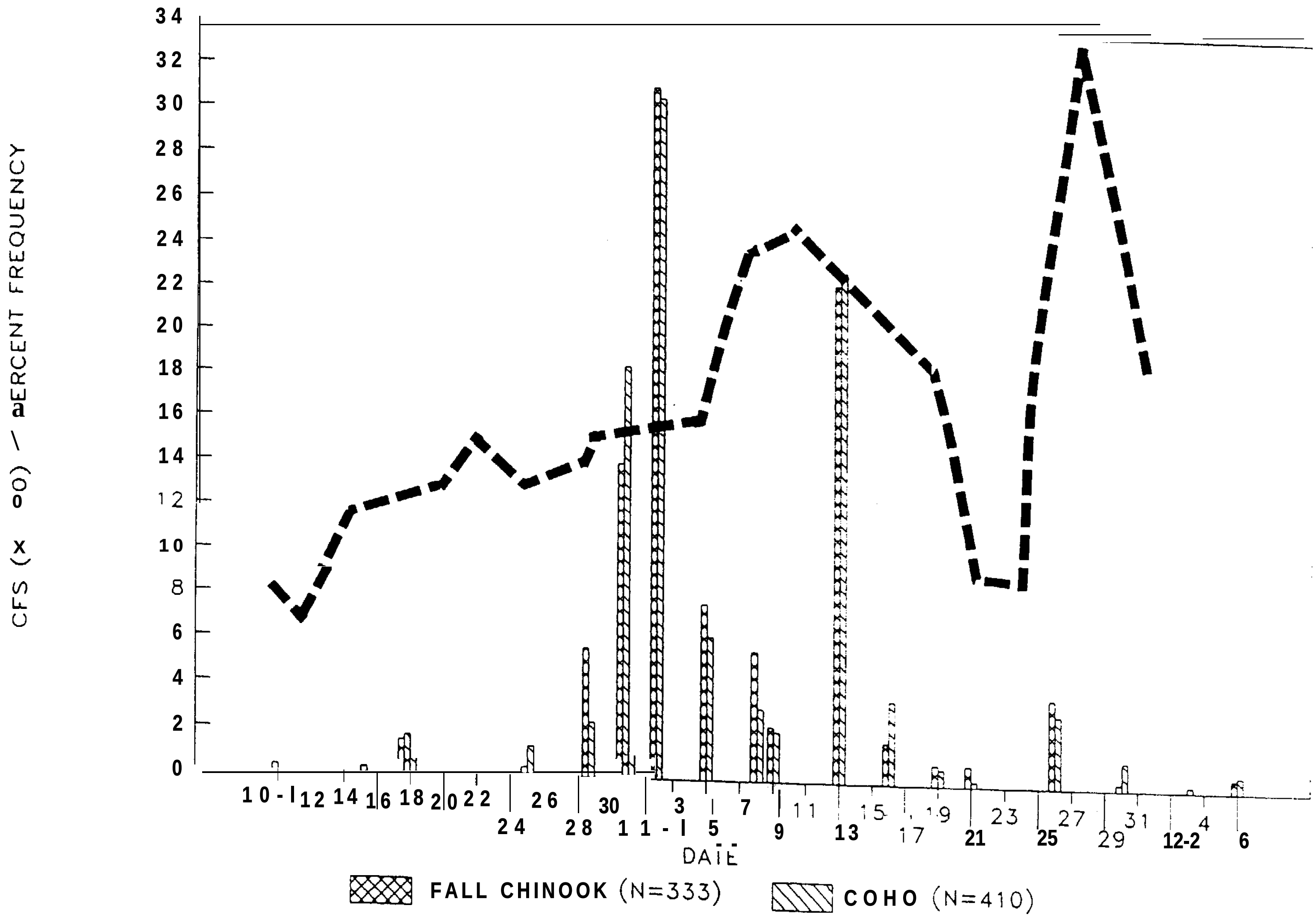

Figure.1. Percent frequency of adult fall chinook and coho salmon returning by day to Threemile Falls Dam on the Umatilla River compared to mean daily flows at the Umatilla guage, 1990..

Average daily water temperatures ranged from .5 c in December to 20.0 c during June (Appendix 2). Turbidity ranged from the clearest water in early May (2.OM) to the most turbid several weeks later during a major flood (.2M).

Video Data and Visual Observations

The fall chinook and coho salmon spawning migration was video taped at Three Mile Falls Dam during October through November, 1990. As observed during the spring chinook and steelhead salmon spawning migration during February through May of 1990 (Kutchins, 1990), the fall chinook and coho salmon moved upstream past the video recording window then back downstream of the window many times before finally moving upstream through the denil steep pass to the holding pond (Appendix 3). When the denil steep pass and holding pond are operated there is much more attraction water coming through the lead gate then the steep pass and fish are obviously having difficulty being attracted to the steep pass. This delay in entrance to the holding pond is probably not serious unless fish are physically injuring themselves during their search to migrate into the facility. During the 1991 spring chinook adult spawning migration a number of recent injuries were noted; however, it was unclear where these injuries were occurring. Blocking of a one or two foot section of the lead gate nearest the steep pass, which would separate the flows from the steep pass and lead gate should permit salmonids to enter the steep pass more rapidly.

Enumeration of the escapement of fall chinook and coho salmon at Three Mile Falls Dam by video camera during 1990 was extremely difficult because of these back and forth movements and advanced maturation of the fall chinook and coho salmon which made species identification difficult and/or impossible.

For example, during the period October 31 (2pm) through November 14, a total of 269 adult Coho, 232 adult fall chinook, 28 steelhead, 261 jack coho, 49 jack fall chinook and 335 subjack fall chinook were enumerated at the holding facility at Three Mile Falls Dam. Analysis of video tapes during this period indicated that 132 adult coho, 673 adult fall chinook, 64 steelhead and 883 unidentified fish were enumerated (Table 5). Variation in comparison of adult salmonid numbers by the two methods exceeded 100%.

Based on video counts from six twenty-four hour periods in October and November hourly movement of fall chinook salmon varied greatly from day to day (Table 6).

The west bank adult ladder and trap was operated for a three day evaluation period and several operational difficulties were noted. The ladder has exposed metal corner edging and keyways which could cause injuriee to returning adults. The spacing in the v-trap fingers may allow jacks and steelhead to escape upstream. The v-trap has to be closed each time the fish are to be crowded. The crowder does not have enough vertical lift to force fish into the lift system. The crowder foot and lift system entrance are too narrow. The lift system is completely enclosed which does not allow the fish being loaded to be observed anytime between exiting the pond and entering the truck. There are also no provisions for sorting or enumerating any fish that have been captured.

In addition, the flood of May 18-24 silted in the intake channels for

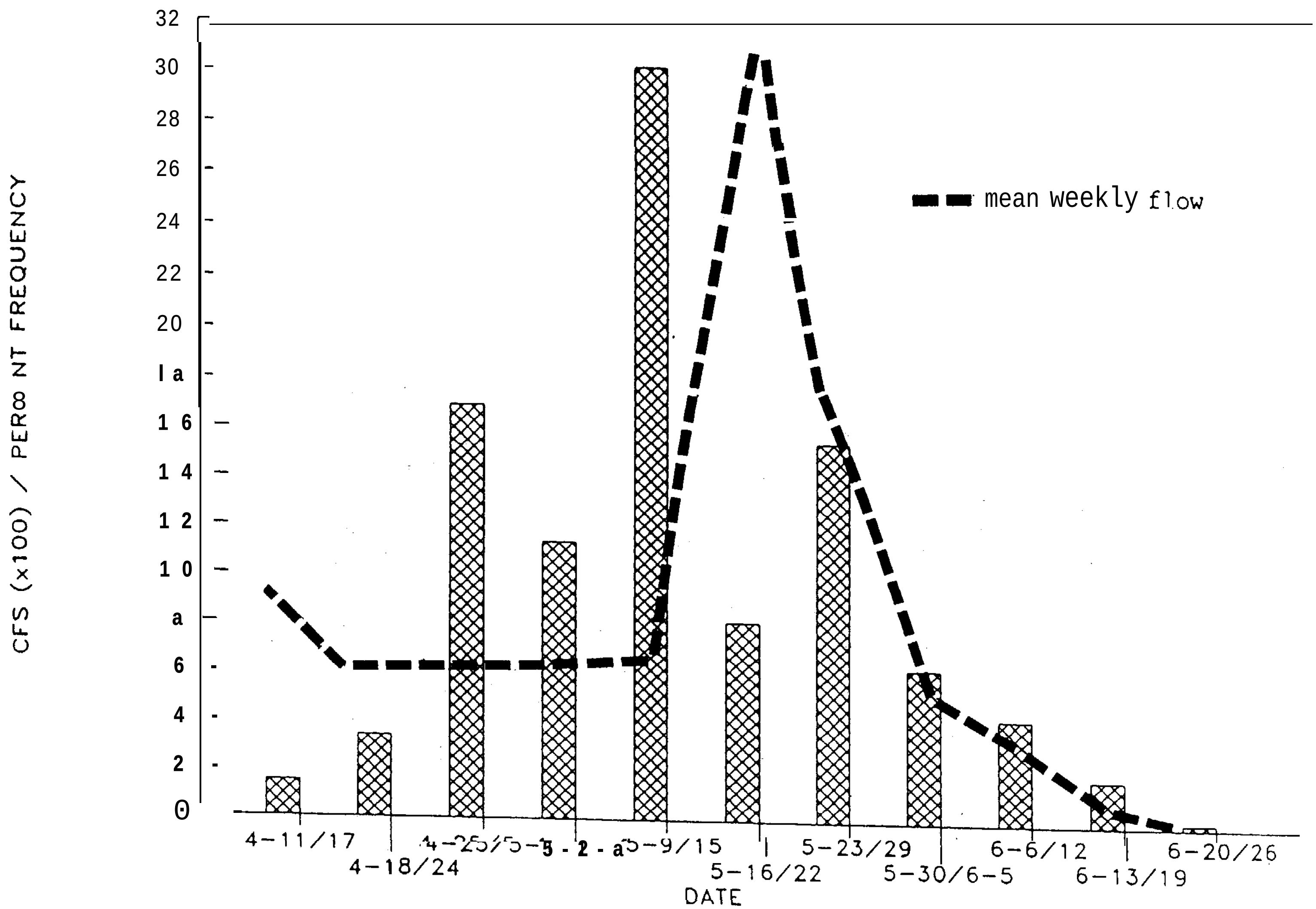

Figure 2. Percent frequency of adult spring chinook salmon returning by week to Threemile Falls Dam on the Umatilla River compared to mean weekly flow, 1991 (N = 1,291).

both the ladder, trap and attraction water. substantial dredging will be necessary to re-open the adult portion at the facility. In our opinion, the west bank facility should be operated in a swim through mode only after modifications are made to prevent possible injuries while passing the facility.

Two of the objectives, examination of the adult passage with the lead gate open and denil steep pase turned off and examination of passage at Maxwell, Westland and Cold Springs irrigation diversions were not accomplished because Three Mile Fall Dam was not operated in the fish by-pass mode, and flows remained below trap and haul criteria throughout the year (Olson, 1990).

Soawnina Ground Survevs

Four spawning ground surveys were conducted below Three Mile Falls Dam during November and December of 1990 to evaluate possible prespawning mortality and/or passage problems of fall chinook and coho salmon and to enumerate the escapement (Table 7).

Comparison of the enumerated escapement of adult fall chinook salmon through Three Mile Falls Dam with the number of fish observed during escapement surveys below Three Mile Falls Dam indicates that a minimum of 24.8% of the fall chinook return spawned below the dam. This appears to be a high percentage of the escapement to spawn in a marginal area (ie. mostly bedrock with a little available gravel) and indicates possible passage problems. However, the majority of the adult coded wire tag recoveries from the 1990 fall chinook escapement were from juvenile releases that occurred below Three Mile Falls Dam in 1986, and a v-notch was removed from the fish ladder on November 17, 1990 after it was discovered that very large fish were unable to pass through the opening. The v-notch has since been modified and now has an adjustment opening range of 3.0 to 8.0 inches.

Prespawning surveys of spring chinook salmon were conducted in late June through mid-July to determine if significant prespawning mortality was occurring in the Umatilla River. A total of 194 spring chinook salmon were observed in the Umatilla River and tributaries and an additional 73 were observed in the Tribal harvest. Four fish were observed with minor fungus, two were fungused severely (prespawning mortality eminent) and four mortalities were noted (Table 8).

Additional prespawning mortality surveys will be conducted in early to mid-August, 1991.

DISCUSSION

The objective of the video camera technology developed at Three Mile Falls Dam (Kutchine, 1990) wae to aid in current evaluation of the passage of adult salmonids and to evaluate if video camera technology could be utilized to accurately enumerate the various adult salmonid returns in the future, when the facility is operated in the by-pass mode.

The video camera study has shown that salmonids are having difficulty

Table 5. Preliminary video counts versus trap counts for Threemile Falls Dam, east bank 1990/1991.

	Video Tape Counts						Trap Counts								
Date	Tape	Coho	Chf	Sth	Unk	Total	Coho Adult	Coho Jack	Chf Adult	Chf Jack	Chf SubJack	Sth Total	Total Adult	Total SJ/Jk	Total
10/01/90	1	1	0	0	0	1									
10/02/90	1,2	22	0	0	2	24									
10/03/90	2	4	0	0	18	22									
10/04/90	2	0	2	0	3	5									
10/05/90	2,3	1	0	0	5	6	0	2	0	2	2	0	0	6	6
10/06/90	3	1	0	0	2	3									
10/07/90	3	0	0	0	2	2									
10/08/90	3,4	0	0	0	4	4									
10/09/90	4	0	0	1	0	1									
10/10/90	4	1	0	0	3	4	0	2	1	0	7	1	2	9	11
10/11/90	4,5	0	0	1	0	1									
10/12/90	5	0	0	0	11	11									
10/13/90	5	0	1	0	8	9									
10/14/90	5,6	0	0	0	5	5									
10/15/90	6	2	2	0	25	29	1	21	0	4	15	1	2	40	42
10/16/90	6	3	5	2	41	51									
10/17/90	6,7	3	1	0	46	50									
10/18/90	7	0	0	1	39	40	7	65	5	6	34	5	17	i05	122
10/19/90	7,8	0	0	0	45	45									
10/20/90	8	0	0	0	47	47									
10/21/90	8	0	0	1	34	35									
10/22/90	8,9	5	2	1	17	25	1	36	0	1	15	1	2	52	54
10/23/90	9	0	9	0	5	1 4									
10/24/90	9	8	4	0	2	14									
10/25/90	9,10	3	0	0	7	10	5	12	1	4	24	2	8	40	48
10/26/90	10	1	0	1	2	4									
10/27/90	11	3	11	0	9	23									
10/28/90	11	3	17	0	41	61									
10/29/90	11	14	21	4	140	179	10	14	19	13	60	2	31	87	118
10/30/90	11,12	18	124	5	142	209									
10/31/90	12	16	100	4	175	295	76	53	47	22	111	3	126	186	312

Table 5. (continued)

Date	Tape	Video Tape Counts: Coho	Chf	Sth	Unk	Total	Trap Counts: Coho Adult	Coho Jack	Chf Adult	Chf Jack	Chf SubJack	Sth Total	Total Adult	Total SJ/Jk	Total
11/01/90	12,13	25	141	29	138	333									
11/02/90	13	17	55	3	105	180	126	73	104	17	135	3	233	225	458
11/03/90	13,14	0	12	2	53	67									
11/04/90	14	1	10	1	62	74									
11/05/90	14	4	18	0	64	86	26	20	26	9	60	4	56	89	145
11/06/90	15'	2	17	1	63	83									
11/07/90	15	3	14	0	18	35									
11/08/90	15,16	0	16	0	6	22	13	19	19	7	42	1	33	68	101
11/09/90	16	12	65	6	58	141	9	10	8	2	13	2	19	25	44
11/10/90	16,17	20	138	5	102	265									
11/11/90	17	11	72	13	59	155									
11/12/90	17	21	59	1	34	115									
11/13/90	17,18	6	5	0	11	22	95	139	75	14	85	18	198	238	426
11/14/90	18	5	4	1	7	17									

Table 6. Percent frequency of fall chinook salmon migrating past the viewing window at Three Mile Falls Dam by four hour periods, 1990.

	DATE					
TIME	OCT. 30	OCT. 31	NOV. 01	NOV. 09	NOV. 10	NOV. 10
1-4 AM	5.6%	13.0%	14.9	0%	5.1	18.1
4-8 AM	14.5%	12.0%	18.4	3.0	10.9	30.6
8-12 AM	14.5%	17.0%	24.8	1.5	23.2	38.9
12-4 PM	21.8%	25.0%	9.9	13.8	16.7	8.3
4-8 PM	28.2%	19.0%	7.8	18.5	28.3	1.4
8-12 PM	15.3%	14.0%	24.1%	63.1	15.9	2.8
N=	124	100	141	65	138	72

Table 7. Spawning ground survey from 700 feet below Three Mile Falls Dam to river mouth backwater, 1990.

Redds				Live Fish				Dead Fish			
Date	Miles	Occ.	Unocc.	CHF	COH	Unid.	TOT.	CHF	COH	Unid.	Total
11/09	2.5	8	8	13	9	11	33	3 [A/]	1 [B/]	0	4
11/28	2.5	5	11	8	0	0	8	44 [C/]	1 [D/]	1	46
12/05	2.5	14	39	15	0	0	15	48 [E/]	2 [F/]	4	54
12/18	2.5	0	20	1	0	0	1	25 [G/]	1 [H/]	3	29
TOTAL	2.5	14	39	37	9	11	57	120	5	8	133

[A/] M:F = 03.0 (n=3); 3 spawned out, 0 prespawn morts; 0 jacks; 0 CWT, 0 snouts

[B/] M:F = 1:0 (n = 1); 1 spawned out, 0 prespawn morts; 1 jack; 0 CWT, 0 snouts

[C/] M:F = 1:1.1 (N = 38); 35 spawned out, 3 prespawn morts; 6 jacks; 16 CWT, 15 snouts

[D/] M:F = 0:1 (n = 1); 0 spawned out, 1 prespawn mort; 0 jacks; 0 CWT, 0 snouts

[E/] M:F = 1:2.6 (n = 47); 46 spawned out, 1 prespawn mort ; 1 jack ; 20 CWT, 20 snouts

[F/] 2 jacks

[G/] M:F = 1:2.1 (n = 22); 22 spawned out, 0 prespawn morts; 3 jacks; 6 CWT. 6 snouts

[H/] One female prespawn mortalitv

locating the steep pass entrance. This is not a serious problem unless injuries are occurring that cause prespawning mortality and will not occur when the facility is operated in the by-pass mode.

We feel that from the operational experience gained from this project, the return of steelhead and spring chinook salmon can accurately be determined utilizing video technology when Three Mile Falls Dam is operated in the by-pass mode. It appears that it will be many years before Three Mile Falls Dam will be operated in a by-pass mode because of evaluation of various enhancement strategies involving CWT sampling of returning adult salmonids and because minimum flow criteria for trap and haul usually are not exceed (Olson, 1990).

The video camera study also helped determine that the v-notch was to small to permit passage of large chinook salmon.

It is obvious that accurate enumeration of salmonids from video tapes of the fall adult salmonid return to the Umatilla River is difficult. Identification of fall chinook and coho salmon, which is the major problem, could possibly be apportioned by sampling at the holding pond. Biological data such as age, sex and size could be collected concurrently.

