

FISHWAY INSPECTIONS AT COLUMBIA AND SNAKE RIVER DAMS, 1998

INTRODUCTION

Fish agency personnel inspected fish passage facilities at 13 hydroelectric dams located on the Snake and Columbia rivers. These projects were inspected monthly to assure that fish facilities were being operated according to established criteria documented in the Corps of Engineer (COE) Fish Passage Plan (FPP), or in the Detailed Fishery Operating Plan (DFOP) for the Public Utility District (PUD) projects in the Mid-Columbia. The Fish Passage Center (FPC) coordinated the fishway inspection program for the State and Federal fish agencies. The FPC continued to coordinate special fish facility operations with fish and wildlife agencies and tribes. This report summarizes results obtained from the individual project inspections during the 1998 fish passage season.

The inspection program normally covers the March or April through October or November months, a time frame when most adult and juvenile fish are passing the mainstem dams. The fish facilities are normally inspected 7 or 8 times during the season by a State or Federal inspector. The FPC coordinator makes site visits with the inspectors on several occasions during the year, generally early and late in the fish passage season. The monthly project inspections were coordinated with the salmon managers as well as the operating agencies, i.e., the COE and PUD through monthly updates or forums such as the Fish Passage Operations and Maintenance Committee (FPOM). The main goal of a fishway inspection is to assess passage conditions at the time of the inspection and then throughout the fish passage season. Out-of-criteria problem areas are then coordinated with the projects for resolution, where possible. The agency representative is responsible for coordinating these problems to project personnel. The monthly update and this final Report by the FPC operations coordinator will serve to alert the operating agency of problems that were noted during the inspections, and that require resolution in some cases.

BACKGROUND

Adult fish passage facilities were incorporated into thirteen mainstem Columbia and Snake River dams. Fish passage was blocked in the Columbia River at Grand Coulee Dam and in the Snake River at Brownlee Dam. Fish passage criteria have been developed to achieve known hydraulic conditions within a fishway that should provide adult fish with acceptable swimming conditions through the projects to reduce potential migration delays and mortality of upstream migrating adult fish.

The operating agencies are expected to operate their fish facilities within the agreed upon criteria unless a major equipment failure or other problem occurs that would prevent operation of the fish facilities

within best operating ranges. The operating agencies are responsible for maintenance of the fish facilities and for operating them at the agreed upon criteria year round, with special or annual maintenance accomplished during the winter maintenance period. Planned fishway outages occur mainly when adult fish passage is minimal, such as the winter season. Outages during the fish passage season require special coordination between the operating entities and the fishery agencies and tribes.

Through the fish passage season, project personnel on at least a daily basis inspect the fish facilities. Most adult fishways operate in an automatic mode and require no manual adjustments unless the equipment malfunctions. The project operators normally will put a fishway back in criteria as a discrepancy is found.

Key items recorded during an inspection include: weir gate depths at the main fishway entrances, hydraulic head differentials at the entrances and along the channels, depth of water over the fish ladder weirs, collection or transportation channel velocities, head differentials across trashracks, picketed leads, powerhouse operations including number of fish turbines operating and at what Mw or Q , number of spill bays operating and quantity of spill, and other measurements. Inspections of juvenile fish facilities are normally completed while on site as well. The fishway inspectors usually schedule their monthly inspections with the project prior to the inspection date, however, the inspections can be made unannounced. The inspectors always check into a project to announce that they will be completing an inspection. The inspectors are responsible for contacting project operations personnel to review the inspection and coordinate problems that require correction. A completed copy of the inspection report can be left at the project or sent to the project operations biologist. The FPC fishway coordinator receives a copy of the inspection, reviews it, and then follows up on problem areas that were noted with the COE project or district fish biologists.

The Fish Passage Center has been coordinating fishway inspections at the mainstem Columbia and Snake River projects since 1984. The 1998 season was a continuation of the long-term inspection program that the State and Federal fish agencies have endorsed since the 1960's. Funding for the inspection program comes from Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), National Marine Fisheries Service (NMFS), and the United States Fish and Wildlife Service (USFWS).

GENERAL RESULTS

Inspections were completed on a monthly basis in 1998 at all the mainstem dams. Most projects operated their fish facilities close to accepted criteria during the adult fish migration season. Monthly updates of the 1998 inspection reports were summarized and distributed to the Salmon Managers and

COE and PUD operations biologists or operations personnel. Other pertinent adult passage information was disseminated weekly or bi-weekly in FPC reports.

Key factors that affected fishway operations at the mainstem dams during the 1998 fish passage season are listed below:

- Medium to high flows and spills were prevalent during the spring and early summer months in the Snake and Columbia rivers in 1998.
- Debris loads brought down the river due to the spring freshet caused some problems related to operating fish facilities, but was considerably reduced from the previous year.
- The Snake River projects were operated at Minimum Operating Pool (MOP) plus 1-ft during the spring and summer months to improve juvenile fish passage conditions. The additional 1-ft was required to assist passage of navigation barges up and down stream through the lock channel. During the summer months, some fishway entrances at the Snake River dams were operated at reduced weir depths due to the gates resting on sills (no additional depth can be achieved).
- Mechanical failures on essential fishway equipment such as fish pumps, fish turbines, or other auxiliary water equipment were minimal during the 1998 fish passage season.

SUMMARY BY PROJECT

State and Federal Fishery Agency personnel completed fish facilities inspections and results from the inspections are summarized by project below. Dates of inspections and problem areas are noted as well as special activities that occurred during the year. The criteria used to evaluate a fishway's operation are found in the FPP and DFOP for each project.

BONNEVILLE DAM

Bonneville Dam has two powerhouses with powerhouse one (ph1) constructed in 1938, located on the Oregon shore or south shore of the Columbia River, and powerhouse two (ph2), constructed in 1981, located on the Washington shore or north shore of the Columbia River. Powerhouse one contains ten main turbine units while the new powerhouse has eight main turbine units and two smaller fish turbines that supply water for the WA shore fishway. Between the two powerhouses is the spillway that incorporates 18 spillbays to pass excess or designated flow past the project. The adult fishways consist of gravity-flow water provided to the auxiliary water system that supplies attraction-flow water to the main fishway entrances at ph1 and the spillway entrances. At ph2, the two fish turbines together supply about 5,000 cfs of water to the auxiliary water system that distributes flow to the four main entrances and the orifices along the powerhouse collection channel.

1998 Fishway Inspections

Ed Meyer, NMFS, completed nine inspections of the adult and juvenile fish facilities at Bonneville

Dam during 1998. The fish facilities were inspected from March through November (Table 1). Generally the inspector followed this routine:

1. The inspector met with the project biologist(s) prior to inspecting the fishway to determine existing problem areas with the fish facilities or related equipment, and what corrective actions were being taken by the project to remedy the problems;
2. Completes the on-site inspection; which includes taking computer readings at the control room and B- and Cascades Island fishways, and comparing those readings to the on-site readings taken from staff gages or other sensors and
3. Normally, after the inspection, out-of-criteria problems noted by the inspector were discussed with the project biologist(s) for possible resolution.

Powerhouse 1 Fishway

The auxiliary water supply to the fishway is gravity flow water supplied from the forebay. Normally the auxiliary water source can supply adequate flow to meet criteria through high and low flow tailwater elevations. The old ph main entrances are operated in pairs, i.e., Gate 2 and Gate 64, or Gate 1 and Gate 65 depending on tailwater elevation. Five orifice gates or 5 sluice gates operate along the powerhouse collection channel depending on tailwater elevation.

Weir Gate 2 located at the south end of the powerhouse had head differentials that ranged between 0.9 ft and 1.6 ft. The gate depths ranged from a low of 2.6 ft to a high reading of 13.9 ft for the season, with the readings less than 8 ft on 4 of the 9 inspections. According to the FPP, the gates at the south end of the powerhouse are set to maintain head differential along the channel and in doing so, keep the velocity at a satisfactory rate in the channel. After reviewing the problem in the FPOM meeting, it appears that the project will change the criteria to include a minimum depth of 6-ft at the entrance in addition to the minimum head differential reading of 1.0 ft. Direct reading of the gate positions was not possible so it was always difficult to assess what depth the gate was positioned without using the computer reading. Weir Gates 64 and 65 are located on the north end of the powerhouse. Normally one gate operates to meet the gate depth criteria depending on the tailwater elevation. Gate 64 operated on 8 of the 9 inspections with Gate 65 operating during the high flow period when tailwater elevations exceeded 26-ft (May). The gate depths at the A-Branch entrances ranged from 5.3 ft to 11.6 ft with head differentials through the season ranging from 1.0 ft to 1.7 ft. The main problem was noted on June 23 when only 5.3 ft gate depth was recorded. It is unknown whether this was a computer-related problem (most likely) or if the Gate was stuck in place.

Channel velocities along the powerhouse collection channel ranged from less than 1.0 fps to 2.6 fps and 7 of the 9 records were within the criteria range of 1.5 to 4.0 fps. On August 27, the velocity was reported at < 1.0 ft, due mainly to the way the channel and Gate 2 was set. Gate 2 was recorded at only

Table 1. Pertinent Data for Fish Facility Inspections in 1998 at BONNEVILLE DAM.

CRITERIA ITEMS	DATE OF INSPECTION									
	<u>Bradford Island Fishway</u>	<u>27-Mar</u>	<u>28-Apr</u>	<u>27-May</u>	<u>23-Jun</u>	<u>28-Jul</u>	<u>27-Aug</u>	<u>17-Sep</u>	<u>29-Oct</u>	<u>20-Nov</u>
<i>Bradford Island Entrances</i>										
Criteria: (Head Differ. = 1.0-2.0 ft); (Weir Depth + 8 ft or >); (Depth over ladder weirs = 1-1.3 ft); (Velocity + 1.5-4.0 ft)										
Head at A-Branch entrance	ft	1.5	1.5	1.6	1.3	1.7	1.7	1.0	1.4	1.4
Depth over Gate 64/65	ft	8.2	8.4	8.7	5.3	8.2	7.7	11.6	6.6	8.5
Head at South ph entrance	ft	1.1	1.3	1.4	1.3	1.6	1.2	1.6	1.1	0.9
Depth over Gate 1/2	ft	11.6	13.9	10.8	8.4	7.3	2.6	8.4	6.5	7.6
Channel Velocity	fps	2.0	1.3-2.6	2.2	OOS	2.0	<1.0	1.5-2.5	1.5-2.2	1.5-2.2
Depth over ladder weir (1.0-1.3ft)	ft	1.2	1.0	1.3	1.3	1.0	1.1	1.1	1.0	1.0
Exit clean (Yes or No)		yes	yes	yes	yes	yes	yes	yes	yes	yes
B-Branch Entrance										
Head at B Branch entrance	ft	1.3	1.6	1.5	1.4	1.6	1.5	1.4	1.6	1.6
Staff gages clean		yes	yes	yes	yes	yes	yes	yes	yes	yes
Cascades Island Entrance										
Head at main entrance	ft	1.6	1.5	1.7	1.3	1.5	1.5	1.5	1.5	1.2
Depth over ladder weir	ft	1.2	1.0	1.3	1.3	1.3	1.2	1.1	1.0	1.0
<u>Washington Shore Fishway</u>										
WA Shore Entrance:										
Depth over entrance weir (Criteria = 13.0 ft or >)										
NUE	ft	6.9	6.5	5.8	13.2	13.7	10.3	13.8	7.9	8.9
NDE	ft	7.9	6.5	5.8	13.3	13.6	10.2	13.8	7.9	1.1
SUE	ft	6.3	6.3	13.5	13.3	13.3	10.4	13.8	7.7	8.3
SDE	ft	13.4	10.2	13.5	13.3	13.3	10.1	13.8	7.7	11.2
Head at entrance (Criteria = 1.0-2.0 ft)										
NUE	ft	1.2	1.4	1.4	1.9	1.7	1.8	1.6	1.7	1.1
NDE	ft	1.1	1.3	1.4	1.4	1.3	1.5	1.4	1.5	1.1
SUE	ft	1.2	1.2	1.2	1.6	1.4	1.0	0.8	1.0	0.8
SDE	ft	1.1	1.2	1.2	1.3	1.4	1.2	0.8	1.0	0.4
Depth over ladder weir	ft	1.0	1.1	1.3	1.3	1.4	1.1	1.1	1.0	1.1
Channel Velocity (Elect. Meter)		OOS	2.2	OOS	OOS	1.5	1.8	1.6	unk	2.0
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes	yes	yes
Staff gages clean		no	yes	yes	yes	no	yes	yes	yes	yes
Comment # (if applicable)		1	1	2	3	4	5		6	7

Comments:

1. Fish Turbine F-2 at ph2 was OOS so the project was operating at 1-unit levels.
2. Fish Trubine F-2 still OOS. Several diffuser valves were being worked on by the project for use in Cascade Is fishway. A large boil was noted at FG3-5
3. All velocity meters were out of service. Entrance Gate 64 was submerged only 5.3 ft instead of greater than 8.0 ft.
4. A dead lamprey recovered at p2 DSM channel. Electionic velocity meter was OOS.
5. Entrance Gate #2 was submerged only 2.6 ft rather than 8.0 ft or greater.
6. Most gates were on sill; UMT was closed.
7. Fish Unit F-2 was OOS; COE should have started ice/trash sluice to supplement single turbine flow to fishway. The Project needed to calibrate the control panel at ph2; head differentials were less than 1.0 ft minimum.

2.6 ft submerged below tailwater, and this essentially reduced flow down the collection channel, and resulted in the low velocity that day. The velocity readings were normally taken from the older mechanical velocity reader installed in the southern end of the channel and from an electronic velocity meter installed at the northern end of the channel.

South Spillway or B-branch Fishway and the **North Spillway or Cascades Island Fishway** are part of the original fishway system with detailed write-up in the Bonneville Dam section of the FPP. Gravity flow water is supplied from the forebay, through the diffusion system into the lower end of the fish ladder. Both fishways have similar main entrances (design-wise) with side and downstream entrances that operate as continuously open free-flowing vertical slots. Adjacent to each entrance is a spill bay (1 or 18) that is operated at a minimum of 4-inches open or passes about 1 kcfs of water. Each main entrance requires a head differential of between 1.0 to 2.0 ft with the targeted head of 1.5 ft.

During 1998, the B-branch entrance operated within a range of 1.3 to 1.6 ft, while the Cascades Island entrance operated within a range of 1.2 to 1.7 ft. Head differentials for the B-branch and Cascades Island entrances were within criteria range during the entire fish passage season. The supply valves worked satisfactorily as well. Only on occasion was there a diffuser valve found out of sequence.