Suggestions for future operation of a video system when Three Mile Falls Dam is operated in the by-pass mode include: 1) back up system with alternative power supply for power outages; 2) close fish ladder during extremely turbid conditions (less that .2' secchi disk reading); 3) read tapes daily to trouble shoot potential problems.

The adult passage project should now concentrate on evaluating the passage of adult salmonids throughout the year, at various flow levels, from the lower Umatilla River, past all irrigation diversions and associated ladders. The Stanfield Dam ladder (to be operational in the Fall of 1992) will be the last of the four major adult passage facilities to be completed in the lower Umatilla River. Because of the relatively small numbers of adults anticipated to be released directly above Three Mile Dam in the near future, visual observations to evaluate passage would be very difficult. Evaluation should include definition of flow levels necessary for successful movement through the various diversions and injuries and/or prespawning morality associated with migration. Radio tagging is recommended, with a feasibility study being conducted during 1991-1992. The pilot radio tagging project should develop capture, handling, tagging, and radio tag monitoring techniques. Additional fish should be captured and marked at various locations at and below Three Mile Falls Dam. Comparison of recovery percentages at Three Mile Falls Dam and observations on injuries should aid in determination of where injuries observed at Three Mile Falls Dam are occurring. A large scale radio tagging and tracking study in 1992 and 1993 should follow the feasibility study in order to evaluate adult salmonid passage throughout the entire lower Umatilla River.

The passage project may then be able to better define criteria for trap and haul by determining flow requirements for passage and timing from Three Mile Falls Dam upstream through the various irrigation diversions.

Additionally the passage projects should collect all available timing

data associated with Umatilla River fall chinook salmon throughout the Columbia River in an attempt to determine the timing of peak abundance at the Umatilla River mouth. The proper release timing and amount of McKay Reservoir water released for fish migration in the future may be critical to minimize straying of Umatilla River fall chinook salmon.

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Table	Observations of Prespawning Spring Chinook Salmon in the Urnatiiia River, 1991.
June 14 - 30, 1991	Sport harvest observed by David Wolf. 73 fish observed - 3 with minor fungus, most in good shape
June 24, 199 1	Westiand Trap - A five year old spring chinook mortality -head and gills completely fungused
June 27, 199 1	Westiand to Dillon Dam - No adult chinook observed - viewing conditions fair to poor - water turbid
June 28, 1991	Five year old adult male killed in Maxwell Canal by moss killer - no fungus or injuries on fish
June 28, 1991	Three Mile Fails Dam to 300 yards above highway bridae crossinq - viewing conditions excellent - no chinook observed
June 28, 1991	Westland Trap - female coded wire tag mortality. Fish looked ok - no fungus or injury
July 02, 1991	North Fork of Umatilla - walked 1.5 miles - no chinook observed South Fork - Checked holes - no chinook observed Mainstem Umatilia - Corporation to Bar M Hole - observed three fish - ail in good shape
July 03, 1991	Umatiila - Bar M to Ciarks Bridge - eleven adults observed - one was blind and completely fungused head and one with skin on head gone - neither would have survived to spawn Clarks Bridge to Elephant Rock - nine adults observed - all in good shape
July 08, 1991	Elephant Rock to Grays Property - observed six fish - all in good shape Gravs Prooertv to Meacham Creek - observed five fish - all in good shape Meacham Creek to Sauaw Creek- observed fifty fish - all ok - some turning red
July 09. 1991	Squaw Creek to Thornhollow Bridge - observed fourteen fish - one fungused on tip of tail Thornhollow Bride to Thornhollow Railroad Bridge - observed sixty-five fish - ail in good shape
July 10, 1991	Boston Canvon Creek mouth to Meacham Mouth - observed two fish - all in good shape Thornhollow Railroad Bridge to Cavuse - observed five fish - all in good shape Cavuse to Minthorn - female 34" mortality, no adipose clip - good looking fish - no fungus or injury
July 11'1991	Meacharn above Boston Canvon - observed 20 fish - all in good shape - no fungus or injury
July 12, 1991	Minthorn to McKav Creek Mouth - suckers only - water warm

NOTE: Water was extremely turbid in the Umatilla River: below McKay Creek mouth to Westland as the result of the May flood and McKay water releases.

Appendix 1. Spring chinook returns to Threemile Falls Dam (right bank) on the Umatilla River in 1991.

	Number Trapped						Disposition							
	Adult			Jack			Sacrificed		Trap Morts		Brood		Hauled Upstream	
Date	Ad clip	No mark	Total	Ad clip	No mark	Total	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack
4-11	0	1	1	0	0	0	0	0	0	0	0	0	1	0
4-12	0	1	1	0	0	0	0	0	0	0	0	0	1	0
4-13	1	1	2	0	0	0	1	0	0	0	0	0	1	0
4-14	1	1	2	0	0	0	0	0	0	0	0	0	2	0
4-15	2	1	3	0	0	0	0	0	0	0	0	0	3	0
4-16	2	3	5	0	0	0	0	0	0	0	0	0	5	0
4-17	2	3	5	0	0	0	0	0	0	0	0	0	5	0
4-18	1	6	7	0	0	0	0	0	0	0	0	0	7	0
4-19	6	4	10	0	0	0	0	0	0	0	0	0	10	0
4-20	1	3	4	0	0	0	0	0	0	0	0	0	4	0
4-22	8	13	21	0	0	0	1	0	0	0	0	0	20	0
4-23	0	2	2	0	0	0	0	0	0	0	0	0	2	0
4-25	12	14	26	0	0	0	1	0	0	0	0	0	25	0
4-26	11	24	35	0	0	0	0	0	0	0	0	0	35	0
4-27	17	22	39	1	0	1	2	1	0	0	0	0	37	0
4-28	9	11	20	0	0	0	0	0	0	0	0	0	20	0
4-29	18	22	40	0	0	0	2	0	0	0	0	0	38	0
4-30	11	7	18	0	0	0	7	0	0	0	0	0	11	0
APRIL TOTAL	102	139	241	1	0	1	14	1	0	0	0	0	227	0
5-1	21	20	41	0	0	0	10	0	0	0	0	0	31	0
5-2	19	16	35	0	0	0	9	0	0	0	0	0	26	0
5-3	14	5	19	0	0	0	7	0	0	0	0	0	12	0
5-4	22	19	41	0	0	0	10	0	0	0	0	0	31	0
5-5	12	11	23	0	0	0	7	0	0	0	0	0	16	0
5-6	5	7	12	0	1	1	2	0	0	0	0	0	10	1
5-7	0	3	3	0	0	0	0	0	0	0	0	0	3	0
5-8	5	9	14	0	0	0	2	0	0	0	0	0	12	0
5-9	32	24	56	0	0	0	14	0	0	0	0	0	42	0
5-10	29	34	63	0	0	0	14	0	0	0	0	0	49	0
5-11	43	39	82	0	0	0	21	0	0	0	0	0	61	0
5-12	51	33	84	0	0	0	19	0	0	0	0	0	65	0
5-13	22	18	40	1	0	1	6	1	0	0	0	0	34	0
5-14	25	11	36	1	0	1	4	1	0	0	0	0	32	0
5-15	18	12	30	0	0	0	5	0	0	0	0	0	25	0
5-16	21	12	33	0	2	2	6	0	1	0	0	0	26	2
5-17	15	13	28	1	0	1	4	1	1	0	0	0	23	0

Revised: S-19-91 CTUIR File Name: D:/123R2/DATA/SUMCHS91

Appendix 1. (cont.)

	Number Trapped						Disposition							
	Adult			Jack			Sacrificed		Trap Morts		Brood		Hauled Upstream	
Date	Ad clip	No mark	Total	Ad clip	No mark	Total	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack
5-18	21	9	30	1	0	1	4	1	0	0	0	0	26	0
5-19	7	6	13	0	0	0	0	0	0	0	0	0	13	0
5-20	1	2	3	0	0	0	0	0	0	0	0	0	3	0
a/														
5-24	7	5	12	1	0	1	0	1	0	0	0	0	12	0
5-25	22	8	30	0	1	1	9	0	0	0	0	0	21	1
5-26	41	18	59	4	1	5	14	4	0	0	0	0	45	1
5-27	27	25	52	5	2	7	6	5	0	0	0	0	46	2
5-28	14	18	32	2	0	2	3	2	0	0	0	0	29	0
5-29	9	7	16	2	0	2	2	2	0	0	0	0	14	0
5-30	11	9	20	0	0	0	0	0	0	0	0	0	20	0
5-31	8	7	15	0	0	0	3	0	0	0	0	0	12	0
MAY TOTAL	522	400	922	18	7	25	181	18	2	0	0	0	739	7
6-1	9	7	16	1	0	1	1	0	0	0	0	0	15	1
6-2	6	4	10	2	1	3	0	2	0	0	0	0	10	1
6-3	5	2	7	0	0	0	0	0	0	0	0	0	7	0
6-4	3	10	13	0	0	0	0	0	0	0	0	0	13	0
6-6	0	1	1	0	0	0	0	0	1	0	0	0	0	0
6-7	4	3	7	0	0	0	0	0	0	0	0	0	7	0
6-9	14	11	25	3	1	4	4	3	0	0	0	0	21	1
6-10	2	11	13	2	0	2	0	2	0	0	0	0	13	0
6-11	6	4	10	0	0	0	0	0	1	0	0	0	9	0
6-12	1	0	1	0	0	0	0	0	1	0	0	0	0	0
6-14	4	4	8	0	0	0	1	0	0	0	0	0	7	0
6-17	3	7	10	1	0	1	0	1	0	0	0	0	10	0
6-19	2	3	5	1	1	2	0	1	0	0	0	0	5	1
6-24	0	2	2	0	0	0	0	0	0	0	0	0	2	0
JUNE TOTAL	59	69	128	10	3	13	6	9	3	0	0	0	119	4
CUM. TOTAL	683	608	1291	29	10	39	201	28	5	0	0	0	1085	11

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a/ The trap was shut down from 5-21 to 5-23 due to flood conditions.

Appendix 1. Summer steelhead returns to Threemile Falls Dam (right bank) on the Umatilla River in 1990-1991.

	Number Trapped				Disposition				
DATE	LV clip	Ad clip	No mark	Total	Sacrificed	Trap Morts	Brood	Released a Dam	Hauled Upstream
10-05	0	0	0	0	0	0	0	0	0
10-10	0	0	1	1	0	0	0	0	1
10-15	0	0	1	1	0	0	0	0	1
10-18	0	0	5	5	0	0	0	0	5
10-22	0	0	1	1	0	0	0	0	1
10-25	0	0	2	2	0	0	0	0	2
10-29	0	0	2	2	0	0	0	0	2
10-31	1	1	1	3	0	0	1	0	2
	---	---	---	---	---	---	---	---	---
OCT TOTAL	1	1	'13	15	0	0	1	0	14
11-2	0	0	3	3	0	0	3	0	0
11-5	0	0	4	4	0	0	2	0	2
11-8	0	1	0	1	0	0	0	0	1
11-9	0	0	2	2	0	0	1	0	1
11-13	2	1	15	18	0	0	6	0	12
11-16	0	1	5	6	0	0	0	0	6
11-19	0	0	2	2	0	0	0	0	2
11-21	0	0	1	1	0	0	D	0	1
11-26	1	0	5	6	0	0	1	0	5
11-30	0	0	4	4	0	0	0	0	4
	---	---	---	---	---	---	---	---	---
NOV TOTAL	3	3	41	47	0	0	13	0	34
12-3	0	2	9	11	0	0	0	0	11
12-6	1	0	6	7	0	0	1	0	6
12-10	0	0	9	9	0	0	0	0	9
12-13	0	5	5	10	0	0	5	0	5
12-17	0	0	3	3	0	0	0	0	3
12-26	0	0	0	0	0	0	0	0	0
12-27	2	0	4	6	0	0	2	0	4
12-31	0	0	0	0	0	0	0	0	0
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DEC TOTAL	3	7	36	46	0	0	a	0	38

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Appendix 1 . (cont.)

	Number Trapped				Disposition				
DATE	LV clip	Ad clip	No mark	Total	Sacrificed	Trap Horts	Brood	Released @ Dam	Hauled Upstream
1-3	0	0	0	0	0	0	0	0	0
1-8	0	0	0	0	0	0	0	0	0
1-11	0	0	0	0	0	0	0	0	0
1-14	0	0	0	0	0	0	0	0	0
1-16	0	0	4	4	0	0	0	0	4
1-22	2	0	44	46	0	0	6	0	40
1-25	0	0	5	5	0	0	0	'0	5
1-28	0	2	2	4	0	0	0	0	4
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JAN TOTAL	2	2	55	59	0	0	6	0	53
2-1	0	0	4	4	0	0	2	0	2
2-4	5	4	36	45	0	0	5	0	40
2-6	19	11	80	110	1	0	28	0	81
2-7	4	5	19	28	1	0	15	0	12
2-8	0	3	7	10	0	0	0	0	10
2-11	0	2	12	14	0	0	7	0	7
2-13	2	2	6	10	0	0	2	0	8
2-15	5	6	36	47	0	0	9	0	38
2-17	3	1	18	22	0	0	3	0	19
2-19	2	3	22	27	0	0	2	0	25
2-21	11	11	21	43	0	0	21	0	22
2-22	5	9	13	27	3	0	2	0	22
2-25	6	10	12	28	0	0	9	0	19
2-27	11	4	10	25	0	0	11	0	14
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FEB TOTAL	73	71	296	440	5	0	116	0	319
3-1	2	10	15	27	0	0	7	0	20
3-4	1	10	5	16	0	0	9	0	7
3-6	1	5	21	27	0	0	1	0	26
3-a	2	0	1	3	0	0	2	0	1
3-11	3	4	11	18	0	0	7	0	11
3-15	3	2	8	13	0	0	4	0	9
3-18	0	2	6	8	0	0	2	0	6
3-20	1	3	2	6	0	0	1	0	5
3-22	3	5	10	18	2	0	0	0	16
3-25	3	6	15	24	3	0	0	0	21
3-27	2	5	5	12	2	0	0	0	10
3-29	3	8	10	21	3	0	6	0	12
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MARCH TOTAL	24	60	109	193	10	0	39	0	144

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Appendix 1 . (cont.)

DATE	Number Trapped LV clip	Ad clip	No mark	Total	Disposition Sacrificed	Trap Morts	Brood	Released @ Dam	Hauled Upstream
4-1	5	20	34	59	5	2	0	0	52
4-3	1	3	10	14	1	0	6	0	7
4-4	1	1	8	10	1	0	0	0	9
4-5	0	7	8	15	0	0	0	0	15
4-6	0	7	3	10	0	0	0	0	10
4-7	1	4	4	9	1	0	0	0	8
4-8	2	1	6	9	2	0	0	0	7
4-9	0	2	2	4	0	0	1	0	3
4-10	0	2	6	8	0	0	6	0	2
4-11	1	0	6	7	1	0	1	0	5
4-12	4	6	7	17	4	1	0	0	12
4-13	0	6	8	14	0	0	0	0	14
4-14	1	9	7	17	1	0	0	0	16
4-15	2	2	5	9	2	0	0	0	7
4-16	1	0	1	2	1	0	0	0	1
4-17	2	0	5	7	2	0	0	0	5
4-18	0	2	0	2	0	0	0	0	2
4-19	2	3	7	12	2	0	3	0	7
4-20	0	3	6	9	0	0	0	0	9
4-22	1	2	10	13	1	1	2	0	9
4-23	1	2	2	5	1	0	0	0	4
4-25	0	3	4	7	0	0	0	0	7
4-26	0	1	2	3	0	0	0	0	3
4-27	1	2	2	5	1	0	0	0	4
4-28	1	0	4	5	1	0	0	0	4
4-29	0	3	2	5	0	0	0	0	5
4-30	0	0	1	1	0	0	0	0	1
APRIL TOTAL	27	91	160	278	27	4	19	0	228
5-1	0	0	1	1	0	0	0	0	1
5-2	1	3	1	5	1	0	0	0	4
5-3	0	2	0	2	0	0	0	0	2
5-4	0	0	3	3	0	0	0	0	3
5-5	0	0	0	0	0	0	0	0	0
5-6	0	0	1	1	0	0	0	0	1
5-7	0	0	0	0	0	0	0	0	0
5-8	0	1	0	1	0	0	0	0	1
5-9	0	0	1	1	0	0	0	0	1
5-10	1	0	0	1	1	0	0	0	0
5-11	2	1	0	3	2	0	0	0	1
5-12	0	4	0	4	0	0	0	0	4

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Appendix 1. (cont.)

DATE	Number Trapped: LV clip	Ad clip	No mark	Total	Disposition: Sacrificed	Trap Morts	Brood	Released @ Dam	Hauled Upstream
5-13	0	1	0	1	0	0	0	0	1
5-14	0	0	3	3	0	0	0	0	3
5-15	0	0	0	0	0	0	0	0	0
5-16	0	0	0	0	0	0	0	0	0
5-17	1	0	0	1	1	0	0	0	0
5-18	0	0	0	0	0	0	0	0	0
5-19	0	0	0	0	0	0	0	0	0
5-20	0	0	0	0	0	0	0	0	0
5-24	0	0	1	1	0	0	0	0	1
5-25	0	0	1	1	0	0	0	0	1
5-26	1	0	0	1	1	0	0	0	0
5-27	0	1	0	1	0	0	0	0	1
5-28	0	0	0	0	0	0	0	0	0
5-29	0	0	0	0	0	0	0	0	0
5-30	0	0	0	0	0	0	0	0	0
5-31	0	0	1	1	0	0	0	0	1
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MAY TOTAL	6	13	13	32	6	0	0	0	26
CUMM TOTAL	139	248	723	1110	48	4	202	0	856

Revised: 6-2-91 CTUIR File Name: D:/123R2/DATA/SUMSTS90

Appendix 1. Coho salmon returns to Threemile Falls Dam (right bank) on the Umatilla River in 1990.

	NUMBER TRAPPED						DISPOSITION						
	Adult (20"+)			Jack (< 20")			Sacrificed		Trap Mort		Hauled	Upstream	Released at Dam
DATE	Ad clip	No clip	Total	Ad clip	No clip	Total	Adult	Jack	Adult	Jack	Adult	Jack	Jack
10/01													
10-05	0	0	0	0	2	2	0	0	0	0	0	2	0
10-10	0	0	0	0	2	2	0	0	0	0	0	2	0
10-15	0	1	1	2	19	21	0	2	0	0	1	19	0
10-18	1	6	7	5	60	65	1	5	0	0	6	52	8
10-22	1	0	1	8	28	36	1	8	0	0	0	0	28
10-25	0	5	5	2	10	12	0	2	0	0	5	0	10
10-29	0	10	10	1	13	14	0	1	0	0	10	0	13
10-31	3	73	76	7	46	53	3	7	1	0	72	0	46
OCT TOTAL	5	95	100	25	180	205	5	25	1	0	94	75	105
11-2	16	110	126	5	68	73	16	5	0	0	110	0	68
11-5	2	24	26	3	17	20	2	3	0	0	24	0	17
11-8	5	8	13	2	17	19	5	2	0	0'	8	1	16
11-9	2	7	9	3	7	10	2	2	0	0	7	1	7
11-13	10	85	95	18	121	139	10	18	0	0	85	2	119
11-16	3	12	15	2	23	25	3	2	0	0	12	0	23
11-19	0	3	3	0		11	0	0	0	1	3	0	0
11-21	0	1	1	0	0	0	0	0	0	0	1	0	0
11-26	2	11	13	4	14	18	2	4	0	0	11	0	14
11-30	0	5	5	0		11	0	0	0	0	5	0	1
NOV TOTAL	40	266	306	37	269	306	40	36	0	1	266	4	265
12-3	0	1	1	0	0	0	0	0	0	0	1	0	0
12-6	0	2	2	0	0	0	0	0	0	0	2	0	0
DEC TOTAL	0	3	3	0	0	0	0	0	0	0	3	0	0
JAN TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0
2-6	0	0	0	0	1	1	0	0	0	0	0	1	0
2-15	0	1	1	0	0	0	0	0	0	0	1	0	0
FEB TOTAL	0		11	0	1	1	0	0	0	0	1	1	0
CUMM TOTAL	45	365	410	62	450	512	45	61	1	1	364	80	370

Revised: 3-7-91 CTUIR File Name: 123R2/DATA/SUMCOH90

Appendix 1. Fall chinook salmon returns to Threemile Falls Dam (right bank) on the umatilla River in 1990.