Fish Ladder: Depth of water measured over the Bradford Island fish ladder weirs ranged from 1.0 to 1.3 ft. The readings should be between 1.1 to 1.25 ft to equate to about 1.3 ft of water down the individual A- and B-branch fish ladders. The fish ladder exit at Bradford Island was reported clear of debris on all inspections during the 1998 fish passage season. The depth of water measured over the Cascades Island fish ladder weirs ranged between 1.0 ft to 1.3 ft as well and fell within the normal range for depth of water over the fish ladder weir crests.

Powerhouse 2 Fishway

Fish turbines F1 and F2 were operated whenever possible during the fish passage season and supplied about 5,000 cfs of water to the main entrances and orifice gates along the powerhouse collection channel. During the evenings (approximately midnight to 3 a.m.) the fish units were simultaneously shut down to float debris off the trashracks and reduce the head differential across the racks. This action appeared to keep the head differential across the trashracks in an acceptable range as the project did not rake the racks during the fish passage season. Note that shutting down the fish turbines would not change the fish ladder operation only the attraction flows from the main entrance gates for the 3-h time period.

During the winter maintenance period, Fish Unit F2 was out of service for repairs. The project did not receive the rotor and other parts in time to allow the project to fix the Unit prior to the fish migration season. In fact, the WA shore fishway was operated with one fish turbine until late May when the

second unit was brought back on-line. **Basically, adult fish passage at the WA fishway was compromised for a large part of the spring fish passage season.**

The head differentials measured at the four main entrances ranged between 0.8 ft and 1.9 ft for the March through October inspections with the head only 0.4 ft and 0.8 ft at the SUE and SDE during the November inspection when only one fish unit was operating. **The project was not operating the fishway correctly for having only one fish turbine on-line during the November inspection.** The ice trash sluice should have been adding water to the channel to meet full criteria for the fishway. The gate depths were normally set correctly except for the November inspection when the NDE was submerged only 1.1 ft. That gate should have been closed. The gates were on sill, elevation 1.0 ft, during the August and October inspections. The project can normally keep gate depths within criteria range (about 13.0 ft submerged) under all tailwater elevations above elevation 14.

Fish Ladder: The exit from the fish ladder as well as the serpentine section of the fish ladder was reported clear of debris during 1998. The depth of water measured over the fish ladder weirs was operated close to criteria (1.0-1.4 ft) during the inspection season at the WA fish ladder. We did note that a heavy equipment operator was working too close to the fish ladder on one inspection, and this was reported to the project for action.

Overall, problem areas that occurred at Bonneville Dam during 1998 that could have affected fish passage are listed below:

- Fish turbine F2 was out of service for the spring migration season (March through late May) and as a result less attraction flow was provided at the WA fishway.
- Water temperatures during the summer and fall months were very high, greater than 70°F and were a major concern regarding handling of adult fish at the trapping facility in the WA fish ladder. Operating the adult fish trap can also result in fish being delayed at the project.
- The project should increase the requirement for weir depth at the south end of ph1 and have a minimum requirement of 6.0 ft weir submergence along with the normal head criteria to achieve the proper velocities through the ph1 channel. This should be placed into the 1999 FPP to assure that better adult passage conditions occur during low tailwater conditions at the project.
- The project should modify their fishway control panel at ph2 and assure that the controlling system is calibrated with the on-site readings as well as in the Control Room of the dam. The system should be run on auto as much as possible rather than manual.
- The project should place a gage in/on the south shore weirs at ph1 so that an on-site elevation reading can be taken and then compared to the computer reading to assure the gates are calibrated correctly.

THE DALLES DAM

At The Dalles Dam, two fish turbines supply auxiliary water to the Oregon fishway with a smaller fish turbine supplying auxiliary water to the Washington fishway. Approximately 5,000 cfs of water is distributed from these fish turbines to the East, West, and South fishway entrances as well as to the orifice gates along the powerhouse collection channel. The WA fish turbine normally supplies about 800 cfs to the operating entrance, usually Gate N-1.

Doug Case, Oregon Department of Fish & Wildlife (ODFW) inspector for the 1998 fish passage season, completed eight fishway inspections beginning on March 30 and ending on October 7 (Table 2). Spill was present during the April through August inspection with no spill in September and October or the initial inspection in March.

East Fishway Inspections

The East fishway entrance gates (E-2 and E-3) were submerged 8.0 feet or greater on 7 of the 8 inspections (range was 8.1 ft to 8.8 ft). The head differentials ranged from 0.9 ft to 1.8 ft. East entrance gate E-1 had about 5.3 ft depth over the weir with the high tailwater elevations that occurred during May. Normally the weir is not operated and the weir gate set at elevation 81. The project coordinated a short outage of one fish turbine during August and the fishway was set up with one weir operating (Table 2). Normally, the East fishway entrances were found operating in satisfactory criteria range during the inspections completed in 1998.

The velocity was taken via a continuous recording unit at the eastern end of the powerhouse collection channel and then estimated by the inspector at the midpoint and western end of the channel. Water velocity in the collection channel ranged between 1.0-2.0 fps at the eastern end and increased to approximately 1.5-3.0 fps at the western end. The orifice gates located along the collection channel worked satisfactorily during the 1998 fish passage season. We did not see any orifice gates overtopped with water as was common during the high tailwater elevations that were present in 1997.

The West fishway entrances (W-1 and W-2) were submerged 8.0 feet or greater on all inspections during 1998 with exception of the August inspection when only one fish turbine was operating. The gate depths ranged from 8.0 ft to 11.0 ft. Head differential readings ranged between 1.0 and 1.4 ft. All inspection reports indicated that operation of the weirs in 1998 was satisfactory and within acceptable criteria.

The South fishway entrances (S-1 and S-2) were normally operated very close to criteria regarding gate depth, with 8.0 ft average depth or greater recorded through the passage season. Gate depths ranged from 7.8 ft to 9.1 ft. During the May and June inspections, the two operating gates were about 1.0 ft different from the adjacent operating gate (See Table 2). Head differential ranged from 0.9 ft to 1.5 ft

Table 2. Pertinent Data for Fish Facility Inspections in 1998 at THE DALLES DAM.

<u>CRITERIA ITEMS</u>	<u>DATE OF INSPECTION</u>								
	<u>30-Mar</u>	<u>21-Apr</u>	<u>7-May</u>	<u>10-Jun</u>	<u>14-Jul</u>	<u>6-Aug</u>	<u>10-Sep</u>	<u>7-Oct</u>	
<u>SOUTH SHORE FISHWAY</u>									
<i>East Entrance:</i>									
Depth over entrance weir									
E-1 (gate set at elev. 81.0 ft)	ft	0.0	0.0	5.3	2.3	0.0	0.0	0.0	0.0
E-2 (crit. = 8 ft or >)	ft	8.3	8.3	8.7	8.1	8.8	0.0	8.5	8.4
E-3 (crit. = 8 ft or >)	ft	8.3	8.1	8.3	8.3	8.6	5.9	8.7	8.6
Head at main entrance (crit. = 1-2 ft)	ft	1.7	1.8	0.9	1.7	1.6	1.5	1.6	1.6
Depth over ladr. weir (crit. = 1-1.3 ft)	ft	1.1	1.1	1.0	1.3	1.3	1.3	1.1	1.2
Channel Velocity (crit. = 1.5 - 4.0 fps)	fps	2.0-3.0	1.5-2.0	2.0	1.4	1.4	0.2	1.0-1.5	1.0-2.0
Ladder exit clean (yes or no)		no	yes	yes	Note1	yes	yes	yes	yes
Selsyns operating (yes or no)		yes	yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		no	yes	yes	no	no	no	no	no
<i>West Entrance:</i>									
Depth over entrance weir									
W-1 (crit. = 8 ft or >)	ft	9.1	8.0	8.5	8.5	8.3	6.0	8.2	8.1
W-2 (crit. = 8 ft or >)	ft	8.1	8.7	8.7	9.9	11.0	0.0	10.0	8.9
Head at main entrance (crit. = 1-2 ft)	ft	1.4	1.1	1.0	1.3	1.0	1.1	1.0	1.1
<i>South Entrance:</i>									
Depth over entrance weir									
S-1 (Crit. = 8 ft or >)	ft	7.8	8.7	8.9	8.8	8.8	6.8	8.6	8.7
S-2 (Crit. = 8 ft or >)	ft	8.2	8.2	7.9	7.9	9.1	0.0	8.7	8.6
Head at main entrance (Crit. = 1-2 ft)	ft	0.9	1.2	1.2	1.5	1.0	1.5	0.9	1.0
<u>NORTH SHORE FISHWAY</u>									
<i>North Shore Entrance:</i>									
Depth over entrance weir									
N-1 (crit. = 8 ft or >)	ft	9.5	9.3	10.2	12.4	9.0	8.9	8.5	8.7
Head at main entrance (Crit. = 1-2 ft)	ft	1.2	1.0	1.2	0.8	1.6	1.3	1.5	1.4
Depth over ladr. weir (Crit. = 1-1.3 ft)	ft	1.0	1.0	1.0	1.3	1.2	1.3	1.0	1.0
Ladder exit clean		no	no	yes	yes	yes	yes	no	yes
Selsyns operating		yes	yes	yes	yes	yes	yes	yes	yes
Picket leads clean		no	yes	yes	no	no	no	no	yes
Spill Pattern w/i Criteria (yes or no)		n/sp	yes	yes	yes	no	yes	n/sp	n/sp
Comment Number (if applicable)		1			2		3	4	5

Comments

1. The project needed to calibrate the Spillway entrance; all picketed leads and exits required cleaning. N-2 was inoperable.
2. The north shore readings were within criteria on later check by Doug Case. Treaty shad fishers had ropes & floats set up at east fish ladder exit, but no fishing occurred during inspection. Lots of woody sticks in picketed leads & exit.
3. Fish Unit F1 out of service - fishway set for 1-turbine operation; expected back on-line by 8/8.
4. At the Spillway entrance, the FPC sensor probe gave a head differential of 1.1 ft. A large 30' log was on PUD trash rack during the September and October inspections.
5. Velocity in the channel was slow from junction pool through Unit 22 and to 20 before it speeds up to criteria (1.5 to 4.0 fps); these conditions existed throughout the year. The project needs to calibrate gages.

for the season. With the one turbine operation in August, Gate S-1 was submerged 6.8 ft with a head of 1.5 ft. During the 8 inspections, we found the South (Spillway) fishway entrances operating satisfactorily regarding head differential with the exceptions being the March and September inspections when 0.9 ft was recorded.

Fish Ladder: The picketed leads located at the OR fish counting station and also the exit trash racks were reported with some amount of debris on 6 of 8 inspections. **This continues to be one area that the project should increase frequency of checking and cleaning at the dam.** The depth of water over the fish ladder weirs ranged between 1.0 and 1.3 ft during the season and was acceptable during the inspections we completed.

North Shore Fishway Inspections

At the WA fishway, the North entrance gate, N-1 was operated throughout the fish passage season. The gate depths ranged between 8.5 and 12.4 feet for the season with the head differential ranging between 0.8 and 1.6 ft. During the June inspection, the gate depth and head differential reading was 12.4 ft and 0.8 ft, respectively. Doug Case stopped by the project after his inspection of John Day Dam to check whether the system went back in balance. It had. The gate was submerged 9.1 ft and the head was 1.5 ft; each reading was satisfactory.

The COE will be doing considerable work restoring the damaged areas in the plunge pool section of the fishway during the 1998-99 winter maintenance period. The outage began November 30, 1998 and will be through February 1999.

Fish Ladder: The ladder exit was reported clear of debris during the 7 of 8 inspections. The picketed leads were reported with some buildup of debris during the final 5 inspections. The main problem is linked to sticks and other debris building on the picketed leads. The depth of water recorded over the ladder weirs also showed the fish ladder in proper criteria with a range of 1.0 to 1.3 ft for the season. During the September inspection, a large 30 ft log was resting against the trashrack located in front of the auxiliary water supply for the Wasco PUD project.

Overall, the fish facility inspections showed The Dalles Project was operating fairly close to acceptable criteria through much of the fish passage season. Some areas of concern are listed.

- During periods of low tailwater, the fish turbines at times were not supplying quite enough water to the major entrances; it was suggested at the November O&M committee meeting that it might be possible to increase amperage of the fish units. This may be an acceptable way to increase flow to the main entrances and down the collection channel based on initial tests conducted by the project in November.

- Water velocities measured at the eastern end of the powerhouse collection channel were less than recommended, but until radio telemetry results are analyzed; it is unknown what extent the reduced velocity might be a problem. Same question as in 1996-97 Annual Report.
- In case of an emergency at the North Shore entrance, i.e., the gate or cable was severely damaged, there was no backup gate available for use in 1998. Entrance Gate slot for N-2 was bulkheaded off for the year. This should be remedied prior to the 1999 fish passage season.
- The Tribal shad fishery at the exit of the OR fish ladder was minimal in terms of number of fish harvested as well as days fished this year and should have had little effect on adult fish passage at that site.
- The weir depths of the West and South main entrances at times are nearly a foot different at each location, e.g., 8.9 ft/7.9 ft and 8.8 ft/7.9 ft during the May and June inspection at Gates S1 and S2. At the West entrance, the March readings gave a depth of 9.1 ft at W1 and 8.1 ft at W2. During the season, the average depth of the two gates was normally satisfactory, but we question why there was such a difference between the gate settings. The project should work to calibrate or automate the gates such that they travel close together in gate depth.

JOHN DAY DAM

Eight inspections were completed during the 1998 fish passage season. Doug Case, ODFW made monthly inspections from March 30 through October 7. Table 3 lists the criteria items and the inspection dates for the John Day project.

Auxiliary water is supplied to the Oregon fishway via three turbine-driven pumps. This water is supplied for the fishway through the diffuser system where it exits out 1 main entrance on the south shore, two main entrances at the north end of the powerhouse, and 10 floating orifice gates along the collection channel. Six electric pumps on the Washington shore supply flow through the diffusion system to the lower end of the fish ladder and feed the two main entrances at the north end of the spillway. For the first time, four of the six WA fish pumps operated at one time. The project is still exploring means to fully use the system and meet operating at a range of 8-ft or greater during all times of the year if possible.