	NUMBER TRAPPED									DISPOSITION						
	Adult (>24")			Jack (18"-24")			Subjack (<18")			Sacrificed			Hauled Upstream			Released at Dam
DATE	Ad clip	No clip	Total	Ad clip	No clip	Total	Ad clip	No clip	Total	Adult	Jack	Subjack	Adult	Jack	Subjack	Subjack
10/01																
10-05	0	0	0	2	0	2	0	2	2	0	2	0	0	0	2	0
10-10	1	0	1	0	0	0	0	7	7	1	0	0	0	0	7	0
10-15	0	0	0	1	3	4	1	14	15	0	1	1	0	3	14	0
10-18	3	2	5	1	5	6	0	34	34	3	1	0	2	5	34	0
10-22	0	0	0	0	1	1	0	15	15	0	0	0	0	1	0	15
10-25	0	1	1	0	4	4	0	24	24	0	0	0	1	4	0	24
10-29	6	13	19	2	11	13	5	55	60	6	2	4	13	11	0	56
10-31	26	21	47	5	17	22	2	109	111	27	5	2	20	17	0	109
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OCT TOTAL	36	37	73	11	41	52	8	260	268	37	11	7	36	41	57	204
11-2	52	52	104	2	15	17	0	135	135	52	2	0	52	15	2	133
11-5	15	11	26	3	6	9	1	59	60	15	3	1	11	6	0	59
11-8	6	13	19	0	7	7	0	42	42	6	0	0	13	7	0	42
11-9	6	2	8	1	1	2	0	13	13	6	1	0	2	1	0	13
11-13	35	40	75	1	13	14	1	84	85	35	1	1	40	13	0	84
11-16	3	3	6	1	3	4	0	11	11	3	1	0	3	3	0	11
11-19	1	2	3	0	1	1	0	3	3	1	0	0	2	1	0	3
11-21	2	1	3	0	0	0	0	0	0	2	0	0	1	0	0	0
11-26	7	6	13	0	1	1	0	4	4	7	0	0	6	1	0	4
11-30	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
NOV TOTAL	128	130	258	8	47	55	2	351	353	128	8	2	130	47	2	349
12-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12-6	0	2	2	0	0	0	0	0	0	0	0	0	2	0	0	0
12-10/31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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OEC TOTAL	0	2	2	0	0	0	0	0	0	0	0	0	2	0	0	0
CUMM TOTAL	164	169	333	19	88	107	10	611	621	165	19	9	168	88	59	553

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Appendix 2. Three Mile Falls Dam Trap Data Right-Bank, 1990-1991 (adults only)

DATE	MEAN DAILY [a] FLOW (cfs)	MEAN DAILY TEMP (C)	SECCHI DISK (M)	COH	CHF	STS	CHS
10/10/90	81	13.4			1	1	
10/15/90	99	12.9	1.1	1	0	1	
10/18/90	125	11.4	1.9	7	5	5	
10/22/90	124	10.7	1.4	1		1	
10/25/90	146	10.7	1.3	5	1	2	
10/29/90	137	11.6	1.2	10	19	2	
10/31/90	150	11.9	1.2	76	47	3	
11/02/90	154	9.9	1.2	126	104	3	
11/05/90	161	9.7	1.3	26	26	4	
11/08/90	242	8.5	1.0	13	19	1	
11/09/90	239	9.6	1.1	9	a	2	
11/13/90	236	9.5	1.1	95	75	18	
11/16/90	213	7.9	1.0	15	6	6	
11/19/90	191	7.5	1.7	3	3	2	
11/21/90	99	7.1	1.1	1	3	1	
11/26/90	141	8.8	1.3	13	13	6	
11/30/90	182	5.8		5	1	4	
12/03/90	167	5.1		1		11	
12/06/90	98	5.6	1.5	2	2	7	
12/10/90	104	6.2	1.4			9	
12/13/90	422	4.6	1.0			10	
12/17/90	206	4.7	1.5			3	
12/27/90	NA	.5				6	
01/16/91	3140	4.5				4	
01/22/91	779	2.1				46	
01/25/91	377	2.8				5	
01/28/91	199	2.5				4	

Appendix 2. Three Mile Falls Dam Trap Data Right-Bank, 1990-1991 (adults only).

02/01/91	190	3.0				4	
02/04/91	145	7.2				45	
02/06/91	181	8.0				110	
02/07/91	388	7.1	1.0			28	
02/08/91	459	6.0	.8			10	
02/11/91	505	5.7	1.1			14	
02/13/91	461	6.8	1.1			10	
02/15/91	2080	7.7				47	
02/17/91	1770	7.1	.4			22	
02/19/91	1210	6.5	.4			27	
02/21/91	1300	8.1	.6			44	
02/22/91	1610	8.1	.4			27	
02/25/91	1020	6.4	.8			28	
02/27	758	6.9	.9			25	
03/01/91	619	7.1	1.1			27	
03/04/91	721	8.1	1.0			16	
03/06/91	1110	6.0	.6			27	
03/08/91	945	6.3	.9			3	
03/11/91	752	7.0	.8			18	
03/15/91	730	7.0	1.0			13	
03/18/91	536	7.8	1.2			8	
03/20/81	491	8.1	1.6			6	
03/22/91	464	9.2	1.1			18	
03/25/91	609	8.5	1.1			24	
03/27/91	770	7.8	.5			12	
03/29/91	823	7.5	.9			21	
04/01/91	627	12.7	1.3			59	
04/03/91	788	10.2	1.0			14	
04/04/91	754	9.7	1.3			10	
04/05/91	704	10.9	1.3			15	
04/06/91	793	10.3				10	
04/07/91	773	10.1				9	
04/08/91	639	9.5	1.3			9	

Appendix 2. Three Mile Falls Dam Trap Data Right-Bank, 1990-1 991 (adults only).

04/09/91	529	10.3	1.6			4	
04/10/9	1 993	9.0	1.3			8	
04/11/91	1 1 6 0	a.3	1.3			I	1
04/12/91	1 1 5 0	9.8	1.9			17	1
04/13/91	1 1 6 0	10.4	1.3			14	2
04/14/91	1 1 3 0	10.8				17	2
04/15/91	1050	10.0				9	3
04/16/91	960	9.4	1.3			2	5
04/17/91	869	10.3				7	5
04/18/91	807	11.2	2.0			2	7
04/19/91	700	12.4	1.6			12	10
04/20/91	648	13.1	1.6			9	4
04/22/91	657	14.4	1.9			13	21
04/23/91	684	14.1	1.3			5	2
04/25/91	787	11.6	1.3			7	26
04/26/91	673	10.7				3	35
04/27/91	576	10.9				5	39
04/28/91	555	11.1				5	20
04/29/91	602	10.8				5	40
04/30/91	810	12.0	1.6			1	18
05/01/91	823	12.9	1.9			1	41
05/02/91	791	13.2				5	35
05/03/91	685	13.4	2.0			2	19
05/04/91	570	14.7	1.9			3	41
05/05/91	464	15.1	2.0			0	23
05/06/91	395	14.3	2.0			1	12
05/07/91	584	13.5				0	3
05/08/91	634	13.6				1	14
05/09/91	1020	11.7				1	56
05/10/91	779	11.5				1	63
05/11/91	687	12.5				3	82
5/1 2/91	612	13.6	1.3			4	a4
5/13/91	556	13.0	1.9			1	40

Appendix 2. Three Mile Falls Dam Trap Data Right-Bank, 1990-1991, (adults only).

05/14/91	498	13.4				3	36
05/15/91	467	14.7				0	30
05/16/91	499	15.7				0	33
05/17/91	625	14.4				1	28
05/18/91	2260	11.7	.6			0	30
05/19/91	4610	11.5	.3			0	13
05/20/91	12500	11.1				0	3
05/24/91	2730	13.3	.2			1	12
05/25/91	2130	12.5	.6			1	30
05/26/91	1730	12.9	.15			1	59
05/27/91	1220	14.3	.3			1	52
05/28/91	884	15.7					32
05/29/91	650	16.2	.4				16
05/30/91	539	15.4					20
05/31/91	657	15.2				1	15
06/01/91	611	17.0	1.1				16
06/02/91	513	18.4					10
06/03/91	418	17.4	.4				7
06/04/91	342	16.5					13
06/06/91		16.6					1
06/07/91		16.8	.9				7
06/09/91		17.9	.3				25
06/10/91		19.6	.4				13
06/11/91		20.0	.7			1	10
06/12/91		18.0					1
)6/14/91		16.6	.8				8
)6/17/91		17.7	1.2				10
)6/19/91		17.5					5
)6/24/91		18.2					2

Appendix 3. Enumeration of Salmonids from video tape at Three Mile Falls Dam, 1990.

DATE	COHO		FALL CHINOOK		STEELHEAD	
	# UP	# DOWN	#UP	# DOWN	# UP	# DOWN
10/09/90					1	
10/10190	2	1				
10/11190					6	5
10/12/90						
10/13/90			1			
10/14/90						
10/15/90	42	1	172	12	4	2
10/17/90	7	4	2	1	1	0
10/18/90					1	0
10/19/90						
10/20/90						
10/21/90					1	0
10/22/90	5		2	0	1	0
10/23/90			10	1		
10/24/90	10	2	4	0	0	0
10/25/90	8	5				
10/26/90	1				1	0
10/27/90	5	2	21	10	0	0
10/28/90	3		30	13	0	0
10/29/90	22	8	53	32	5	1
10/30/90	33	15	314	190	12	7
10/31/90	52	36	337	237	9	5
11/01/90	77	52	547	406	55	26
11/02/90	32	15	190	135	16	13
11/03/90	2	2	65	53	2	0
11/04/90	2	1	94	84	1	0

Appendix 3. Enumeration of Salmonids from video tape at Three Mile Falls Dam, 1990.

11/05/90	20	24	105	87	0	0
11/06/90	3	1	103	86	1	0
11/07/90	3	0	92	78	0	0
11/08/90			49	33		
11/09/90	16	4	178	113	9	3
11/10/90	30	10	270	132	5	0
11/11/90	16	5	129	57	23	10
11/12/90	28	7	136	77	1	0
11/13/90	13	7	51	46	1	1
11/14/90	24	19	56	52	1	0
11/15/90	34	35	69	48	1	0
TOTALS	454	256	2,927	1,983	158	73

EVALUATION OF JUVENILE FISH BYPASS FACILITIES AT WATER DIVERSIONS IN THE UHATILLA RIVER

Interim Progress Report

April 1991 - September 1991

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CONTENTS

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ABSTRACT

We report on our effort from April through September 1991 to evaluate the juvenile fish bypass facility in the West Extension Irrigation District Canal at Three Mile Falls Dam on the Umatilla River. We also report on juvenile salmonid outmigration through the eastbank adult fish ladder in 1990 .and through the bypass facility in 1991. We include information on preliminary activities to prepare for future evaluations at Maxwell, Westland, and Cold Springs diversion dams. Tests at Three Mile Falls Dam showed that races of spring and fall chinook salmon (Oncorhynchus tshawytscha) and summer steelhead *(Uncorhynchus mykiss) were* not injured during passage through the entire fish bypass facility. We also observed no significant leakage of chinook salmon fry through the drum screen system with screening efficiency approaching 100%. Some impingement of fry and subyearlings was observed on the secondary traveling screen because of unfavorable hydraulics and insufficient spray water at one location. Fish moved freely through the upper screening facility and generally moved more rapidly during nighttime tests. Fish movement was delayed in the lower bypass outfall at flows of 5 cfs, but quickened when flows were increased to 25 cfs. Although movement of fish in the facility was more rapid at night, the migration of river-run salmonids (probably coho and chinook salmon) showed a distinct diurnal peak. Passage through the eastbank ladder showed that some fish movement was correlated with higher river flows. We offer recommendations for structural and operational improvements in the West Extension Irrigation District Canal juvenile fish bypass facility at Three Mile Falls Dam. We fabricated and partly tested collection systems for the juvenile fish bypass facilities at Maxwell, Westland, and Cold Springs diversion dams to be used in future evaluations. The primary problem encountered with the Maxwell trap was a backwash eddy that stranded fish. Preliminary monitoring of fyke net operation at the Westland Diversion Dam showed that the net worked well and only required minor modifications. During 1992, we will continue tests at Three Mile Falls Dam and prepare for evaluation activities at Westland Dam in 1993.

INTRODUCTION

Background

The Northwest Power Planning Council's (NPPC) Columbia River Basin Fish and Wildlife Program (1987) called for the improvement of anadromous fish passage facilities at irrigation diversion projects in the Umatilla River Basin in the form of passage improvements (Section 1403, Measure 4.2). Under contract with the Bonneville Power Administration (BPA) and in cooperation with the Confederated Tribes of the. Umatilla Indian Reservation (CTUIR) and fish and wildlife agencies, the U.S. Bureau of Reclamation (USBR) developed and carried out -a program to improve fish passage facilities at Umatilla River diversion dams. State-of-the-art passage facilities at Three Mile Falls Dam were the first to be constructed, followed by Maxwell and Cold Springs diversion dams. Westland Diversion Dam passage facilities were reconstructed under the direction of the Oregon Department of Fish and Wildlife (ODFW). Passage facilities at Stanfield Diversion Dam are currently in the design phase by ODFW staff. New screening facilities are intended to prevent juvenile salmonids from entering the irrigation canals by guiding them unharmed back to the river from which they were diverted. Evaluation of the passage improvement projects at the five major diversion dams on the Umatilla River was suggested in A *Comprehensive Plan for Rehabilitation of Anadromous Fish Stocks in the Umatilla River Basin* (Boyce 1986).

Construction of similar fish passage and protection facilities at major (Phase I) irrigation diversions in the Yakima River Basin, Washington has also been funded by BPA and USBR under Section 803 (b) of the NPPC's Columbia River Basin Fish and Wildlife Program (NPPC 1987). Evaluations of the effectiveness of these fish screening facilities on the Yakima River have been carried out by Neitzel et al. (1985, 1987, 1988, 1990a, 1990b) and Hosey & Associates (1988, 1989, 1990). We considered their experiences when designing evaluations of fish screening facilities in the Umatilla River basin.

We began the first year of our evaluation of juvenile fish bypass facilities in the Umatilla River at Three Mile Falls Dam in November 1989. During this period, we operated and evaluated the efficiency of the juvenile fish bypass system in the West Extension Irrigation District (WEID) Canal. Improvements were. made to the fish bypass collection facilities, a system was developed to collect juvenile salmonids at the bypass outfall, and preliminary information on juvenile fish passage condition was collected (Knapp and Ward 1990). A subsequent report (Knapp 1991) described our approach to and preparatory activities for conducting the second year of the study.

In this report we describe our progress toward addressing second year study objectives. These study objectives were to (1) evaluate the passage of juvenile salmonids through the bypass system in the WEID Canal facility at Three Mile Falls Dam, including the evaluation at design flow .of injury and mortality rates, and passage of juvenile salmonids through and over the screens, and (2) perform preliminary activities that would facilitate passage evaluations at the Maxwell, Westland, and Cold Springs diversicns dams in coming years.

Study Sites

A description of the Three Mile Falls Dam and associated WEID Canal and fish screening facilities is in our first annual progress report (Knapp and Ward 1990). A description of the Maxwell and Westland dams was included in the second annual progress report (Knapp 1991). Cold Springs Diversion Dam is located at river mile 29.2 and reconstruction of the old juvenile fish screening facility was completed in 1990. Components of the new facility and associated canal structure include a trashrack, 10 rotary drum screens, a bypass chamber and outlet, and a canal check and wasteway structure. All sites are located on the lower Umatilla River (Figure 1) and a schematic diagram illustrates the fish bypass facility at Three Mile Falls Dam (Figure 2).

METHODS

Three Mile Falls Dam Juvenile Fish bypass Facility Evaluation

The evaluation of the juvenile fish bypass facility at Three Mile Falls Dam consisted of several different tests to evaluate various components of the facility at designed operating criteria and flow. The primary tests conducted were the screen injury, bypass pipe and outfall injury, and drum screen leakage tests. Secondary tests evaluated headgate injury and traveling screen leakage. We conducted these tests with different species or races (sizes) of chinook salmon *(Oncorhynchus tshawytscha)* and summer steelhead *(Oncorhynchus mykiss)* in April and May of 1991. Methods were described in detail in Knapp (1991).

We conducted all injury tests using yearling spring chinook salmon and summer steelhead and subyearling fall chinook salmon. For the headgate injury test we used fish saved from previous tests that were in good condition. Drum screen leakage was tested with fall chinook salmon fry. These species were selected because they are present in the Umatilla River system. All fish used in the screen injury tests were freeze-branded with a unique group brand and held in separate containers for 48 to 72 hours to allow the brand to set and the fish to acclimate. For the screen leakage test, control fall chinook salmon fry were marked with bismark brown dye to differentiate them from the treatment groups and placed in an aerated container for one hour to allow the dye to set. Marked groups were held in large tanks supplied with pumped river water from the canal. In addition, floating net pens were used to hold fish in the canal headworks area or in the river when necessary. More detailed information on test fish, branding, and the holding system is available in Knapp (1991).

We determined fish condition for all injury tests using descaling criteria developed by the U.S. Army Corps of Engineers (Neitzel et al. 1985) and described in Knapp (1991). Fish condition was based on the percentage of scale loss in each of five designated sections per side of fish. Fish were classified as "healthy" (scale loss c or = 3% per section), "partially descaled" (scale loss > 3% but < 40% per section), or "descaled" (cumulative scale loss > *or* = 40% in any two sections). We also recorded observations of other injury types such as cuts, bruises, eye or head injuries, and torn operculums.