South (Oregon Shore) Fishway Inspections

The south shore fishway operated gate SE-1 throughout the season. The head differential measured at the main entrance was between 1.0-2.0 ft on every inspection (range = 1.0 to 1.6 ft) with the weir depth ranging between 8.1 ft and 8.9 ft. The gate depth was 8.0 ft or greater on all 8 inspections. Throughout the 1998 season, entrance conditions at SE-1 gate should have provided satisfactory fish passage during these eight inspections. The Project has done an excellent job on keeping the south shore entrances operating in proper criteria range.

Table 3. Pertinent Data for Fish Facility Inspections in 1998 at JOHN DAY DAM.

CRITERIA ITEMS		DATE OF INSPECTION							
		30-Mar	21-Apr	7-May	10-Jun	14-Jul	6-Aug	10-Sep	7-Oct
SOUTH SHORE FISHWAY									
South Shore Entrance:									
Depth over entrance weir									
SE-1 (Crit. = 8 ft or >)	ft	8.1	8.5	8.3	8.1	8.7	8.9	8.2	8.8
Head at SE-1 (Crit. = 1-2 ft)	ft	1.2	1.3	1.3	1.6	1.2	1.0	1.1	1.2
Dep. over ladr. weir (Crit.=1.0 +/-0.1) ft [normal] & 1.3 ft shad season)	ft	1.0	1.0	1.1	1.0	1.3	1.2	1.1	1.2
Channel Veloc (Criteria = 1.5 - 4.0 fps)	fps	satis.	3.8	2.0-3.0	~2.0	2.0-3.0	~2.0	1.5	~2.0
Ladder exit clean (Yes or No)		yes	yes	yes	yes	yes	yes	yes	yes
Staff gages clean (Yes or No)		yes	no	yes	yes	yes	yes	yes	yes
Picket Leads Clean (Yes or No)		yes	yes	no	no	no	yes	yes	yes
North Powerhouse Entrance:									
Depth over entrance weir									
NE-1 (Crit. = 8 ft or >)	ft	8.6	9.0	9.1	8.4	8.8	8.2	8.5	8.6
NE-2 (Crit. = 8 ft or >)	ft	8.7	9.2	8.2	8.8	9.0	8.4	8.1	8.5
Head at NE-1&2 (Crit. = 1-2 ft)	ft	1.3	1.6	2.0	1.5	1.6	1.2	1.0	1.2
Staff gages clean (yes or no)		yes	no	yes	yes	yes	yes	yes	yes
NORTH SHORE FISHWAY									
North Shore Entrance:									
Depth over entrance weir									
N-1 (Crit. = 6 ft or >)	ft	6.1	5.9	8.2	6.8	7.5	6.2	6.1	6.3
N-2 (Crit. = 6 ft or >)	ft	6.1	5.4	8.1	6.7	7.6	6.2	6.1	6.4
Head at N-1&2 (Crit. = 1-2 ft)	ft	1.0	1.1	1.8	1.5	0.7	1.2	1.0	0.9
Depth over ldr weir (Crit.=1.0 +/-0.1)	ft	1.0	1.0	1.0	1.0	1.5	1.3	1.1	1.0
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes	yes
Staff gages clean		yes	no	yes	yes	yes	yes	yes	yes
Picket leads clean		yes	no	no	yes	no	yes	no	no
Comment number (if applicable)		1	2	3	4	5	6	7	

Comments:

1. A "T" shaped valve handle was present in south fish ladder; COE had been fixing leak at that point. Valve handle later removed.
2. N. shore fish pumps tested but when 4th pump added, it kept tripping off. New juvenile fish facility will be inspected each month.
3. Addition of 4th pump on n shore was excellent during high tw; see results above.
4. Velocity meter at Unit #3 appears to read way lower than the visual estimate; recommended the project re-calibrate the meter.
5. The north fish ladder had excess flow over the ladder weirs, 1.5 ft depth; a number of dead shad building on picketed leads.
6. Two fish turbine pumps were operating and can keep the OR fishway within criteria limits.
7. Calibration of N-2 was off 1-ft. Calibration of NE-1 & 2 appeared off about 0.6 ft; this was also the case in October.

In 1998, the north powerhouse entrance gates, NE-1 and NE-2, were operated within the criteria ranges for weir depth (8 ft or greater) and head differential (1.0 to 2.0 ft) on each inspection. The gate depths ranged from 8.1 ft to 9.2 ft with head differentials ranging from 1.0 ft to 2.0 ft. All readings were acceptable during the 1998 season. This was the third season in a row that the entrances were in criteria at the north powerhouse (1996-98).

The powerhouse collection channel velocity ranged from about 1.5 to 3.0 fps (south to north) during the eight inspections. The electronic velocity meter that was installed in the collection channel in Unit #3 appeared to record velocities that were less than actual. Our visual estimates of the velocities in the channel showed it to be within acceptable criteria range. We had recommended that the meter be recalibrated to assure correct readings. The velocity meter was not working during the final 2 inspections.

Fish Ladder: During the 1998 inspections, the exit section of the ladder was clear of debris. The picketed leads at the OR fish counting station had some amount of sticks or other debris on them on three of the eight inspections; however, the leads generally had only 0.1 ft difference across them. Through the season, staff gages were reported as clean and readable except for the May inspection. As noted in all previous seasons, fish are still jumping in the upper section of the fish ladder during the late fall.

The depth of water measured over the ladder weirs ranged between 1.0 ft and 1.3 ft for the season and were generally within the criteria range of 1.0 ft \pm 0.1 ft during the non shad period and 1.3 ft \pm 0.1 ft during the shad passage season.

North Shore Fishway Inspections

The criteria settings for the north shore fishway entrances were changed prior to the 1995 season and remained in effect for the 1998 season. The two entrance gates, N-1 and N-2, are to be maintained at a minimum depth of 6.0-ft below tailwater with a head differential of 1.0 to 2.0 ft. Under normal tailwater elevations, the 6.0-ft depth and 1.0 ft head can be achieved. With higher tailwater elevations, the project can come fairly close to meeting 8.0-ft gate depth with satisfactory head differential as during the May inspection. The minimum 6.0-ft gate depth criteria were met on seven of the eight inspections; the depths ranged from 5.4 ft to 8.2 ft. The head differentials were below acceptable criteria range on two inspections, July and October. The differential ranged from 0.7 to 1.8 ft. For the season, the gate depth and head differential readings resulted in the entrances being less than criteria on 3 of the 8 inspections.

Fish Ladder: The exit from the ladder was reported clear of debris on all inspections. The picketed leads were noted with sticks and other debris on 5 of the 8 inspections. The picketed leads had 0.2 ft

differential on 5 inspections indicating that debris was building up on the racks. Depth of water over the fish ladder weirs ranged from 1.0 ft to 1.5 ft with the 1.5 ft recorded during the shad season when they operated at 1.3 ft.

Overall, the main entrances at the south fishway were operated very close to criteria during the 1998 fish passage season. Areas of concern based on observations from the inspections are listed.

- Fish jumping/leaping (mainly steelhead) in the exit section of the fish ladders at John Day Dam still occurs. Hydraulic conditions need to be improved to keep fish moving through the upper section of the north and south fish ladders (Continuing Recommendation through many years).
- The passage of adult fish through the north shore counting station has been and continues to be a problem with a high percentage of fish falling back through the counting window (especially late summer and fall run fish). During the 1997-98 winter maintenance period, a solid ramp was added on the upstream end of the counting slot. Potentially this could smooth flows through the counting window as well as provide adult fish better exit conditions from the counting slot. This likely provided a better transition for the fish from the count station, but problem still exists. A change is required.
- The north shore auxiliary water supply should be changed to allow more flow through the supply conduit. The John Day Project completed wiring to reduce overloading of the fish pumps. It was thought that this fix would allow the pumps supply sufficient flow to achieve an 8-ft or greater weir depth with 1.0 ft or greater head differential at the north shore entrances. This operation was only partially successful and more modifications are required to operate at the higher flow rate.
- This was the initial year of checking the new juvenile bypass system during the inspection program. A new inspection form is being developed to incorporate operation of the juvenile bypass system.
- The project should assure that the panel readings are calibrated properly; the site readings varied from the panel readings by 0.6 ft during the final two inspections.

MCNARY DAM

Larry Swenson, NMFS, inspected the fish facilities at McNary Dam on nine separate occasions between April and October 1998. Table 4 lists the data collected for each inspection.

The project has been able to print a copy of the computer-generated Status Report of the fishway readings for a number of years. These were obtained by the inspector at the beginning of the inspection and compared with the field data taken at the main entrances. The site readings and the computer-generated report of the fishway readings were normally close during the inspections and did not require calibration, i.e., the readings were less than 0.3 ft different.

The three electric pumps that supply auxiliary water to the Oregon fishway worked satisfactorily during most of the fish passage season with the exception being the November inspection when two of the three were operating. Whenever the juvenile fish bypass system was out of service, the pumps were required to supply extra flow to the north powerhouse entrances as the excess flow from the juvenile bypass system equates to about 350 to 400 cfs. The project can normally meet criteria operating with 2 of the 3 pumps. When 3 pumps operate, the blade angle open is normally nearly 24 degrees while the blade angle is increased to 31-32 degrees when two pumps operate.

Spill was present from May through August with the higher levels recorded in May and June. Normally, the spill patterns were satisfactorily followed, using the daytime pattern for adult fish passage.

South Shore (Oregon) Fishway Inspections

During 1998, the main entrances at the south shore (SFEW-1 & 2) were reported within the criteria range of 9 ft or greater gate depth and 1.0 ft to 2.0-ft head differential on all inspections. The gate depths ranged from 9.0 ft to 9.4 ft (same as in 1997) with head differentials ranging from 1.1 ft to 1.5 ft. The north powerhouse entrances (NFEW-1 & 2) had one reading of 8.5 ft gate depth with a corresponding head differential of 1.8 ft. Although the depth was below the 9-ft depth, the system was supplying adequate flow with the 1.8 ft of head. The north powerhouse gates operated within a range of 8.5 ft to 9.8-ft gate depth. Head differentials ranged from a low of 0.9 ft to 1.8 ft. The November inspection showed the north powerhouse entrance to be 0.9 ft, slightly below the minimum 1.0 ft requirement. As noted previously, only two of the three fish pumps were operating and this probably resulted in the minimum reading.

The channel velocities were estimated between 1.0 to 2.0 fps at the southern end of the channel and increased to near 2.5 to 3 fps at the northern end of the channel. The southern end was recorded via an electronic meter installed downstream of the junction pool and upstream of ph turbine unit #1. The surface velocity was estimated at the northern end of the channel by timing a wood chip or floating object a given distance along the channel.

Fish Ladder: The picketed leads located at the OR fish ladder count station were reported clear of debris during the inspections; the leads were pulled on the November inspection. On the final inspection there was debris building up at the exit from the fish ladder that required cleaning. The depth of water reported over the OR fish ladder weirs ranged between 1.0 ft to 1.2 ft for the season and was within acceptable range during the season.

North Shore (Washington) Fishway Inspections

A small hydro-turbine supplies auxiliary water through low-pressure diffusion gratings in the lower end of the fish ladder. The system operated satisfactorily during the season. A backup water supply system

Table 4. Pertinent Data for Fish Facility Inspections in 1998 at MCNARY DAM.

CRITERIA ITEMS		DATE OF INSPECTION								
		30-Mar	22-Apr	27-May	17-Jun	22-Jul	12-Aug	16-Sep	10-Oct	16-Nov
SOUTH SHORE FISHWAY										
South Shore Entrance:										
Depth over entrance weir (Criteria: 9 ft or > gate depth at SFEW-1,2 & NFEW-1,2)										
SFEW-1	ft	9.2	9.2	9.3	9.2	9.1	9.2	9.2	9.0	9.1
SFEW-2	ft	9.2	9.3	9.4	9.2	9.0	9.2	9.2	9.0	9.1
Head at SFEW-1,2 (Crit.= 1-2 ft)	ft	1.3	1.3	1.2	1.1	1.3	1.1	1.2	1.5	1.1
Dep. over ladr. weir (Crit.=1-1.3')	ft	1.2	1.2	1.1	1.1	1.1	1.0	1.0	1.1	1.1
Channel velocity (Crit.= 1.5-4.0 fps)	fps	0.9-2.0	1.5-3.3	not taken	2.0-2.9	2.4-2.8	1.6-2.8	1.3-3.0	2.3-2.5	2.4
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes	yes	no
Picket leads clean		yes	yes	yes	yes	yes	yes	yes	yes	
North Powerhouse Entrance:										
Depth over entrance weir										
NFEW-2	ft	9.2	9.3	9.8	9.6	9.0	9.3	9.0	9.0	9.1
NFEW-3	ft	9.2	9.3	9.8	9.6	8.5	9.3	9.0	9.0	9.1
Head at NFEW-2&3 (Crit. = 1-2ft)	ft	1.4	1.2	1.5	1.5	1.8	1.5	1.6	1.5	0.9
WA.SHORE FISHWAY										
North Shore Entrance:										
Depth over entrance weir										
WFE-2 (Crit. = 8 ft or >)	ft	10.4	9.8	8.5	9.9	8.9	10.1	9.6	9.6	9.0
WFE-3 (Crit. = 8 ft or >)	ft	10.4	9.8	8.5	9.8	8.9	10.1	9.6	9.6	9.1
Head at WFE-2&3 (Crit. = 1-2 ft)	ft	1.2	1.4	1.5	1.2	1.6	1.7	1.3	1.4	1.5
Dep. over ladr. weir (Crit. = 1-1.3 ft)	ft	1.1	1.2	1.1	1.1	1.1	1.0	1.0	1.1	1.0
Ladder exit clean		yes	no	yes	yes	yes	yes	yes	yes	no
Picket leads clean		yes	yes	yes	yes	yes	yes	yes	yes	
Comment number (if applicable)				1	2	3	4			

Comments:

1. Floating orifice gate # 44 submerged and #41 almost submerged. Turbidity dropped from 4 to 2-ft during inspection.
2. Spill schedule appeared different from expected pattern.
3. Spillgate #7 operating, it was closed by operators. The project was working on the computer that controls the gate positions at the north powerhouse entrances. The gates were returned to proper position by 1:30 p.m.
4. Orifice gates # 4, 32, 37, and 41 were overtopped with water. Project will remedy situation.

will automatically operate should the turbine unit shut down. Approximately 1,600-1,700 cfs of auxiliary water is supplied to attract adult fish to the main entrance gates.