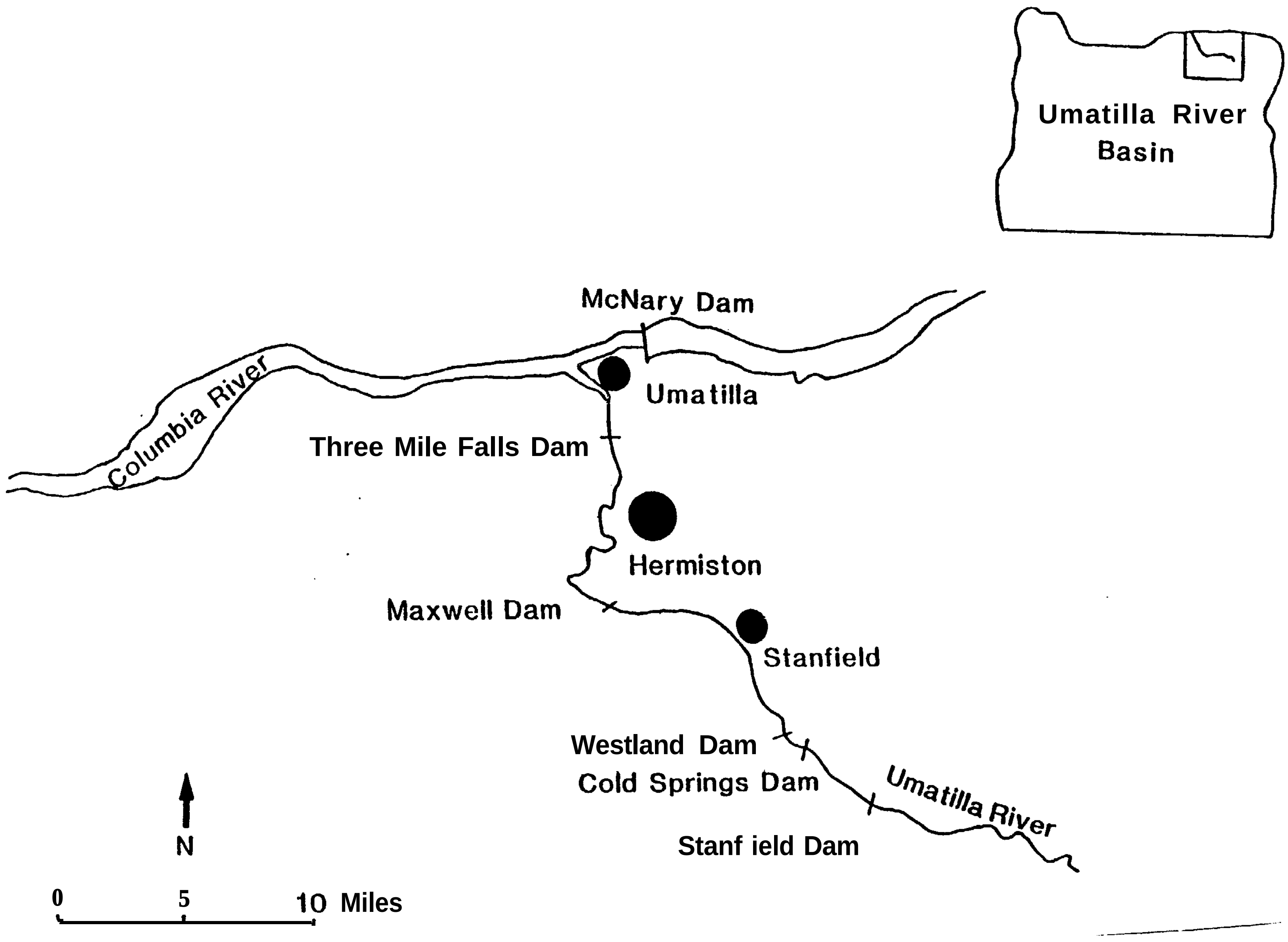
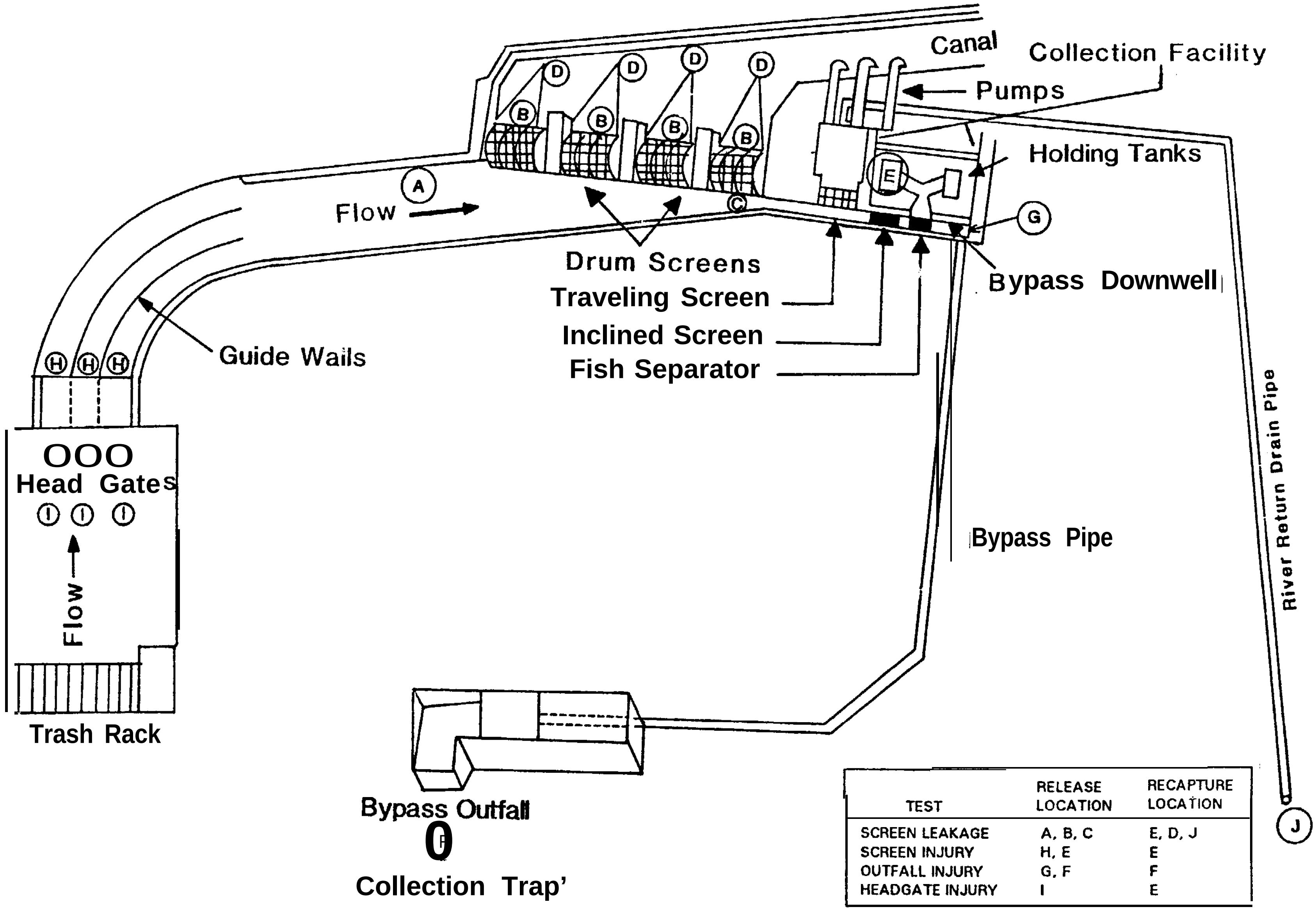


Figure 1. Location of diversion dams on the lower Umatilla River, Oregon



TEST	RELEASE LOCATION	RECAPTURE LOCATION
SCREEN LEAKAGE	A, B, C	E, D, J
SCREEN INJURY	H, E	E
OUTFALL INJURY	G, F	F
HEADGATE INJURY	I	E

Figure 2. Schematic of the juvenile bypass facility at Three Mile Falls Dam including sampling locations for release and recapture of fish.

Screen Injury

To evaluate injury and mortality rates associated with the drum screens, we released replicate groups of healthy, freeze-branded fish upstream of the drum screens and recaptured them at the bypass collection facility (treatment). We also released replicate groups of healthy fish (control) directly into the collection facility (sample tank) to allow us to evaluate injury caused by the collection and handling process. All recaptured fish were examined for descaling and other injuries.

We conducted tests with spring and fall chinook salmon during the day and at night and summer steelhead during the day from 23 April to 9 May 1991. We conducted tests on three different dates with up to three replicates tested each day. Treatment'and control fish were released on the same day. Each test consisted of approximately three, 100-fish groups for each species or race of test fish. We released treatment groups at approximately 0900 hours and 2100 hours, respectively, for three consecutive 24-hour periods. Treatment groups were released immediately following the release of the control groups into canal flows ranging from 116 cfs to 149 cfs (77%-99% of maximum design canal flow). Occasionally, control groups were pooled, creating only one group per day. A 10% subsample from each replicate group was examined for condition before release to ascertain pre-release condition. These subsample fish were not returned to their groups.

Treatment groups were released immediately below the headgates in each of three flume sections in the canal headworks (Figure 2). Groups of control fish were released directly into the collection facility sample tank and handled during examination in the same manner as the treatment fish. We followed operation criteria for a sampling mode when capturing released test fish in the collection facility. This included the installation of sampling equipment (orifice plate, inclined screen, fish separator), and operation of the traveling screen and pumpback pumps, and the proper setting of weir gate positions and headworks water levels (USBR 1989). On occasion, we partially opened the 21-inch diameter drain pipe gate to return water to the river in lieu of pump operation.

We recaptured treatment fish in the sample tank at the bypass collection facility (Figure 2). Fish were crowded and removed from the tank every hour to determine travel time and prevent tank crowding. Treatment fish were captured for at least 96 hours after release to allow sufficient time for a 95% recovery. Fork lengths.were taken from a random selection of control and treatment fish.

River run fish collected during the evaluation were separated from test fish and returned to the river. If necessary, we anesthetized all fish to separate test from river run fish. We examined test fish immediately upon recapture or transferred them to the holding containers for later processing. Anesthetized river run and test fish were placed in a holding tank to recover from the anesthetic and then released into the bypass downwell. All test fish were placed in an anesthetic trough and anesthetized with Finquel (MS222). Fish condition was determined and recorded on descaling forms. We examined fish for descaling in the collection facility which included an overhead canopy for protection from the weather, and a high pressure sodium light to maintain consistent lighting conditions. Fish in good condition were retained for use in secondary tests.

Bypass Pipe and Outfall Injury

To evaluate injury and mortality rates associated with the bypass pipe and bypass outfall, we released replicate groups of freeze-branded healthy fish into the bypass downwell, recaptured them in the bypass outfall collection trap (floating net pen) and examined the fish for descaling and other injuries (treatment). We also released replicate groups of fish directly into the bypass outfall collection trap to allow us to evaluate injury caused by the collection and handling process (control).

We conducted tests from 16 April to 31 May 1991. Generally, we conducted tests on three different dates for each species or race of test fish and at bypass flows of 5 cfs and 25 cfs. Each test consisted of three, approximately 100-fish groups. A 10% subsample from each treatment and control group was examined prior to release to ascertain pre-release condition. These subsampled fish were not returned to their groups.

The operation criteria for bypass flow were adhered to when performing the tests. This included the installation of the restrictive orifice plate for 5 cfs flow and the concurrent operation of the traveling screen and pumpback pumps (USBR 1989). Weir gate positions for both flow regimes were also properly set according to operating criteria. During the 25 cfs tests, we installed a bypass channel stoplog to reduce flows during control releases and subsequent net positioning. The stoplog was removed to achieve a full 25 cfs flow before releasing the treatment groups.

We released control fish into the net pen immediately before releasing treatment fish at the bypass channel weir crest upstream of the downwell. Therefore, both groups were in the net pen simultaneously during the recapture interval. To capture the majority of the test fish, the net pen remained in position for about one hour, We retrieved the net pen after the prescribed interval, and retrieved control fish and test fish, placing them in containers for immediate examination. River run fish were released to the river. We examined fish for injury in the same manner as in the screen injury test. Fish were allowed to recover from the anesthetic in net pens placed in the river prior to release.

Headgate Injury

To evaluate injury and mortality associated with passage through the headgates, we released groups of previously used, good condition fish upstream of the headgates, recaptured them at the collection facility, and examined them for injury or descaling. We used the results from treatment fish in the screen injury tests that were released downstream of the headgates as a control. During testing, we followed normal canal operations and operating criteria for a sampling mode at the collection facility (USBR 1989). All three headgates were fully open.

Three daytime tests and two nighttime tests for spring chinook salmon were conducted from 30 April to 2 May 1991; and two daytime tests and two nighttime tests for fall chinook salmon were conducted on 7 and 8 May 1991. The number of fish released in each test ranged from 77 to 190. We did not subsample test fish to determine pre-test fish condition, but for purposes of analysis we assumed that all fish began the test in good condition. Fish were released in separate groups in front of the headgates (Figure 2).

Fish were recaptured in the bypass collection facility at hourly intervals, and examined for descaling and other injury, following the same procedure used in the screen injury test. We recorded fish condition, and time of release and recapture. After processing, we released the fish back to the river.

Drum Screen Ceakage Test

To evaluate passage of juvenile salmonids through (leakage) and over (impingement) the drum screens, we released treatment groups of fall chinook salmon fry upstream from the screens and recaptured them either in fyke nets placed immediately behind the screens in the WEID Canal or in the bypass collection facility (Figure 2). We also released groups of bismark-brown dyed control fish in the fyke net mouth to obtain an estimate of net collection and retention efficiency. An estimate of bypass collection efficiency was obtained by releasing groups of control fish in the bypass channel and recapturing them in the sample tank at the collection facility. We also monitored fish passage over the screens during tests to estimate rollover caused by impingement. Because salmonid fry are not a normal contingent of the juvenile outmigration, our test fry were easily discernable.

Tests were performed at a canal flow of 74 to 78 cfs from 5 April to 10 April 1991. Three tests were made, each during mid-morning and separated by 48-hour periods. The 48-hour interval was necessary to allow fish from one group to clear the system before release of the next group, since test fish groups could not be differentiated.

Because of our inability to designate separate groups for each test, we released a single 300-fish treatment group upstream of the screens, and a single 300-fish control group in the bypass channel on each test day. Control fish were also released behind each of the four screens in the net mouth in separate 75-fish group. Each test was designed to comprise 900 fish for three days, for a total of 2,700 fry.

To capture test fish in the collection facility, we followed the operation criteria for sampling. This included the installation of bypass channel sampling equipment, operation of the traveling screen, opening of the river return drain pipe (pumpback pumps could not be operated with fyke nets in place), and proper setting of weir gate positions and headworks water levels (USBR 1989).

Fyke nets were placed behind the screens before releases. The fyke nets were monitored for approximately 48 hours after release to capture control fish and any test fish that leaked past or rolled over the screens. At 4 to 6-hour intervals during this 48-hour period, we examined the contents of the fyke net by individually raising the nets, removing the contents of the cod end, and placing the contents in buckets. The nets were cleaned with water supplied from the traveling screen spray water pump and immediately lowered back into place. We collected fry from the sample tank in the bypass collection facility every hour. Data on river run fish collected in the sample tank were recorded, and then the fish were returned to the river.

We recorded the numbers of fry retrieved (treatment and control) from each fyke net and from the hourly sample tank crowding. During the tests, we monitored the drum screens for any indication of fry impingement and documented numbers of rollover fish. We recorded lengths of all treatment fish that passed through or over the screens. We recorded lengths from subsamples of treatment and control fish.

Traveling Screen Leakage Test

To determine if leakage was occurring at the secondary traveling screen, we installed a fyke net at the terminus of the river return pipeline (Knapp 1991). Any fish leaking past the screen when the sluice gate to the river return drain pipe was open would be eventually captured in the fyke net. We planned to retrieve the contents of the fyke net on a hourly basis.

We were unable to devise a method to capture fish impinged on the traveling screen during pumpback pump operation. However, we made two fish releases in the bypass channel to determine if we could directly observe impingement of fall chinook salmon fry on the traveling screen. On 24 April, we released 110 fry into the bypass channel. The two 10 cfs pumpback pumps were in operation with the sluice gate closed. On 2 May we made another release of fry into the bypass channel with the river return drain pipe opened more than 12 inches on the pipe stem. We adjusted the pipe stem down to 9-inches to reduce turbulence, and hydraulic conditions appeared similar to conditions during pumpback pump operation.

Travel Time

We examined fish movement during the screen injury.and bypass outfall tests to determine if the fish bypass facility could delay fish migration. The time of release and recapture was recorded to ascertain movement rates through the facility. In the screen injury test, we estimated travel time through the screen facility by calculating the time to recapture 50% (mean travel time) and 95% of the test fish. In the bypass outfall test, we estimated fish travel time through the lower bypass and outfall by computing the total number of test fish recaptured in one hour.

Juvenile Passage

Fish passage information on wild and hatchery-reared salmonids released upstream from Three Mile Falls Dam was obtained during tests from 5 April to 10 April, and from 23 April to 9 May 1991. We sampled hourly all fish entering the fish bypass facility and recorded the numbers of wild and hatchery fish present. Because of the large number of fish moving through the facility, species of fish were combined.

The numbers of juvenile salmonids moving through the eastbank fish ladder at Three Mile Falls Dam were documented in the spring of 1990 using video cameras placed in the east ladder viewing window to record adult passage. Video tape information was monitored periodically from 23 March to 7 June 1991. These video tapes were reviewed to determine the number and timing of downstream migrating juvenile salmonids using the eastbank ladder. Individual species could not be determined.

Data Analysis

We used analysis of variance (ANOVA) to test the hypothesis that the relative condition of control and treatment fish were equal in all injury tests. Sources of variation tested in each ANOVA were treatment versus control, and time of day (day or night) or flow (5 cfs or 25 cfs). We chose as our significance level a p value of $<.10$. All testing was completed using the General Linear Model Procedure in the SAS program for personal computers (SAS Institute Inc 1990).

Injury Estimates: For purposes of analysis, we calculated pre-test condition (from subsamples) and post-test condition (from control or treatment test fish) of fish observed as percentages of recaptured injured fish (the sum of partly descaled, descaled, and other injured fish). We then calculated net injury rate as the difference between pre-test and post-test condition.

We computed a 95% confidence interval about the net injury rate for each treatment and control group. In the headgate injury test, no subsamples to measure pre-test condition were obtained. Therefore, we assumed the condition of treatment fish was equal to zero, meaning that no injured fish were present.

Screen Efficiency Estimates: We evaluated the ability of the drum screens to prevent fish from entering the irrigation canal and guide fish that encounter the drum screens into the bypass. We estimated screen efficiency for each test and for all tests combined. We combined all data from the various tests to compensate for differences in test size and theoretically, in the number of fish encountering the screen.

Estimates of screen efficiency were corrected for bypass collection efficiency (EFF_{bc}) and net capture efficiency (EFF_{nc}). We assumed net retention to be equal to net efficiency, giving it a value of 1. The formula for estimating screen efficiency (EFF_{sc}) was:

$$EFF_{sc} = 1 - \frac{X_{net}}{EFF_{nc}N}$$

where

X_{net} = number of fish released upstream of the screens and caught in the nets

N = an estimate of the total number of fish encountering the screens (it may be less than the actual number of fish released:

$$N = \frac{X_{net}}{EFF_{nc}} + \frac{X_{bc}}{EFF_{bc}}$$

where

X_{bc} = the number of fish released upstream of the screens and caught in the bypass collection facility

$$EFF_{nc} = \frac{n_{nc}}{N_{nc}}$$

$$EFF_{bc} = \frac{n_{bc}}{N_{bc}}$$

where

n_{nc} = the number released in the net mouth and caught in the net

N_{nc} = the number released in the net mouth

n_{bc} = the number of fish released in the bypass channel and caught in the bypass collection facility

N_{bc} = the number released in the bypass channel

Activities at Maxwell, Westland, and Cold Springs Diversion Dams

Maxwell Diversion Dam

We fabricated a bypass trap for the Maxwell Dam facility using an inclined plane design (Knapp 1991). We subsequently used the bypass trap at the Maxwell screening facility on 6 June 1991 to test for suitability and effectiveness in capturing fish without injury. Before testing, we constructed a 4 X 4-inch wooden frame and installed two 1/2-ton hoists to lift and lower the trap in place in the bypass downwell. We positioned the trap and channel weir boards so that approximately 10-cfs bypass flow entered the trap. The trap angle was adjusted with the use of the pivot rod front entrance assembly to achieve a suitable, nonturbulent water flow into the live box without impinging fish.