The WA shore fishway entrances, WFE-2 and WFE-3, operated with gate depths ranging from 8.5 ft to 10.4 ft, and with head differentials ranging between 1.2 ft and 1.7 ft. The gate depths and head differentials were operated within acceptable criteria range through the season, i.e., greater than 8.0 ft gate depth and head differential between 1.0 ft to 2.0 ft. The computer-generated report gave close correlation with the on-site readings.

Fish Ladder: The fishway exit was reported with some debris (tumbleweeds or other grasses) on two of the inspections. The picketed lead section located at the counting station in the WA fish ladder was reported clear of debris through the 1998 inspection season. The depth of water recorded over the ladder weirs was satisfactory on each inspection with the depth ranging from 1.0 to 1.2 ft. The project normally cleared the leads on Monday and Thursday of each week.

Overall, the adult fishways normally operated close to the criteria established for the WA and OR fish passage facilities. Basically, the main entrances were operated in a manner that should have provided satisfactory adult fish passage conditions through the entire season.

- The orifice gates along the powerhouse collection channel can be found overtopped or stuck in position when tailwater changes occur. This problem should be corrected.
- The electronic water velocity meter should be calibrated to provide more stable reading.

The inspections made of the **juvenile fish passage system** showed some continued problem areas that were present during the inspection season. Debris continues to be especially hard on the juvenile equipment, i.e., vertical barrier screens, extended bar screens, de-watering screens, and any screen material at the juvenile bypass facility. With ESBSs installed in the gatewell slots, additional debris has been diverted into the gatewells and the collection channel in the past few years. The inclined and wall screens with their cleaning systems are many times taxed to the limit and can break down resulting in the juvenile bypass system taken off-line for a period of time. The project should continue to make improvements to the screening system. The Walla Walla District is scoping the following issues: juvenile facility piping debris problems, debris under raceway floor diffusers, water level control in collection channel, UBS cleaning, orifice shelter and effect on debris management and orifice passage efficiency, juvenile fish holding in the collection channel, and disposition of adult fallback in the juvenile fish facility. Timelines are being set to address these and other concerns in near future years.

PRIEST RAPIDS DAM

The adult fish facilities consist of two fishways located on the Left and Right bank of the Columbia River. Five fish pumps that pull water from the tailrace of the dam and gravity-flow water from the

forebay of the project supply the required auxiliary water to operate the fishways. If the fish pumps fail, there should be sufficient flow through the gravity flow system to meet criteria levels. In practice, the gravity flow system might not be able to achieve or provide that much water to the fishway to meet the criteria levels. Main entrances on the left fishway are located at the eastern end (shore entrance) and the western end of the powerhouse. Nine orifice gates operate along the powerhouse collection channel. The Right Bank fishway operates one main entrance gate to attract fish that might be swimming on that shore or are guided from the spillway flows.

As in previous years, fish agency and tribal personnel met with Grant PUD personnel prior to the 1998 fish passage season for the purpose of reviewing the previous year's fishway operations, planned operations for the upcoming passage season, and changes that might affect fishway inspections for the year. This has been very beneficial as it helps set the stage for the upcoming year.

Bryan Nordlund, NMFS, completed 7 inspections of the adult fish facilities during the 1998 season beginning April 24 and ending on October 16 (Table 5). The inspector was normally accompanied by an operator and a fish biologist or tech from Grant PUD. Priest Rapids Dam has a computer controlled fishway system that allows a computer printout of the settings on an instantaneous basis if desired. A copy of the computer-generated readings was normally compared to the site readings to assure if any calibration was necessary.

At the Left Bank fishway, Gate LEW-4/5 was operated to meet depth criteria of $8.8 \text{ ft} \pm 0.5 \text{ ft}$ and the head differential targeted at 1.5 ft (range between 1.0 ft - 2.0 ft). During 1998, the project operated between 8.6 ft and 9.1 ft with head differential ranging between 1.3 ft and 1.6 ft. All readings were within the proper criteria range with most inspections near the targeted values for depth as well as head differential. Normally, the orifice gates were set at proper elevations unless flows resulted in rapidly increasing or decreasing tailwater conditions. On one instance, Orifice #12 was overtopped with water and was reset by the operator. On the final inspection, severe fluctuations in flow resulted in 7-ft difference in tailwater in 4 hours. Extreme water fluctuations can also result in unreadable tailwater and channel staff gages. This was the case during the final two inspections.

Gate LEW-2/3 has depth criteria of $8.5 \text{ ft} \pm 0.5 \text{ ft}$ and head differential criteria of 1.2 ft target (range of 1.0 ft to 2.0 ft). The project operated Gate LEW-2/3 within the following range, 8.1 ft to 8.7 ft, and with head ranging from 1.2 to 1.7 ft. The project met the targeted head and depth criteria on all inspections for the 1998 season. Channel velocity was visually estimated and ranged between a low of near 1.0 fps to a high estimate of 2.0 fps. At times, channel velocity was minimal.

Fish Ladder: The depth of water at the Left Bank fish ladder weirs ranged between 1.0 ft to 1.1 ft for the season; all satisfactory readings. The exit from the fish ladder was clear of debris on all occasions as well as the picketed leads at the counting station.

Table 5. Pertinent Data for Fish Facility Inspections in 1998 at PRIEST RAPIDS DAM.

CRITERIA ITEMS		DATE OF INSPECTION						
		<u>24-Apr</u>	<u>18-May</u>	<u>18-Jun</u>	<u>21-Jul</u>	<u>19-Aug</u>	<u>16-Sep</u>	<u>16-Oct</u>
LEFT BANK FISHWAY								
<i>Left Bank Entrance:</i>								
<u>Depth over entrance weir</u>								
LEW-2 (Criteria = 8.5' +/- 0.5')	ft	8.2	8.3	8.7	8.7	8.7	8.3	8.1
LEW-4 (Criteria = 8.8' +/- 0.5')		8.8	8.8	8.6	8.7	8.6	8.7	9.1
<u>Head at main entrance</u>								
LEW-2 (Criteria = 1.2 ft target)	ft	1.2	1.5	1.4	1.3	1.2	1.5	1.7
LEW-4 (Criteria = 1.5 ft target)	ft	1.5	1.5	1.6	1.3	1.3	1.3	1.6
Depth over ladr. weir (Crit. = 1-1.2 ft)	ft	1.0	1.1	1.0	1.1	1.1	1.1	1.0
Channel velocity (Criteria = 1.5-4 fps)	fps	1.3	2.0	1.5	2.0	1.0	1.8	1.0
Ladder exit clean (Criteria = yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (Criteria = yes or no)		yes	yes	yes	yes	yes	no	no
Picket leads clean (Criteria = yes or no)		yes	yes	yes	yes	yes	yes	yes
RIGHT BANK FISHWAY								
<i>Right Bank Entrance:</i>								
<u>Depth over entrance weir</u>								
REW-2 (Criteria = 7.5 ft +/- 0.5 ft)	ft	unk	8.2	9.1	7.7	7.4	6.7	9.3
Head at REW-2 (Criteria = 1-2 ft)	ft	3.5	1.5	1.5	1.2	1.2	1.0	1.2
Depth over ladr. weir (Crit. = 1-1.2 ft)	ft	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ladder exit clean (Criteria = yes or no)		yes	yes	yes	yes	yes	no	yes
Staff gages clean (Criteria = yes or no)		yes	yes	yes	yes	no	no	no
Picket leads clean (Criteria = yes or no)		yes	yes	yes	yes	yes	yes	yes
Comment number (if applicable)		1	2				3	4

Comments:

1. Gate REW-2 was stuck about elev. 404; the project was asked to switch to Gate REW-1, and it was operated in that manner through the end of the fish passage season.
2. Flow was passing over top of Orifice gate #12; project was to reset the gate level.
3. Staff gages were very dirty and rendered poor inspection data at the main entrances. The inspector noted that on the computer printout, the inflow exceeded the outflow by 1,450 cfs.
4. Severe fluctuations in flow resulted in 7 ft difference in tailwater in 4-h. Unreadable staff gages resulted in using computer reading at several locations. Velocity through junction pool was too slow, about 1.0 fps.