We released one 25-fish group of marked subyearling fall chinook salmon upstream of the bypass near the middle drum screen, and three 25-fish group in the bypass channel. We retrieved the fish from the trap live box, examined them for condition, and documented observable problems with trap operation. Bypass channel releases were retrieved in 2 minutes; the drum screen release was retrieved in 30 minutes.

Westland Diversion Dam

A fyke net and floating live box assembly for use in the juvenile pond at the Westland Dam fish facility was fabricated (Knapp 1990). During mid-June, we deployed the modified fyke net in the juveni'ie holding pond to test the efficiency and effectiveness of the net in capturing fish. We installed the fyke net in stop log grooves at the upstream end of the pond. A 2 x 12-inch board was placed across the pond to access the live box. The pond inflow was adjusted to 4 cfs. We released one 35-fish replicate of dyed subyearling fall chinook salmon downstream of the bypass weir and a second 17-fish replicate upstream of the weir. Subyearlings were retrieved from the live box 5 to 10 minutes after release and examined for condition. We documented operation and design deficiencies for future modifications.

Cold Springs Diversion Dam

We designed and fabricated an aluminum inclined plane trap for the bypass at Cold Springs Dam. The design incorporated features of the bypass channel, bypass downwell, maximum design bypass flow, and available structures for trap alignment and deployment. The inclined plane was 7.6-ft long by 2.5-ft wide with 3.0-ft sidewalls that served as splash guards and incorporated a 90-degree turn at the outlet. The entrance width was 3.9-ft tapering to an outlet width of 2.5-ft. A 2.5-ft long by 1.3-ft wide x 2.0-ft deep live box (47 gal capacity) was welded to the downstream end of the trap. Perforated sheeting containing l/8-inch diameter, staggered holes (40% open) was used for part of the floor and live well to dissipate 18 cfs. Two sets of l/2-inch thick lifting brackets were welded to the side walls, and the entire trap was constructed of 3/16-inch solid aluminum supported on sections of l-inch angle iron. This trap will be tested in 1992 and testing of the Cold Springs juvenile fish bypass facility will occur in 1993-1994.

RESULTS

Three Mile Falls Dam Juvenile Fish Bypass Facility Evaluation

Lengths of fish used were similar for control and treatment fish in all tests (Figures 3 and 4). The summer steelhead used were gradeouts that increased the range of fish lengths tested. Summer steelhead lengths averaged 150 mm (fork length) and ranged from 35 mm to 225 mm.

Screen In jury: Fish injury rates of juvenile salmonids moving past the drum screens and into the bypass channel during day and night tests were not significantly greater than control fish for spring chinook salmon ($F=0.63$, $P>0.77$), fall chinook salmon ($F-1.12$, $P>0.42$) or summer steelhead ($F=1.91$, $P>0.28$) (Table 1). The highest mean net injury percentages were found for spring chinook salmon daytime controls (8.7%) and summer steelhead daytime controls (7.2%). Most "other" injuries to fish consisted of eye or head damage.

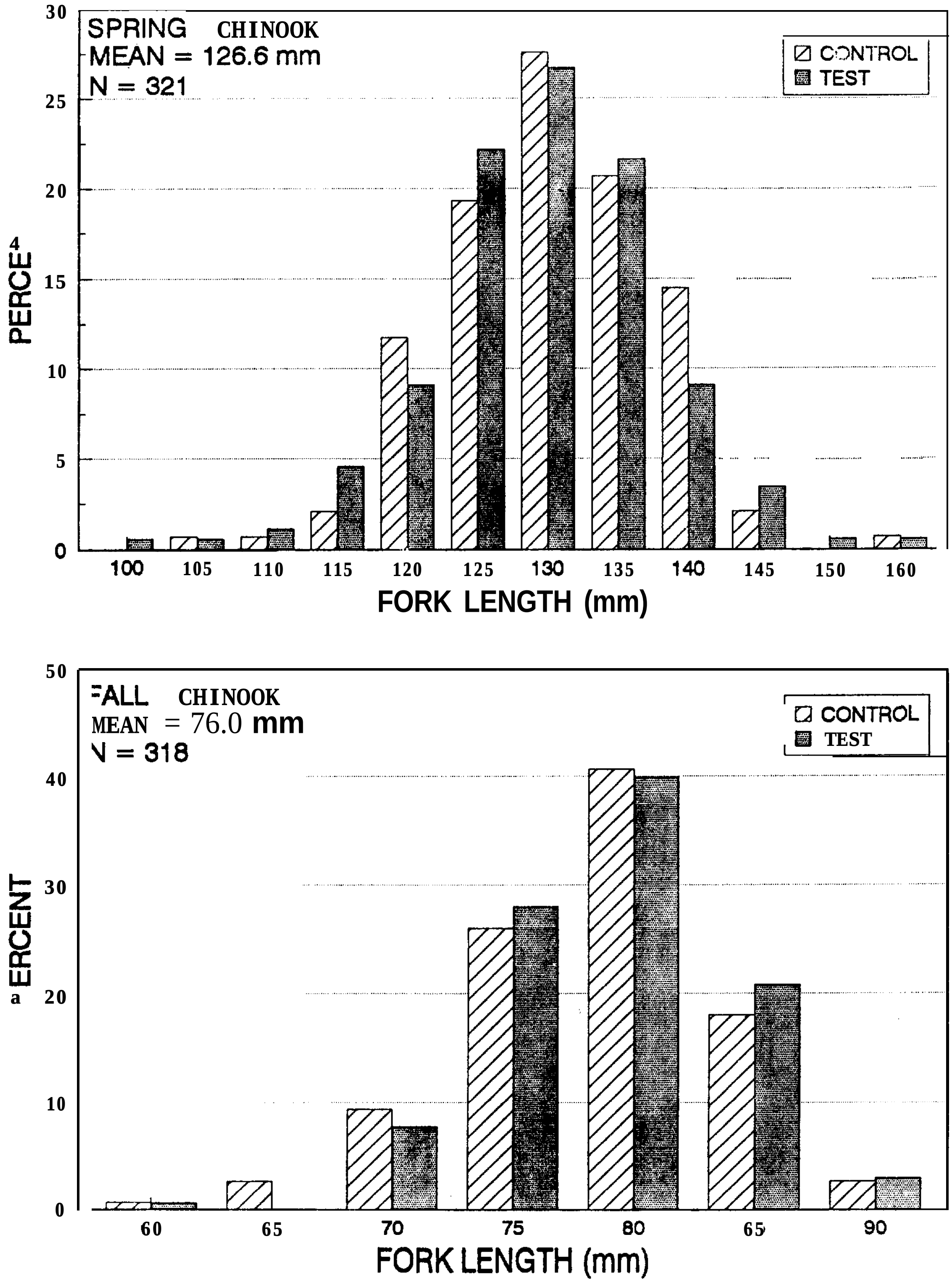


Figure 3. Length frequency distribution of spring chinook salmon and fall chinook salmon used in injury tests at Three Mile Falls Dam, Umatilla River, 1991.

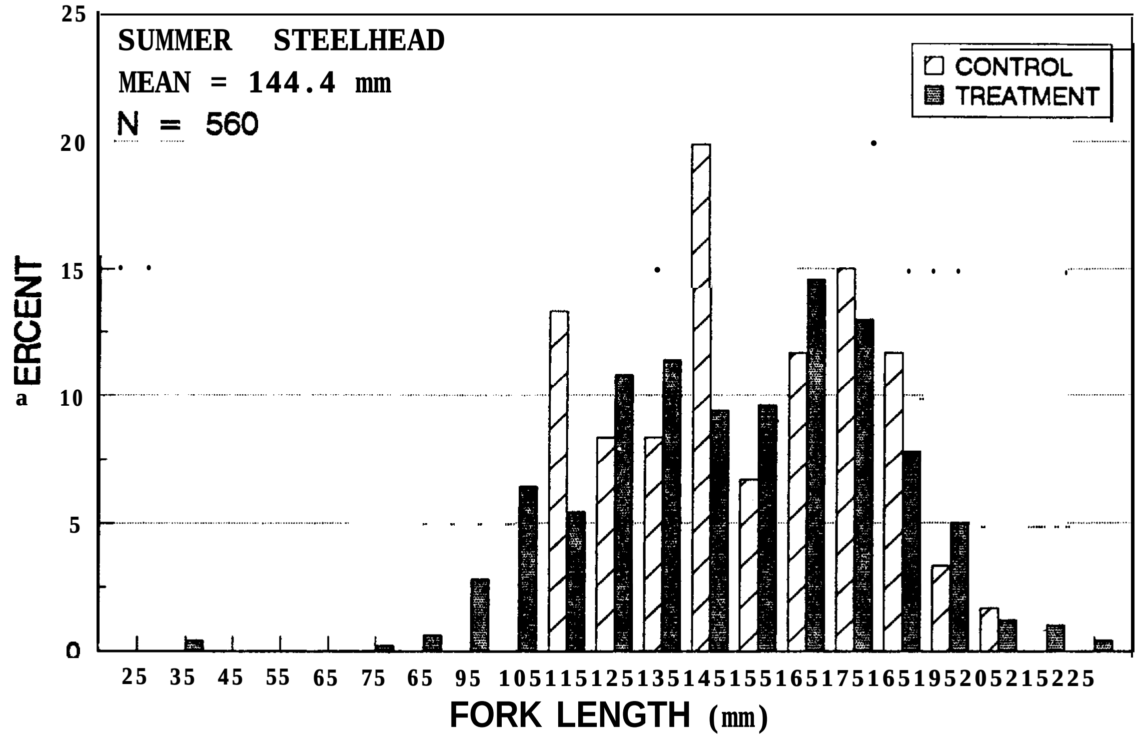


Figure 4. Length frequency distribution of summer steelhead used in injury tests at Three Mile Falls Dam, Umatilla River, 1991.

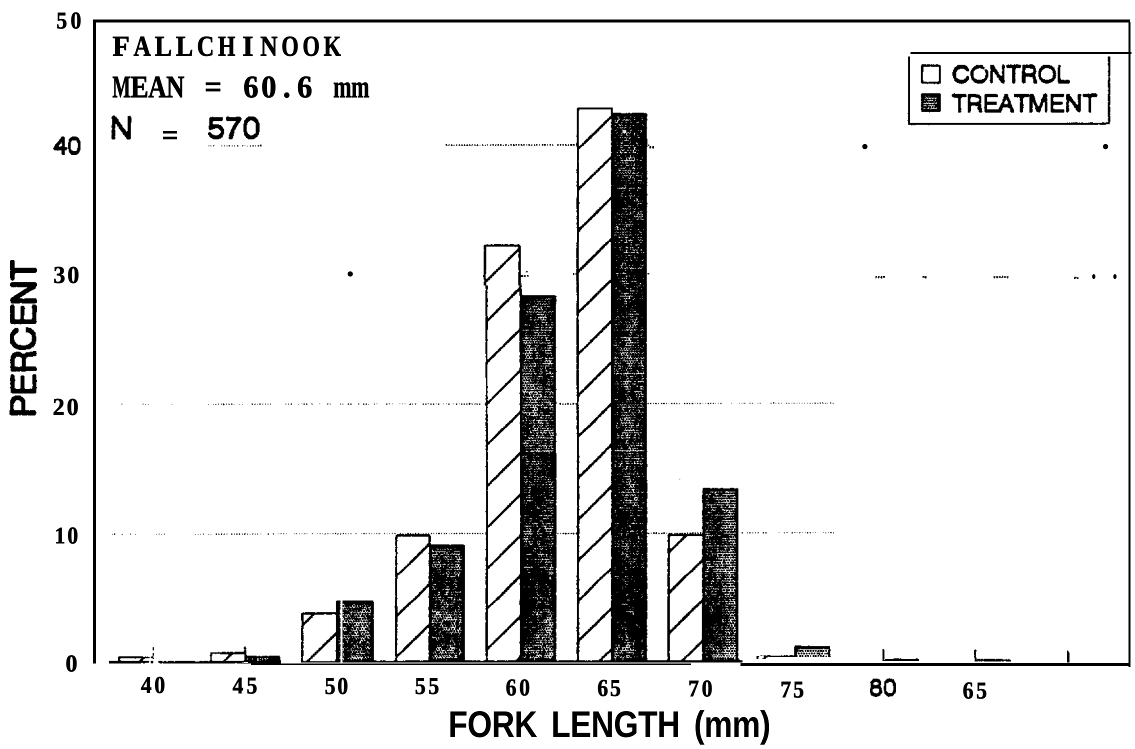


Figure 5. Length frequency distribution of fall chinook salmon used in the screen leakage tests at Three Mile Falls Dam, Umatilla River, 1991.

Injury

Bypass Outfall Injury: Condition of fish returning to the river through the bypass pipe and outfall at flows of 5 cfs and 25 cfs was not significantly different than control fish for spring chinook salmon ($F=1.71$, $P>0.19$). There was a higher probability of a significant difference for fall chinook salmon ($F=1.79$, $P>0.11$) and summer steelhead ($F=1.86$, $P<0.10$) (Table 2). However, the major source of variation was caused by a day effect ($F=4.47$, Pt0.02) for fall chinook and a day*flow interaction (F-5.42, $P<0.01$) for steelhead, and was not attributable to the bypass outfall. Generally, spring chinook salmon showed higher net injury rates (range of 12%-30%) than either fall chinook salmon or summer steelhead, but this occurred for treatment and control fish. The percentage of "other" injuries for fall chinook salmon were higher in this test than for all other tests and species, and ranged from 4% to 13%. The majority of these injuries were from predators and parasites or were stress-induced mortalities and were not caused by the testing procedure. These mortalities comprised approximately 80% of the "other" category for both flow regimes, and were a result of holding fish for a prolonged period during flooding in late May.

Treatment fish in the outfall injury test were recaptured with less success than in the screen injury test. Generally, less than 60% of the released fish were recaptured, and for summer steelhead the recapture percentage was less than 30%.

Headgate Injury: Limited testing suggested that injury rates of juvenile salmonids that traveled past the headgates were not significantly different than control fish for spring chinook salmon ($F=1.00$, $P> 0.49$) or fall chinook salmon ($F=0.50$, $P>0.85$) (Table 3).

Leakage

Drum Screen Leakage: The overall mean efficiency rata of fish passing the drum screens without leaking into the canal was estimated at 99.8% (Table 4). Estimated mean efficiency rates for each of the four drum screens showed little variability and ranged from 99.6% - 99.9%. In addition, screen efficiency estimates for an individual drum screen were similar among days. Efficiency of the bypass collection system averaged 77.0%, while net efficiency averaged 82.3%. Of 900 fish released upstream of the screens, only 6 fish passed through the screens. Because we observed one rollover impinged fish, we suspected that rollover may have been the cause for the net capture of the other five fish. During the test period, canal flows were approximately 50% of maximum design flow and ranged from 74.0 cfs to 78.0 cfs.

The lengths of fish released upstream of the screens and caught in the fyke nets were 60, 60, 62, 64, and 66 mm. These lengths were near the average length of fall chinook.salmon used for both control and treatment tests (Figure 5).

Table 1. Mean percentages of partly descaled, descaled, and other injured fish; net injury rate; and 95% confidence intervals for the screen injury test at Three Mile Dam Falls, Umatilla River, 1991 (subsample values are in parentheses; N = number of test replicates).

Species	Control /Test	Time	Number Released	Number Recaptured	Partly Descaled	Descaled	Other	Net Injury Rate	95% Confidence Interval LowerCI	UpperCI	N
Spring Chinook	Control	Day	809	797	14.0 (5.6)	0.0(0.0)	0.7(0.0)	a.7	-4.1	21.4	5
	Test	Day	799	757	20.6(20.0)	O.l(O.0)	OA(l.1)	0.4	-9.1	9.9	9
	Control	Night	813	811	6.9(12.2)	O.O(O.0)	O.O(O.0)	-5.4	-21.9	11.0	3
	Test	Night	807	638	18.9(26.7)	0.7(0.0)	0.3(0.0)	-6.8	-16.3	2.7	9
Fall Chinook	Control	Day	806	803	7.2 (3.0)	0.0(0.0)	0.l(0.0)	4.3	-1.5	10.1	5
	Test	Day	700	513	7.2 (1.3)	0.0(0.0)	0.0(0.0)	5.9	1.4	10.5	8
	Control	Night	790	795	3.2 (8.0)	0.0(0.0)	0.0(0.0)	-4.9	-12.3	2.6	3
	Test	Night	808	715	5.6 (2.2)	0.0(0.0)	0.2(0.0)	3.7	-0.6	8.0	9
Sumner Steelhead	Control	Day	324	321	28.7(21.5)	0.0(0.0)	0.7(0.0)	7.2	-13.0	27.4	4
	Test	Day	322	145	35.5(32.1)	0.0(0.0)	O.O(O.0)	3.2	-13.4	19.7	6

Table 2. Mean percentages of partly descaled, descaled, and other injured fish; net injury rate; and 95% confidence intervals for the outfall injury test at Three Mile Falls Dam, Umatilla River, 1991 (subsample values are in parentheses; N = number of test replicates).

Species	Control /Test	Flow	Number Released	Number Recaptured	Partly Descaled	Descaled	Other	Net Injury Rate	95% Confidence Interval LowerCI	95% Confidence Interval UpperCI	N
Spring Chinook	Control	5	589	576	55.8(36.2)	0.0(0.0)	0.0 (0.0)	19.7	3.8	35.6	7
	Test	5	624	355	69.1(40.5)	0.4(0.0)	0.4 (0.0)	29.5	13.6	45.4	7
	Control	25	352	302	48.3(36.8)	O.O(O.0)	0.0 (0.0)	11.6	-9.5	32.6	4
	Test	25	330	173	63.9(41.5)	3.5(0.0)	0.9 (0.0)	26.9	5.8	48.0	4
Fall Chinook	Control	5	693	673	55.0(58.3)	2.1(2.6)	4.0 (0.0)	0.2	-11.5	11.9	9
	Test	5	748	357	46.8(61.8)	l.B(O.0)	8.6 (0.0)	-4.5	-16.2	7.2	9
	Control	25	637	601	33.1(15.3)	l.J(O.0)	6.6(18.2)	7.3	-4.4	19.0	9
	Test	25	688	487	24.1(17.8)	2.1(0.0)	12.7(17.8)	3.4	-8.3	15.1	9
Sumner Steelhead	Control	5	810	823	27.7(31.1)	O.l(O.0)	0.0 (0.0)	-3.3	-12.5	5.9	9
	Test	5	538	152	20.6(28.9)	O.O(O.0)	0.0 (0.0)	-8.3	-17.6	0.9	9
	Control	25	810	723	15.8(20.0)	0.0(0.0)	0.0 (0.0)	-4.2	-13.5	5.0	9
	Test	25	801	240	32.1(26.7)	O.O(O.0)	0.4 (0.0)	5.8	-3.4	15.0	9

Table 3. Mean percentage of partly descaled, descaled, other injured fish, net-injury rate and 95% confidence intervals for the headgate injury test at Three Mile Falls Dam, Umatilla River, 1991 (subsample values are in parentheses; N = number of test replicates).

Species	Control /Test	Time	Number Released	Number Recaptured	Partly Descaled	Descaled	Other	Net Injury Rate	95% Confidence Interval LowerCI	95% Confidence Interval UpperCI	N
Spring Chinook	Control	Day	799	757	20.6(20.0)	0.1(0.0)	0.8(1.1)	0.4	-9.9	10.8	9
	Test	Day	478	372	5.5 (0.0)	0.0(0.0)	0.0(0.0)	5.5	-12.5	23.5	3
	Control	Night	807	638	18.9(26.7)	0.7(0.0)	0.3(0.0)	-6.8	-17.2	3.6	9
	Test	Night	238	204	23.1 (0.0)	0.4(0.0)	0.4(0.0)	23.9	1.9	45.9	2
Fall Chinook	Control	Day	700	513	7.2 (1.3)	0.0(0.0)	0.0(0.0)	5.9	0.9	10.9	8
	Test	Day	257	232	10.4 (0.0)	0.0(0.0)	0.4(0.0)	10.8	0.7	20.9	2
	Control	Night	808	715	5.6 (2.2)	0.0(0.0)	0.2(0.0)	3.7	-1.0	8.4	9
	Test	Night	174	152	4.3 (0.0)	0.0(0.0)	0.0(0.0)	4.3	-5.7	14.4	2

Table 4. Estimates of drum screen passage efficiency of fall chinook salmon fry at the juvenile fish bypass facility at Three Mile Falls Dam, Umatilla River, April 1991.

DRUM SCREEN 1	Bvoass		Net		Test Fish					
	*Released	Caught	Released	Caught	*Released	Caught in net	Caught in bypass	Bypass Efficiency	Net Efficiency	Screen Efficiency
1	300	246	75	69	300	2	158	0.820	0.920	0.989
2	300	280	75	51	300	0	264	0.933	0.680	1.000
3	300	167	75	73	300	1	198	0.557	0.973	0.997
TOTAL	900	693	225	193	900	3	620	0.770	0.858	0.996

DRUM SCREEN 2	Bybass		Net		Test Fish					
	Released	Caught	Released	Caught	Released	Caught in net	Caught In bvoass	Bypass Efficiency	Net Efficiency	Screen Efficiency
1	300	246	75	70	300	0	158	0.820	0.933	1.000
2	300	280	75	70	300	0	264	0.933	0.933	1.000
3	300	167	75	75	300	1	198	0.557	1.000	0.997
TOTAL	900	693	225	215	900	1	620	0.770	0.956	0.999

DRUM SCREEN 3	Bvoass		Net		Test Fish					
	Released	Caught	Released	Caught	Released	Caught in net	Caught in bvoass	Bypass Efficiency	Net Efficiency	Screen Efficiency
1	300	246	75	72	300	0	158	0.820	0.960	1.000
2	300	280	75	56	300	0	264	0.933	0.747	1.000
3	300	167	75	41	300	1	198	0.557	0.547	0.995
TOTAL	900	693	225	169	900	1	620	0.770	0.751	0.998

DRUM SCREEN 4	Bypass		Net		Test Fish					
	Released	Caught	Released	Caught	Released	Caught in net	Caught in bvoass	Bypass Efficiency	Net Efficiency	Screen Efficiency
1	300	246	75	67	300	0	158	0.820	0.893	1.000
2	300	280	75	71	300	1	264	0.933	0.947	0.996
3	300	167	75	26	300	0	198	0.557	0.347	1.000
TOTAL	900	693	225	164	900	1	620	0.770	0.729	0.998
GRAND TOTAL	900	693	900	741	900	6	620	0.770	0.823	0.998

• A 300 fish group was released upstream of the drum screens (test) and in the bypass channel (control) for each replicate test.

Traveling Screen Leakage and Fish Impingement: An attempt to capture leakage fish on 9 April was thwarted as the net was torn by the force of the discharge. The net was subsequently repaired and reinstalled on 15 May during the fall chinook outmigration. We captured 1 fall chinook subyearling (85 mm) after 1 hour of sampling. Further sampling was abandoned as the net tore again after reinstallation.

During the drum screen leakage test, we observed 108 fall chinook salmon impinged on the secondary traveling screen (Table 5). These fry were test and control fish from the leakage test. Some of the fry were impinged in debris piles falling behind the screen. During the drum screen leakage test, the sluice gate to the 21-inch river return drain pipe was fully open.

We observed some impingement on the traveling screen of fry released in the bypass channel when we operated the pumpback'pumps and when we opened the river return drain pipe. During pumpback pump operation, some fry were observed to "fight" the current pull through the screen and become temporarily impinged before falling off the screen from the force of the spray water. When the river return drain pipe was open, turbulent conditions existed. These conditions were unfavorable for fry when the pipe was opened more than 12-inches, but were improved when the pipe was opened only g-inches.

As fall chinook salmon subyearlings migrated through the screening facility in May, we observed occasional impingement on the screen, discovered fish in debris piles behind the screen, and captured fish in a bucket placed adjacent to the screen (Table 5). During the flood in late May, the sluice gate was fully opened to clear silt in the pump embayment area. We discovered numerous organisms, including fall chinook salmon subyearlings, in the debris piles behind the secondary screen. Impingement was not observed during a full bypass mode when all bypass flow (25 cfs) was routed directly back to the river with no traveling screen, pump, or sluicing operation.

Travel Time

Screen Facility: Fish travel times past the drum screens varied by species and time of day. Spring chinook salmon travel times showed little difference between day and night tests with approximately 3 hours required to capture 50% of the test fish and 58-67 hours to catch 95% of test fish (Figure 6). Fall chinook salmon traveled past the screens more quickly at night with 50% of the fish caught in 1 hour compared to 5.5 hours for daytime tests. Summer steelhead moved considerably more slowly than spring or fall chinook salmon, requiring 10.5 hours and 162.0 hours to capture 50% and 95% of the test fish, respectively. No nighttime tests were conducted with summer steelhead.

Lower Bypass: In the 5-cfs test, 25% of spring chinook salmon and 27% of fall chinook salmon moved through the outfall system at the end of the first hour. Summer steelhead moved much more slowly through the outfall bypass than chinook salmon with 2% captured in the first hour (Figure 7). Flushing the system with 25 cfs in the period 2-4 hours after testing increased the total percentage of spring chinook salmon captured to 56%. Flushing the system with 25 cfs after the first hour increased capture rates

Table 5. Observations of traveling screen impingement of fall chinook salmon fry at the juvenile fish bypass facility, Three Mile Falls Dam, Umatilla River, 1991.

Date	Time	Number of subyearlings	Number of fry	Headworks elevation	Sluice Gate	Pumps
7 Apr 91	2205	0	20	404.0	open	off
9 Apr 91	0900	0	87	404.1	open	off
24 Apr 91	1015	0	1	403.9	closed	on
8 May 91	0430	1	0	404.0	closed	on
9 May 91	1820	1	0	404.4	closed	on
10 May 91	0700	2	0	404.4	closed	on
11 May 91	0630	2	0	401 .o	closed	on
12 May 91	0730	1	0	ND	closed	on
13 May 91	0640	2	0	ND	closed	on

ND = no data

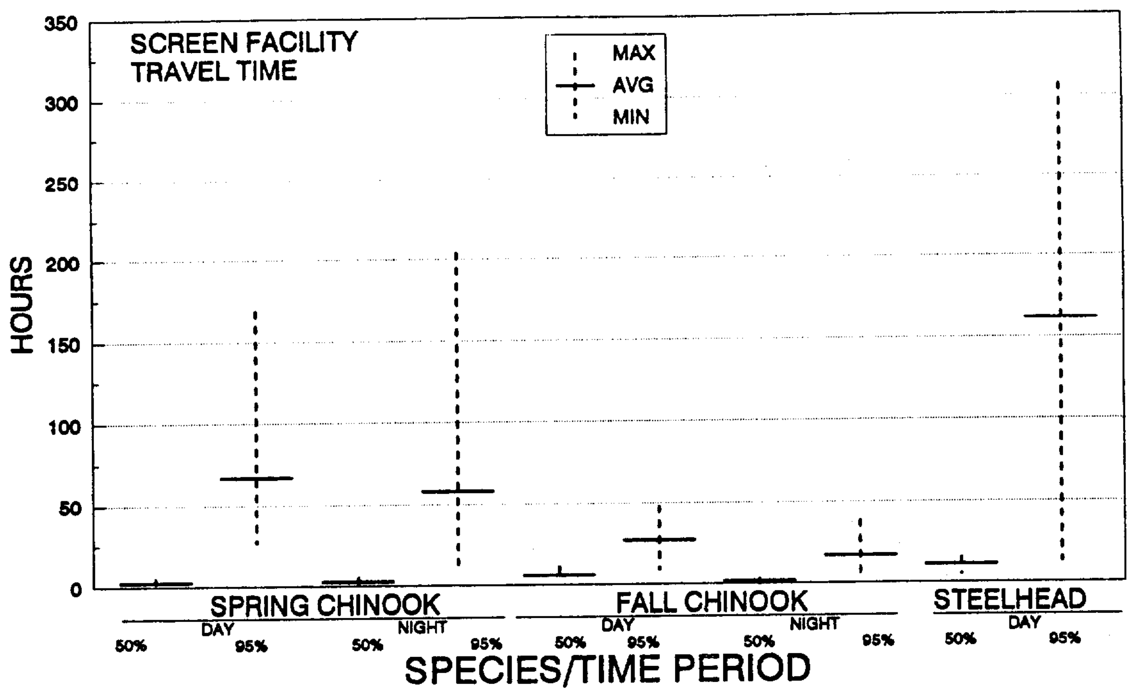


Figure 6. Mean number of hours required to capture 50% and 95% of fish released in the screen injury test at Three Mile Falls Dam, Umatilla River, 1991.

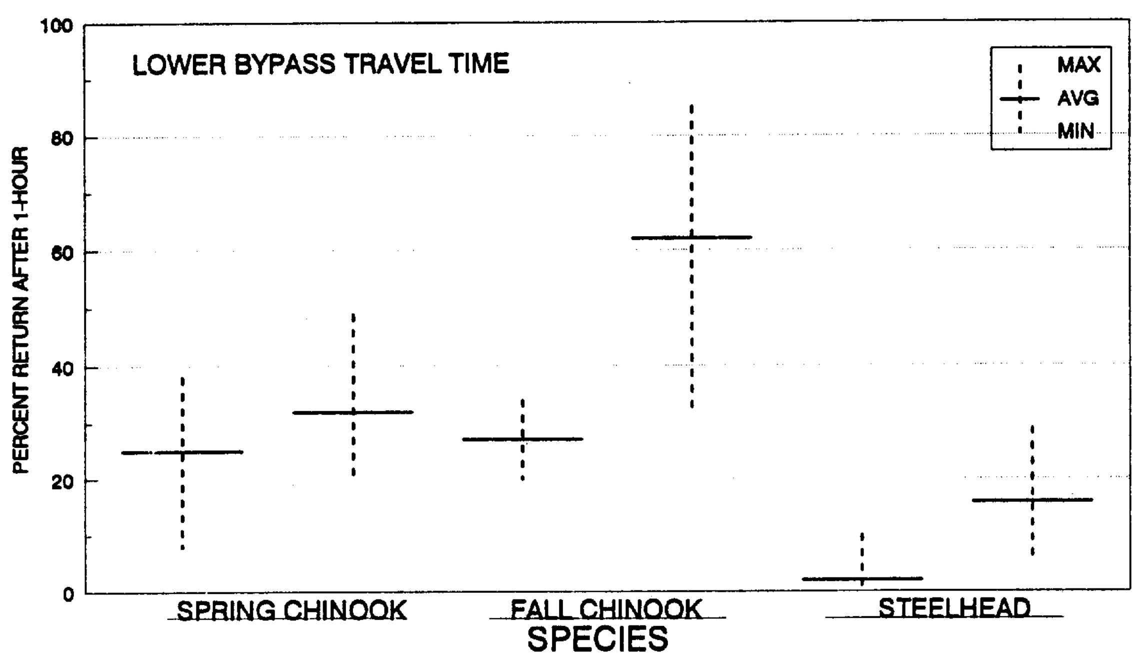


Figure 7. Percent of released fish recaptured at the end of a 1-hour sampling period during the outfall injury test at Three Mile Falls Dam, Umatilla River, 1991.

for three groups of summer steelhead by 41%. An unknown number of fish returned to the river when the net pen was not in place.

When flows in the bypass were 25 cfs, mean capture rates were 62% and 16% for fall chinook salmon and summer steelhead, respectively. Mean capture rate of spring chinook salmon after one hour of testing at a bypass flow of 25 cfs was 32%.

Passage

Fish Bypass Facility: We observed a distinct pattern of diurnal passage of hatchery and wild juvenile salmonids through the facility at Three Mile Falls Dam from upstream locations in the Umatilla River (Figure 8). In most cases, movement through the facility was greatest from sunrise through sunset. The highest hourly number of juvenile salmonids counted was 1,800 on 24 April and approximately 2,000 on 8 May 1991. Total river run passage through the fish bypass facility from 5 April to 10 April and from 23 April to 9 May 1991 was 41,318 fish. River flows during this period ranged from 400-1000 cfs. Included in our sample of river run fish on 2 May was a sockeye salmon measuring 164mm in length.

1990 Ladder Passage: Juvenile fish counts peaked through the eastbank fish ladder from 10 to 13 days after Umatilla River flows reached their highest point (Figure 9). During this time, approximately 30,000 juvenile salmonids were observed moving past the viewing window. The highest daily count was 3,787 fish in early April and the lowest count was 89 on 4 May. Other distinct peaks occurred in mid-May, late May, and early June (end of observation period). Fish ladder flow data during the observation period was not available.

Activities at Maxwell, Westland, and Cold Springs Diversion Dams

During testing of the Maxwell incline plane bypass trap, we recovered all 75 subyearling chinook salmon from releases made in the bypass channel. Only 7 of the 25 fish released in front of the middle drum screen were recaptured. Most of the fish collected were in good condition, with only 7 showing signs of partial scale loss.

Our tests of the modified fyke net used at the Westland Dam juvenile holding pond resulted in recapture rates of 97% and 94% for the first and second release groups, respectively. All fish in the second group were in good condition. Eighty-two percent of the fish in the first release group were in good condition, with 6 fish showing partial scale loss.

No trap testing was conducted at Cold Springs Dam. The design of the inclined plane bypass trap is described in the methods section.

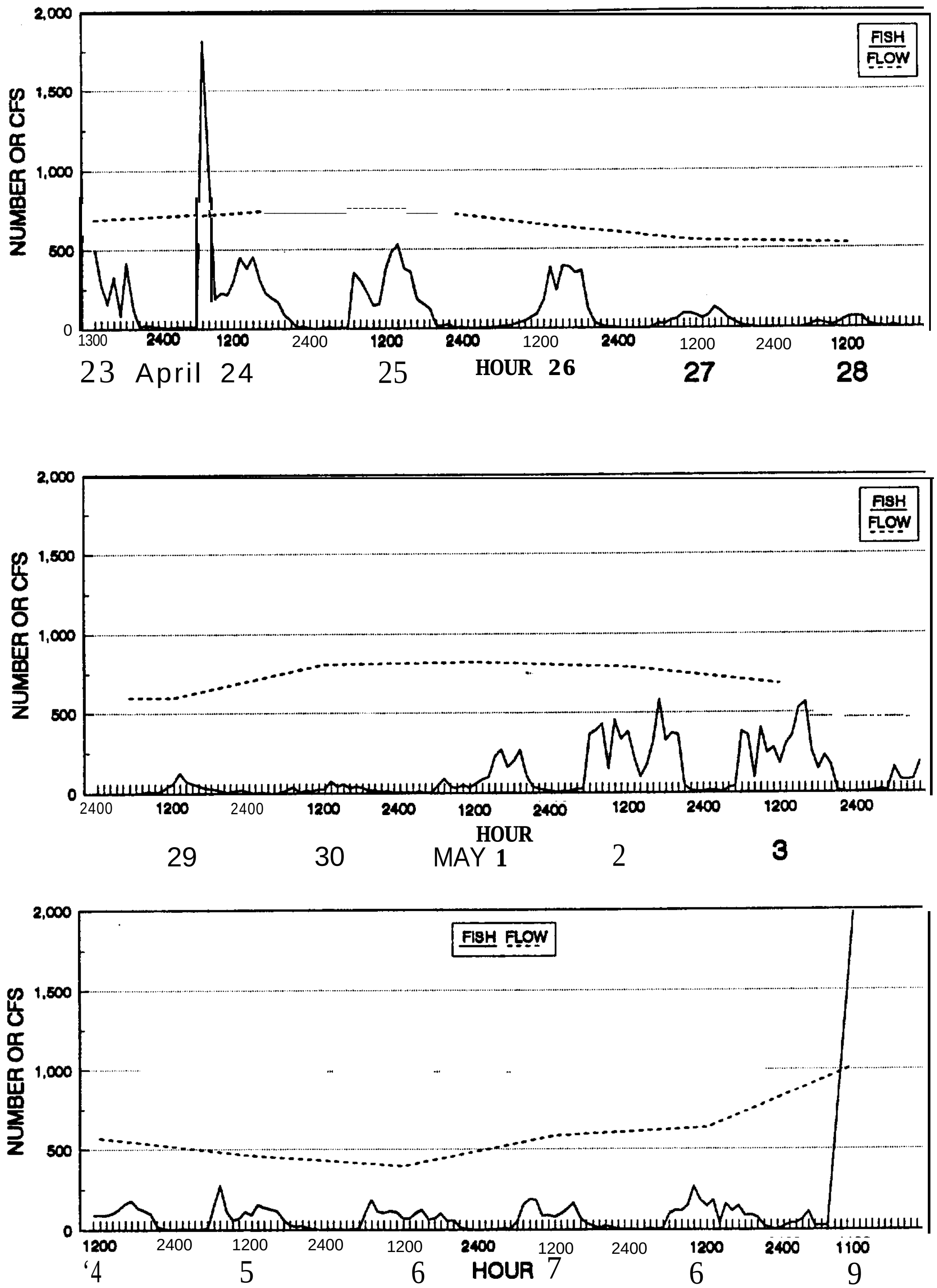


Figure 8. Number of river-run juvenile salmonids passing through the fish bypass facility at Three Mile Falls Dam and Umatilla River flows (cfs) near Umatilla, OR, 23 April - 9 May 1991.

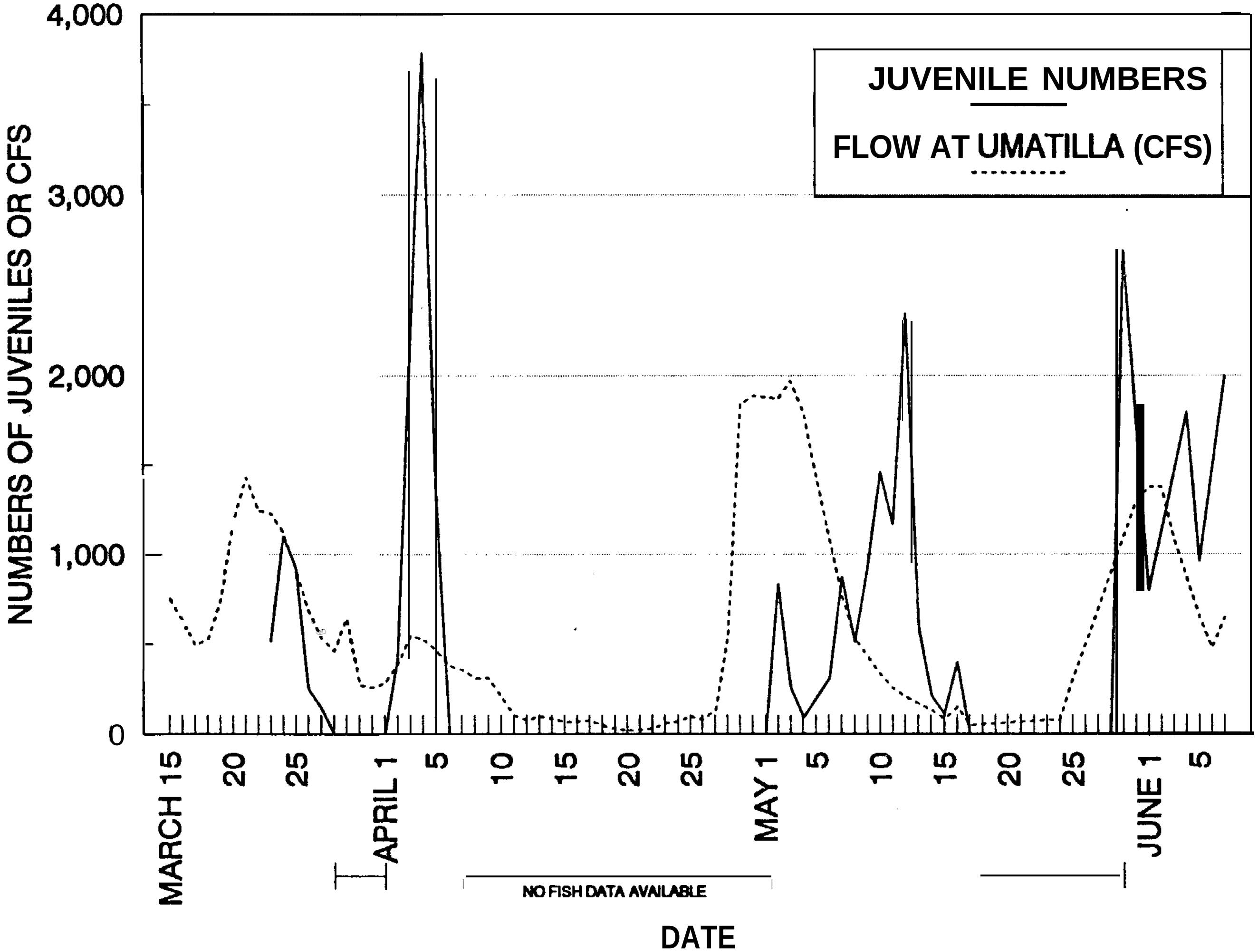


Figure 9. Video tape counts of river-run juvenile salmonids at the eastbank fish ladder, Three Mile Falls Dam and Umatilla River flows (cfs) near Umatilla, OR, 15 March – 7 June 1990.

DISCUSSION

Three Mile Falls Dam Juvenile Fish Bypass Facility Evaluation

Injury

Small sample sizes may have confounded some of our results. We-observed that negative net injury rates were obtained in the screen injury, bypass outfall and headgate injury tests, indicating the condition of post-test fish was better than pre-test fish. Besides the effects of small numbers of fish used to determine pre-test condition, these negative values were also a result of inherent variability in the descaling evaluation.

The results of the headgate injury test were also affected by small sample sizes and uncertainties about the condition of pre-test fish. Since few fish were available, no subsamples were evaluated for pre-test condition and the assumption that their condition was good may not have been valid. More thorough testing will be attempted in 1992.

Based on our tests at Three Mile Falls Dam and a review of other studies evaluating anadromous fish passage facilities in Northwestern rivers, it is unlikely that any significant injury of fish in the Umatilla River can be attributed to the WEID Canal fish bypass facility. Most of the high injury rates that occurred in our tests were part of the sampling procedure and were not caused by the facility. The low fish injury rates encountered during testing of fish passage through the fish bypass facility, past the screens, and through the outfall pipe at Three Mile Falls Dam were similar to results in the Yakima River, Washington. Evaluation at Yakima River screening facilities to determine passage injury to salmonids showed injury rates of less than 5% (Hosey & Associates 1990). Similar tests at other facilities on the Yakima River also showed low injury rates, generally less than 2% (Neitzel et al. 1985, 1986, 1988, 1990a, 1990b).

Leakage

The screening efficiency of the rotary screens at Three Mile Falls Dams was high and similar to the performance of screens at Yakima River facilities (Neitzel et al., 1988, 1990a, 1990b) . The only poor passage efficiency reported during that study was at the Westside Ditch (Neitzel et al. 1990b). In one test, 25% of river run chinook salmon fry passed through the screens, but the poor screen efficiency was believed to be caused by small fish size or behavioral differences. Generally, most evaluations of rotary screens have shown screening efficiencies greater than 99% and summary reports have suggested that angled screens are "highly effective" (Taft 1986) in preventing fish leakage. Continued maintenance of the facilities at Three Mile Falls Dam, emphasizing upkeep of the seals and adherence to operating criteria will ensure that juvenile fish are efficiently screened from the canal and returned to the Umatilla River.

Travel Time

Since canal flows were not altered during the screen injury test and we did not have detailed information on the movement of river-run fish, we could not directly determine if the upper bypass had the potential to delay fish migration. However, in most cases, at least 50% of the test fish moved through the WEID screening facility in less than 11 hours and it did not appear that fish movement was delayed. Our results were similar to the range of salmon and steelhead travel times reported in Yakima River screen facility evaluations (Hosey and Associates 1990; Neitzel et al. 1985, 1986, 1988, 1990a, 1990b). In both river systems, chinook salmon were found to move through the bypass facilities much more quickly than summer steelhead. Similarly, we found that salmon movement was affected by time of day with fish usually moving more rapidly at night.

Our analysis of travel times through the lower bypass during daylight hours indicated that fall chi-nook salmon and summer steelhead moved more slowly through the bypass outfall pipe at low flows than at high flows. Much of the slower movement in our tests was caused by fish holding in a pocket of water at the end of the bypass pipe to the outfall structure. We observed groups of fish holding in the outfall structure on several occasions, and this corroborated observations made in 1990 (Knapp and Ward 1990). Hosey and Associates (1990) found that for salmonids released in the early evening, movement through a Yakima River outfall bypass pipe was rapid. However, the flow volume in the WEID Canal is generally smaller than Yakima River canals and in combination with time of day variables, may partially account for the differences observed in our tests. Although Nietzel et al. (1985, 1986, 1988, 1990a, 1990b) did not directly test transit times through outfall pipes, they reported slower fish movement during low flows at several sites on the Yakima River and suggested that fish could be flushed through some facilities. We were able to flush fish through the bypass system when flow was 5 cfs by increasing flow to 25 cfs for a short period of time. Changes in the outfall design should be considered to reduce this problem and pass fish more rapidly at low flows. The operating guidelines at Three Mile Falls Dam (USBR 1989) that require 25-cfs bypass flow when the drum screens are installed and operating appear to be validated, and show the importance of providing higher bypass flows during critical migration periods to quickly return fish to the river.

It is likely that a wide range of fish migration behaviors will be observed during this study and the causes for different patterns will be difficult to ascertain. Several variables are involved that differ from river to river and could affect passage times, including size of fish, smolting stage, local flow conditions, stream history, and individual characteristics of the facility. Future testing may help to describe fish migration through the fish bypass facility and determine if it is any different from migration patterns in the river.

Passage

It appears that most juvenile salmonids move through the Umatilla River and into the Columbia River during short windows of opportunity. We stopped monitoring fish passage in early May 1991 and failed to separate fish species or strain; therefore, we could not determine how species-specific activity affected the counts. Fish counts in the WEID fish bypass facility increased in magnitude at daybreak. During our monitoring period, most scheduled hatchery releases in the Umatilla Basin were coho and chinook salmon (CTUIR 1991) and we assumed that these species comprised the bulk of daylight migration activity. This assumption was corroborated by data from Neitzel et al. (1987) where coho and chinook salmon in the Yakima River migrated at daybreak while steelhead migratory activity increased at sundown.

Although a clear relationship between fish passage and river flow was not established, it is probable that flow was important. Movement on 24 April may have been triggered by a peak flow of 1,020 cfs on 15 April. The count on 8 May coincided with flows greater than 1,000 cfs, but was not preceded by high flow. A combination of factors including river flow, fish size and condition, stocking locations and dates, and year to year seasonal variability will determine the exact timing of fish passage. Since a primary goal for the basin is to reestablish naturally producing salmonid populations (NPPC 1989), it is essential to accurately document the periods when peak migration occurs to ensure optimal operation of the WEID Canal fish bypass facility for efficient fish passage.

1992 Tests

Some of the tests completed in 1991 will be repeated in 1992 to improve on inconclusive or uncompleted tests. Several aspects of the evaluation can be improved to increase the confidence in our test results. An accurate analysis of fish injury caused by the facility depends on starting the tests with fish in good condition. In several cases, a significant portion of fish used in 1991 were in poor condition prior to testing. In addition, an attempt will be made to ensure more uniform size distribution within each test species group. It is probable that the wide size range of summer steelhead used added to the variability of the test results.

We will implement an improved statistical design in 1992 to provide more balance between treatment and control tests. Occasionally in 1991, we pooled controls thereby reducing the sample sizes for testing. We will also attempt to subsample a larger number of fish to determine the pre-test condition. The appearance of negative numbers in the computation of the net-injury rate may have been the result of subsampling a small number of fish. Our plans for 1992 at Three Mile Falls Dam are described in our statement of work (Appendix A). Work at Maxwell Dam will be discontinued because of plans by the Bureau of Reclamation to cease operation of this facility in the near future.

Operational and Structural Problems at Three Mile Falls Dam

Sampling Equipment

We experienced great difficulty in our efforts to remove and deploy the bypass channel sampling equipment (inclined screen and separator sample box) during our evaluation. The eauioment was cumbersome to maneuver and difficult to align properly. We also had difficulty changing from a full bypass mode to a sampling mode when fish were in the bypass channel. Unless fish were removed from the bypass channel between the weir gate and orifice plate before the inclined screen was deployed, they would become trapped underneath the inclined screen and be ultimately flushed through the auxiliary inflow system. Occasionally, this occurred and created blockages in the auxiliary inflow lines. To effectively drain and remove fish from this area, a stoplog was installed downstream of the traveling screen and fish were netted out.

There is no easy and efficient means to deploy the inclined screen, nor are operating instructions included in the designer's operating criteria for the facility (USBR 1989). We inserted an eye bolt into the top edge of the screen to permit lifting and maneuvering with the crane. The inclined screen needed to be in the correct location and proper position when lowered to attach it to the support frame. The side and bottom rubber seals tended to curl under the screen during deployment and extra effort was required to keep them properly aligned. Future operators of this equipment will need to be aware of the problems to ensure efficient and effective use.

Juvenile salmonids continued to escape into the bypass downwell instead of being diverted into the sampling-trapping area during the sampling mode. Although loss of fish was reduced with the installation of a 2-inch neoprene barrier at the downstream end of the separator in 1990 (Knapp and Ward .1990), some fish were still lost when fish entered the separator too rapidly or at a perpendicular orientation to the separator bars. Continued losses may require that the separator be redesigned or that another modified barrier device be installed. These losses primarily occurred when water flows and canal water levels were normal or somewhat high. At low river flows and a headworks water elevation below 404.1, water and fish trickle onto the separator and fish loss at the end is not a problem. The concern in this scenario is the need to prevent water loss through the separator top perforated plate, a recommendation that was made previously (Knapp and Ward 1990).

During sampling, we observed that fish became trapped behind a perforated plate on the back side of the sample box. Closer inspection revealed that a gap existed along the edge of the transfer chute that led from the separator sample box to the transfer flume. This gap probably resulted from bypass inflow water pressure distorting the separator assembly and leaving a gap on the upstream edge. Fish diverted into the transfer flume apparently swam back up the current, located the side gap, and swam behind the perforated plate, only to become trapped and die. This problem was most pronounced during the fall chinook outmigration because of the small average size of the chinook salmon subyearlings.

We documented several other fish-related structural problems that will require annual inspection and maintenance to correct or prevent, including an unsecured rubber seal at the bottom of the inclined screen. The primary concern is leakage or escape of fish, reducing diversion effectiveness. The fact that one fall chinook salmon subyearling (86mm in length) was captured in the fyke net at the terminus of the river return drain pipe indicates possible traveling screen leakage. Apparently, operational and structural problems pose the greatest threat to small fall chinook salmon subyearlings.

Traveling Screen

Fish impingement on the secondary screen (traveling screen) during the sampling mode was the primary biological problem observed at the facility. During the sampling mode, 20 cfs is taken through the traveling screen and pumped into the canal or returned to the river through the 21-inch diameter river return pipeline. The remaining 5 cfs passes through a bypass orifice plate at the downstream end of the secondary screen. When the sluice gate to the river return pipeline was opened rather than operating the pumps, we observed increased impingement rates of fry.

Contributing factors to this impingement problem may have included the presence of a hydraulically inefficient transition of 25 cfs flow from the bypass entrance to 5 cfs flow through the orifice plate. Because of an abrupt momentum loss upstream of the orifice plate, an unstable flow condition at the screen face was created that resulted in surging and instantaneous high velocity hot spots at the screen face. Depending on the degree of sluice gate opening, the flow through the traveling screen when excess bypass flow is being returned to the river can exceed 30 cfs (letter dated 10 October 1991 from W.S. Rainey, National Marine Fisheries Service, to J. Marcotte, Bonneville Power Administration).

As fish became impinged on the screen, they would "roll-over" to the back side of the screen because of insufficient spray water in the impingement location. Our observations were that impingement occurred entirely in the northeast corner of the rotating screen, an obvious "hot spot" area that did not receive sufficient flushing with spray water. Apparently, frequent plugging of the terminal spray nozzle on the spray water bar occurred because of river debris.

There exists a need to remedy the impingement problem with structural or operational modifications. A recommendation has been made to operate only one pump to reduce the bypass entrance flow from 25 cfs to 15 cfs, and reduce flow through the secondary screen by 50%. This approach would likely reduce surging near the secondary screen and allow more efficient hydraulic conditions for fish passing through the bypass orifice plate. This could be implemented if 15 cfs provides enough flow to efficiently return fish to the river. In addition, it was recommended that use of the sluice gate should be limited to short periods during daylight hours, when juvenile passage rates are presumed to be at the lowest levels, and throttled back as impingement is observed (letter dated 10 October 1991 from W. S. Rainey, National Marine Fisheries Service, to Jay Marcotte, Bonneville Power Administration). In light of our findings on die1 passage of river run fish in which passage rates were hishest during daylight hours, a nighttime operation of the sluice gate may be preferable. This would be particularly important during future high water events, when heavy river silt loads and sedimentation problems at the facility would require intensive sluicing efforts.

Operating Criteria

Fluctuations in headworks water level above or below the normal operating criteria of 404.1 are a concern because they affect bypass operations. At levels greater than 404.1, fish and debris may roll-over at the drum screens.

These situations may occur when river flow rises suddenly as during the flood in late May 1991. More than 80% of the drum screens were submerged during this high flow event. At levels less than 404.1 (403.9) sampling efforts are hampered because minimal water flows across the top of the inclined screen. This problem was reported previously (Knapp and Ward 1990) and may be a concern when trapping and hauling juvenile salmonids during low river flow.

Activities at Maxwell, Westland, and Cold Springs Diversion Dams

We encountered very few problems during testing of traps at Maxwell and Westland dams. At Maxwell Dam, the primary operational problem encountered was the formation of a backwash eddy in the front corners of the trap that stranded fish entering this area. It was necessary to push these fish into the main water flow for recapture in the live box. We subsequently modified the trap by riveting aluminum plates diagonally across the front corners to prevent stranding of fish. We also recovered less than 30% of subyearling chinook salmon released in front of the middle drum screen. These fish were observed schooling in the screen forebay. At Westland Dam, the net appeared to work well and the only modification made was the inclusion of additional floatation material on the live box. Our plans for 1992 at Westland Dam are described in our 1992 statement of work (Appendix A).

RECOMMENDATIONS

Based on our efforts during the evaluation, we recommend the following improvements to ensure safe and effective fish passage through the juvenile fish bypass facility at the WEID Canal.

1. The headgates and checkgates to the WEID Canal should be automated to ensure proper water level elevations in the forebay and headworks area at all times. A normal operating water surface elevation of 404.1 ft at the drum screens should be maintained whenever possible to ensure effective operation of the facility components.

2. All equipment seals should be .annually inspected and regularly replaced to prevent fish loss. This would include the secondary traveling screen, the primary drum screens, and bypass channel sampling equipment. Apparently, structural deficiencies pose the greatest threat to small fish (fry and subyearlings).

3. The operating criteria for the left bank fish facilities at Three Mile Falls Dam should be amended to include specific guidelines for operating the sluice gate to the 21-inch river return drain pipe, and for deploying sampling equipment. We recommend that the sluice gate not be operated during daylight hours when fish passage is most prevalent. Operators need to be made aware that their actions may cause injury to and loss of fish.

4. A mechanism to control the amount of water eliminated through the fish separator perforated plate is needed during low flow periods, particularly when trapping or sampling is occurring unattended. Fish can be stranded on the perforated plate, and in the sample box and transfer flume if little water reaches these areas.

5. In concurrence with the National Marine Fisheries Service, we recommend that only one pump be operated during modes other than a full bypass mode to reduce the bypass entrance flow from 25 cfs to 15 cfs. This would reduce by half the flow through the secondary screen and decrease surging in the separation chamber.

6. The operating criteria for the WEID Canal, as amended, should be followed in the effort to protect fish that move through the system. Operating guidelines and criteria should be made readily available for all users of the facility. Staff gauges should be installed at all critical locations to determine compliance with the operating criteria.

7. A means to prevent fish from leaving the transfer chute and entering behind the back perforated plate in the sample box should be investigated. Removal of the nonfunctional perf plate would eliminate this potential trapping site.

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APPENDIX A

1992 Planned Activities for the Umatilla River Passage Study

Goals and Objectives

Our study goal is to evaluate the passage of juvenile salmonids at diversions in the Umatilla River and make recommendations to improve passage, if applicable. We will investigate effects facility operation and structure have on juvenile fish and their ability to bypass diversions. Our efforts from 1989 through 1990 included modification and operation of the juvenile bypass system in the WEID Canal at Three Mile Falls Dam to obtain preliminary information on facility efficiency and juvenile salmonid condition and passage. In 1991, we prepared for and conducted a full-scale evaluation of juvenile passage at the WEID facility, and designed and fabricated some fish capture facilities for Maxwell, Westland, and Cold Springs dams to enhance our ability to conduct future evaluations of these facilities.

The three objectives for the 1991-1992 project period are to 1) determine if problems exist with passage of summer steelhead, and spring and fall races of chinook salmon through the headgates and the bypass system in the WEID Canal and through the eastbank adult fish ladder at Three Mile Falls Dam, 2) conduct a feasibility study at Westland Dam to ensure readiness for a 1993 evaluation, and 3) determine if flow characteristics at defined locations in the screening facilities at Three Mile Falls and Westland dams meet design specifications. Evaluation efforts at Maxwell Dam will be abandoned due to planned termination of canal and facility operation in the near future as a result of Phase II completion of the Flow Enhancement Project.

Definitions

Evaluation efforts will be accomplished in the context of specific task parameters. For clarity in the purpose of this study, these parameters are defined as follows:

Passage: the movement of fish through the components of a fishway or diversion screening facility, from their entrances to their river return outlets. Passage will also refer to "leakage" of juvenile fish through or over a screening structure.

Passage Success: the ability of fish to pass or navigate through a fishway or diversion bypass system and be returned to the river without incurring injury or mortality, or experiencing impediments to natural movement or, for juvenile fish, loss into the canal.

Diversion Rate: the cumulative percent of released juvenile fish that enter a diversion system.

Travel Time: average time for released fish to travel from a release point to a recovery point.

Injury: fish incurring body injuries or scale loss during passage from a release point to a recovery point.

Mortality: fish not surviving passage from a release point to a recovery point as a result of injuries.

Document: to observe presence or absence.

Estimate: to determine percent of fish in a release and recovery test.

Test Fish: fish used in a mark and recapture study.

River Run Fish: nontest fish that are part of the adult fish migration or juvenile fish outmigration.

Evaluation: the synthesis of estimates, observations, and determinations to determine the synergistic effects of a system in the overall context of passage success.

Specifically, we will repeat several injury and leakage tests and take additional velocity measurements at Three Mile Falls Dam because we were unable to satisfactorily complete these tests in 1990 and 1991. We will also 1) document passage and estimate injury of juvenile fish moving through the eastbank ladder at Three Mile Falls Dam, 2) take velocity measurements at specific locations in the Westland Canal screening facility, 3) operate the Westland facility bypass and associated structures, and 4) design and fabricate all collection traps to carry out an evaluation at Westland Dam in 1993.

We will estimate injury and mortality of fish associated with the Three Mile Falls Dam passage facilities by releasing groups of marked fish at various locations in the ladder and diversion canal, recapturing them at downstream sites, and inspecting them for mortality, descaling or other injury. We will make corresponding releases in the recapture facilities to assess and compare injury caused by the collection and handling process. We will estimate travel time by determining the difference between time of release and time of recapture. We will estimate diversion rates by the proportion of fish entering a diversion system from the total number of fish released in front of the headgates. We will estimate fish loss into the canal through the traveling screen by releasing groups of fish upstream from the screens and recapturing them in a fyke net set downstream from the screen. We will determine if velocity patterns adhere to design criteria by measuring approach and sweep velocities in front of the drum and traveling screens and at the entrances to the bypass channel and the fish return during various phases of operation.

Juvenile fish to be used in the evaluations will be held at hatchery or acclimation facilities and hauled to study sites prior to the tests for freeze branding or dyeing and acclimation. Fall chinook fry will be dyed. Freeze-branded fish will be held in separate containers approximately 48 hours before release.

will pattern our surveys after those performed by previous researchers (Abernethy et al. 1989, Abernethy et al. 1990). We will take measurements during low, normal and high diversion flows to ascertain adherence to screening facility design criteria.

Objectives and corresponding tasks for 1991-1992 are as follows.

Objective 1 Determine the passage success of summer steelhead, and spring and fall races of chinook salmon through the bypass system in the WEID Canal and the eastbank fish ladder at Three Mile Falls Dam.

Task 1.1 Estimate travel time, injury and mortality of summer steelhead associated with the drum screens at design flow: To estimate travel time, injury and mortality associated with the drum screens, we will release replicate groups of healthy, freeze-branded fish upstream of the screens, recapture them at the bypass collection facility, and examine the fish for descaling and other injuries (treatment). We will also release replicate groups of healthy, freeze-branded fish directly into the collection facility to allow us to evaluate injury caused by the collection and examination process (control). We will conduct tests during the day and at night and will repeat each day and night test on three different dates at design flow. Each treatment and control, day and night release will consist of three, 100-fish replicate groups. We will examine a 30% subsample from each replicate group for condition prior to release to ascertain pre-release condition. These subsample fish will not be returned to their groups. We will determine travel time from the release location upstream of the screens to the collection facility by estimating the time to recapture 50% (median travel time) and 95% of the released test fish.

We will use the method of Neitzel et al. (1985) to determine fish condition. The condition of recaptured fish will be categorized as healthy, partially descaled, descaled (or dead), and injured (Hosey & Associates 1988). We will use analysis of variance (ANOVA) to test the hypothesis that the relative condition of control and treatment fish in the various tests are equal in all releases. Sources of variation tested in the ANOVA will be 1) treatment versus control, and 2) time of day (day or night). We will transform the data as appropriate to meet the assumptions of ANOVA. For purposes of analysis, we will calculate pre-test condition (from subsamples) and post-test condition (from control or treatment fish) of fish observed as percentages of recaptured injured fish (the sum of partly descaled, descaled, and other injured fish). We will then calculate net injury rate as the difference between pre-test and post-test condition. We will compute a 95% confidence interval about the difference in the net injury rate between corresponding treatment and control groups.

Rationale: We were not able to satisfactorily complete the screen injury test for summer steelhead in 1991 because of accidental loss of test and control fish.

Products: We will compute mean and 95% confidence intervals for the total proportion of summer steelhead, injured, descaled or killed during passage past the screens. We will use analysis of variance to test for significant difference in injury rates between the respective treatment and control groups. We will compute travel time for 50% and 95% of the recaptured test fish.

Schedule: Test preparation will be completed during winter 1991-1992. Fish will be procured, branded and released during April 1992. Data analysis and a report of results will be completed by September 30, 1992 (Table 1)

Task 1.2 Estimate travel time, injury and mortality of fall chinook subyearlings associated with the bypass pipe and bypass outfall at 5 cfs and 25 cfs outfall flow: To estimate injury and mortality rates associated with the bypass pipe and bypass outfall, we will release replicate groups of healthy, freeze-branded fish at the entrance of the bypass pipe, recapture them at the bypass outfall to the river, and examine the fish for descaling and other injuries (treatment). A floating net pen placed directly beneath the outfall will be used to recapture treatment fish. We will also release replicate groups of healthy, freeze-branded fish directly into the floating net pen to allow us to evaluate injury caused by the collection and handling process (control). We will repeat each test on three different dates and at flows of 5 cfs and 25 cfs. Each treatment and control, 5 cfs and 25 cfs release will consist of three, 100-fish groups. We will examine a 30% subsample from each treatment and control replicate subgroup for condition prior to release to ascertain pre-release condition. These subsample fish will not be returned to their groups. We will determine if fish movement from the bypass downwell to the bypass outfall is impaired by computing the percentage of fish recaptured after a one-hour interval for 5 cfs and 25 cfs bypass flow.

We will examine fish for condition and analyze the data the same as discussed in Task 1.1

Rationale: We conducted the bypass pipe and bypass outfall injury test in 1991 with sub-par fall chinook subyearlings due to a protracted holding period caused by flooding and high flows.

Products: We will compute mean and 95% confidence intervals for the total proportion of fall chinook subyearlings injured, descaled or killed during passage from the entrance to the bypass pipe to the bypass outfall at the WEID facility. We will use analysis of variance to test for significant difference in injury rates between the respective treatment and control groups. We will compute the percentage of test fish recaptured after a one hour interval at operating conditions of 5 cfs and 25 cfs bypass flow to determine if fish movement through the lower bypass system is impaired.

Schedule: Test preparation will be completed during winter 1991-1992. Fish will be procured, branded and released during May 1992. Data analysis and a report of results will be completed by September 30, 1992.

Task 1.3 Estimate diversion rate, travel time, injury, and mortality of summer steelhead and spring and fall races of chinook salmon associated with operating the canal headgates at less than full headgate opening: To estimate injury and mortality associated with passage through a reduced headgate opening, we will release subgroups of healthy, freeze-branded fish upstream of the three headgates, recapture them at the collection facility, and examine them for descaling or other injury (treatment). We will set the headgate openings at approximately 1 ft. (1/3 of normal operation opening). We will follow the same procedures outlined in Task 1.1 to complete the test for each species or race of fish. Travel time will be estimated from the release location upstream of the headgates to the collection facility, as in Task 1.1 and 1.2. We will statistically compare mean travel time with travel time estimated in Task 1.1 for summer steelhead. Diversion rate will be estimated from the cumulative percentage of released fish entering the canal and arriving at the collection facility over time. We will examine fish for condition and analyze the data as discussed in Task 1.1.

Rationale: We observed velocity increases caused by reduced opening size of the headgates. Submergence of a reduced entrance opening may subject fish to nonfavorable hydraulics and encounters with debris piles.

Products: We will compute mean and 95% confidence intervals for the proportion of summer steelhead, spring chinook and fall chinook subyearlings injured, descaled or killed during diversion through reduced headgate openings into the WEID canal. We will use analysis of variance to test for significant difference in injury rates between treatment and control groups. We will compute travel time for 50% and 95% of the recapture test fish to determine if fish diversion is impeded by a reduction in the headgate opening.

Schedule: Fish will be procured, branded and released during April and May 1992. Data analysis and a report of results will be completed by September 30, 1992.

Task 1.4 Document passage (leakage) and impingement of fall chinook fry and subyearlings associated with the traveling screen when operating pump-back bay pumps in tandem or individually and varying gate openings of the river return drain pipe: To document the extent of passage around and over the traveling screen in the WEID canal of smaller-sized fish, we will install a fyke net at the terminus of the 21-inch diameter river return drain pipe. The drain pipe will be in operation during the sampling mode when the traveling screen is functioning but the pumpback pumps are not. All fish that pass through or over the operating traveling screen will eventually be diverted through the drain pipe and recaptured in the fyke net. We will count fish impinged on the traveling screen or fish that have leaked around the screen and into the fyke net at varying openings of the river return drain pipe. When river flow drops and bypass flow needs to be diverted back to the canal, the drain pipe will be closed and the pumpback pumps will be put into operation. We will count fish impinged on the traveling screen when operating the pumpback pumps in tandem or individually. Leakage can not be detected due to the inability to recapture fish during pump operation. To make counts and observations, we will release groups of fall chinook fry upstream of the traveling screen. We will also observe leakage and impingement during tests using fall chinook subyearlings and the during the subyearling outmigration.

Rationale: In 1991, we observed some impingement of fall chinook fry and subyearlings on the traveling screen in the WEID Canal during pumpback pump operations and at varying levels of river return drain pipe gate openings. We collected a fall chinook subyearling in a fyke net placed at the terminus of the river return drain pipe.

Products: We will document the presence or absence of leakage or impingement of fall chinook fry and subyearlings around or on the traveling screen associated with the operation of the pumpback pumps in varying combinations and with a full and throttled river return drain pipe gate opening.

Schedule: Fabrication of a new river return drain pipe fyke net will be completed during the fall of 1991. We will observe leakage and impingement of fall chinook fry in early April and of fall chinook subyearlings in May. A report of our observations will be completed by September 30, 1992.

Task 1.5 Estimate injury of spring chinook salmon at varying degrees of turbulence in the bypass downwell caused by changes in flow and water level: To estimate injury of spring chinook in the bypass downwell, we will release fish at the weir crest in the bypass channel and recapture them at the bypass outfall in the floating net pen. We will vary the bypass channel flow and water height in the downwell to test injury levels against varying turbulence conditions in the downwell. We will also release fish directly in the 24-inch bypass pipe to serve as our control. We will perform similar test procedures, examine fish and analyze data as discussed in Task 1.1.

Rationale: General observations of poor condition of spring chinook in the bypass pipe and outfall test conducted in 1991 indicate that turbulence in the bypass downwell may be causing injury.

Products: We will compute mean and 95% confidence intervals for the proportion of spring chinook that are injured or descaled during passage into the downwell at varying degrees of turbulence caused by changes in flow and water level. We will determine if injury rates of treatment fish are significantly different from control fish using ANOVA.

Schedule: See Table 1.

Task 1.6 Document passage, injury and mortality of Summer steelhead, and spring and fall races of chinook salmon associated with the eastbank fish ladder during the juvenile outmigration: To document the extent of passage of outmigrating juvenile salmonids through the eastbank fish ladder and possible injury and mortality associated with this passage, we will enumerate smolts passing by the fishway viewing window from video tapes of adult passage recorded by CTUIR. We will also visually observe movement of juvenile fish through the various components of the ladder, including the attraction water weir and the entrance pool and other diffusers. We will collect and brand good-condition fish at the bypass facility, release them in the upper portions of the ladder, and collect them at the base of the ladder to estimate injury incurred as fish pass through the ladder structure. Fish condition will be ascertained as described in previous tasks. We will release fish in our capture facilities to evaluate injury caused by collection and handling (control).

Rationale: We observed juvenile passage through the eastbank ladder in 1990 and recorded passage counts from video tapes of adult passage in the spring of 1990. Relative passage rates through the eastbank ladder appeared to be similar to passage through the westbank juvenile bypass facility during the same time period, indicating that smolts use the ladder as a means to bypass the dam even when the bypass is in operation.

Products: We will document numbers of juvenile summer steelhead, and spring and fall races of chinook salmon passing through the eastbank adult fish ladder at Three Mile Falls Dam in 1991 and 1992. We will estimate injury levels of juvenile salmonids passing through the ladder to preliminarily ascertain if ladder passage occurs in an effective and noninjurous manner.

Schedule: We will conduct visual observations and test releases at the eastbank ladder during the spring-summer outmigration from mid-April to mid-June 1992. We will read 1991 adult passage video tapes in the fall and winter of 1991-1992.

Objective 2 Ensure efficient operation of the juvenile salmonid bypass and collection system in the canal at Westland Diversion Dam, and design, fabricate, and test all necessary capture facilities in preparation for passage evaluation activities in 1993.

Tasks 2.1 Operate the bypass and holding pond facilities at Westland Dam: We will operate the bypass and holding pond facilities in concert with irrigation district and trap and haul personnel to familiarize ourselves with the overall operation and ensure that the facilities operate as designed. We will test operate all systems and structures, including gates, pumps, fish separator, bypass inflow and outflow, the juvenile holding pond and associated sampling system, and the drum and traveling screens. All aspects of the day to day operation of the facility will be monitored. We will test operate the bypass facility when juvenile salmonids are migrating past Westland Dam. We will test operate the juvenile collection and holding system during trap and haul operations when river flow is low.

Rationale: We were not able to gain a thorough understanding of facility operation through extensive hands-on experience in 1991 because of limited manpower resources and time constraints. Ability to conduct a successful evaluation is contingent on operational expertise due to the complexity and uniqueness of the Westland Canal system and juvenile facility.

Products: Thorough knowledge of facility operation at Westland Dam and ensurance of an efficient and properly functioning system that will be ready to evaluate after October 1, 1992.

Schedule: We will familiarize ourselves with the system through hands-on operation during the 1992 spring, summer, and fall juvenile outmigration. A report of activities and findings will be completed by September 30, 1991.

Task 2.2 Design, fabricate and test capture facilities necessary for conducting evaluation activities in 1993 at Westland Dam: We will design and fabricate collection facilities to be used at the bypass outlet, downstream of the drum and traveling screens, and in the bypass channel in the Westland Canal. These capture facilities will be used in various injury and leakage tests in 1993. Traps will be similar in design to those used in evaluations at Three Mile Falls Dam.

We will test operate the collection facilities during the migration period of juvenile salmonids.

We will release and recapture marked fish to evaluate the efficiency of the traps in capturing the majority of fish, and to ensure that the trapping process does not result in excess injury or mortality. A modified fyke net with floating live box has been fabricated and tested and will be used for capturing test fish in the juvenile holding pond. We will collect samples of river run fish in these traps to determine if injury or mortality levels are obviously high.

Rationale: We were not able to satisfactorily complete bypass channel and bypass outlet capture facility design and fabrication due to structural complexities of the bypass system and "flood-caused" alteration of the river channel at the outlet.

Products: Ability to efficiently and effectively collect fish at defined locations in the canal and bypass system at Westland Dam. Ability to conduct tests to determine passage success of juvenile salmonids through the bypass system in the Westland Canal after October 1, 1992. Documentation of high injury or mortality rates of river run fish.

Schedule: Traps will be designed and fabricated during spring 1992. Traps will be test operated during summer and fall 1992. A report of results will be completed by September 30, 1992.

Objective 3 Determine if velocities at defined locations in the bypass systems at Three Mile Falls and Westland dams meet design criteria.

Task 3.1 Measure approach velocity in the bypass channel and approach and sweep velocities through the traveling screen at Three Mile Falls Dam: We will use an electromagnetic water current meter and record velocities (feet per second) at 0.2, 0.5, and 0.8 percent of water depth. Measurements will be taken at centerline and at the upstream and downstream edges of the traveling screen, and at the entrance to the bypass channel. The probe will be positioned parallel to the screen pointing upstream for recording sweeping velocities and pointed perpendicularly away from the screen for recording approach velocities. We will measure velocities at the traveling screen and at the entrance to the bypass channel during operation of the pumpback pump in tandem or individually and at varying gate openings of the river return drain pipe. We will also measure velocities in the bypass channel during a 25-cfs flow. Headwork elevation, canal flow and operating conditions, water depth, and time to measure will be noted.

Products: We will determine if velocity patterns meet design criteria at the bypass channel entrance and at defined locations in front of the traveling screen during varying operations of pumpback pumps and river return drain pipe gate in the WEID Canal at Three Mile Falls Dam.

Schedule: We will measure velocity patterns at defined locations in the WEID Canal during April and May 1992.

Task 3.2 Measure approach and sweep velocity at the drum screens, traveling screens, and entrance to the bypass channel at Westland Dam: We will follow the same procedure as described in Task 3.1. We will take measurements during low, medium and high canal flows to determine if velocity patterns meet criteria at all operations. Drum screen velocity measurements will be taken close to the screens and at the centerline perimeter of the screens. Headworks elevation, canal flow and operating conditions, drum screen submerged depth, and traveling screen operations will be recorded.

Products: We will determine if velocity patterns meet design criteria at the drum screens, traveling screens and at the entrance to the bypass channel at Westland Dam at low, medium and high canal flows.

Schedule: We will measure velocity patterns at defined locations in the Westland Canal from April to June 1992.

REFERENCES

Abernethy, C.S., D.A. Neitzel, and E.W. Lusty. 1989. Velocity measurements at six fish screening facilities in the Yakima River Basin, Washington, summer 1988. Prepared by the Pacific Northwest Laboratory, Richland, Washington, for the Division of Fish and Wildlife, Bonneville Power Administration, Portland, Oregon.

Abernethy, C.S., D.A. Neitzel, and E.W. Lusty. 1990. Velocity measurements at three fish screening facilities in the Yakima Basin, Washington, summer 1989. Prepared by the Pacific Northwest Laboratory, Richland, Washington, for the Division of Fish and Wildlife, Bonneville Power Administration, Portland, Oregon.

Hosey and Associates. 1988. Evaluation of effectiveness of fish protection facilities. Chandler facility evaluation. Report by Hosey & Associates Engineering Company for the U.S. Bureau of Reclamation.

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Table 1. Activity schedule summary for evaluating juvenile salmonid passage facilities at Three Mile Falls and Westland dams, October 1991 through September 1992.

	Month											
Activity	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Gear Preparation	—	—	—	—	—	—						
Study Design	—											
Task 1.1							—					
Task 1.2												
Task 1.3							—	—				
Task 1.4							—	—				
Task 1.5												
Task 1.6			—	—	—	—	—	—				
Task 2.1							—	—	—	—	—	—
Task 2.2				—	—	—	—	—	—	—	—	—
Task 3.1							—	—	—	—		
Task 3.2							—	—	—	—	—	—
Data Analysis									—	—		
Report Writing										—	—	—