Right Bank Fishway

The Right Bank fishway entrance obtains its auxiliary water from the Left Bank water supply system via a large conduit that allows water to flow through diffuser gratings into the lower end of the right bank fish ladder. Gate REW-2 operated for the initial inspection before being changed with Gate REW-1 for the remaining inspections of the 1998 fish passage season. Bryan found Gate REW-2 stuck about elevation 404 ft during the April inspection. The head differential was about 3.5 ft. The project was asked to switch the operation of the REW-2 gate to REW-1.

The main gate is required to operate within the following range: 7.5-ft±0.5 ft for gate depth and 1.0 ft to 2.0 ft for head differential (target head was 1.25 ft). Gate REW-1 had gate depths that ranged from 6.7 ft to 9.3 ft and “head” that ranged from 1.0 ft to 1.5 ft. All gate depth readings were satisfactory except for the September inspection when REW-1 was submerged 6.7 ft rather than a minimum 7.0 ft. The head differentials were satisfactory with exception of the April inspection when the Gate stuck in the slot and head was excessive.

Fish Ladder: The depth of water reported over the fish ladder weirs was 1.0 ft on all seven inspections. The picketed leads at the counting station was clear of debris on all inspections with the ladder exit clean on each inspection except for September when grasses and other floating debris was noted.

Overall, operation of the adult fish passage facilities was improved over the preceding year. The settings of the fishway were found operating close to acceptable criteria during 1998 with few exceptions. Problem areas noted during the inspections as well as recommendations are listed below:

- At the Right Bank fishway, there were two inspections when criteria were not met, April 24 and September 16.
- The fallout fence does not appear to provide any benefit for adult fish passage, i.e., it did not reduce fallout of adult fish from the LEW-2 Gate. The fence should be removed from the channel unless modifications can be made to change the fish’s behavior at the west entrance.
- The radio telemetry report should be further analyzed and reviewed for continued operation of the orifice gates as presently operated along the channel. It may be that fewer orifice gates can be operated at the project.
- Severe fluctuations of flow, hence tailwater elevations resulted in staff gages being nearly impossible to read. During these times, computer readings were used at several locations.

WANAPUM DAM

A preseason meeting was held at Wanapum Dam to discuss fishway operation for the previous season (1997), to review changes that were anticipated for the upcoming fish passage season, and to finalize the 1998 operating criteria for the adult fish passage facilities at Priest Rapids and Wanapum dams. Bryan Nordlund, NMFS, made monthly fishway inspections beginning April 24 and ending October

Table 6. Pertinent Data for Fish Facility Inspections in 1998 at WANAPUM DAM.

CRITERIA	DATE OF INSPECTION							
		<u>24-Apr</u>	<u>18-May</u>	<u>18-Jun</u>	<u>21-Jul</u>	<u>19-Aug</u>	<u>16-Sep</u>	<u>16-Oct</u>
LEFT BANK FISHWAY								
<i>Left Bank Entrance:</i>								
<u>Head at entrance</u>								
SE-2 (target head = 1.5 ft)	ft	1.8	1.3	1.5	1.5	1.8	1.2	1.8
SE-3 (target head = 1.25 ft)	ft	1.4	1.2	1.4	1.4	1.5	1.5	1.4
Dep. over ladr. weir (Crit. = 1.0-1.2ft)	ft	1.0	1.1	1.0	1.0	1.0	1.1	1.1
Channel velocity (Crit. = 1.5-4.0 fps)	fps	2.0	2.0	2.5	2.0	1.4	2.0	1.5-2.0
Staff gages clean (Crit. = yes or no)		yes	yes	yes	yes	yes	no	no
Ladder exit clean (Crit. = yes or no)		yes	yes	yes	yes	yes	yes	no
RIGHT BANK FISHWAY								
<i>Right Bank Entrance:</i>								
<u>Head at Entrance</u>								
REW-2 (target head = 1.25 ft)	ft	1.4	1.3	1.2	1.3	1.2	1.3	1.2
Depth over ladder weir	ft	1.0	1.2	1.1	1.0	1.1	1.1	1.1
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Staff gages clean		yes	yes	yes	yes	yes	no	no
Auxiliary H2O Pumps (RPM)		160/160	160/160	160/160	160/160	150/150	155/155	155/155
Comment number (if applicable)		1		2	3	4	5	

Comments:

1. 21% spill level during the inspection.
2. Spring spill for juvenile fish ended on June 15. The new video count system was inspected, and passage conditions through the orifices and counting window looked excellent. The video system boxes are attached at wall #11 for the right bank and wall #5 for the left bank.
3. Spill for juvenile summer migrants was being implemented.
4. Spill level was changed just after our arrival at the dam; two additional turbine units came on-line.
5. Staff gages unreadable or difficult to read during the last 2 inspections; OG 16 was not operating during inspection.

16. A summary of the seven inspections that were completed during the 1998 fish passage season is found in Table 6 and in the text below.

Left Bank Fishway

Two turbine-operated pumps that draw water from the tailwater of the project supply auxiliary water that is mixed with gravity flow water from the forebay. This water is shunted to the two main slotted fishway entrances, SE-2 at the eastern end of the powerhouse (shore), and SE-3 at the western end of the powerhouse. This same water supply also feeds the ten orifice gates along the powerhouse collection channel. Ten orifice gates were operated in 1998 as contrasted to 1997 when the orifice gates were operated in an open or closed position depending on the radio telemetry study requirements.

The east entrance SE-2 operates as a continual open gate with the head differential targeted for 1.5 ft. Gate SE-2 operated within the following range: 1.2 ft to 1.8 ft and was within acceptable range the whole season (1.0 ft to 2.0 ft). The project maintained the targeted head of 1.5 ft on 5 of the 7 inspections. The west entrance, SE-3 is also a continual open slotted gate with a targeted head differential of 1.25 ft. Gate SE-3 operated within the following range: 1.2 ft to 1.5 ft for the year. I considered all the readings satisfactory as they were either were above or very near the target of 1.25 ft on each inspection. This year's reporting appears to be the best to date regarding the project meeting head differential throughout the whole fish passage season.

Water velocity was estimated along the channel and readings ranged between 1.4 and 2.5 fps. All were close to acceptable criteria of 1.5 to 4.0 fps; note one was estimated at 1.4 fps. During the September inspection, an orifice gate was not operating (#16) and was a breaker problem. Since the last inspection, the orifice gate control system has experienced failures and was closed down. The system was being repaired during the 1999 winter maintenance season. On all other inspections, the orifice gates were operating satisfactorily and in proper sequence.

Fish Ladder: The depth of water over the fish ladder weirs ranged from 1.0 ft to 1.1 ft for the season. The ladder exit was clear of debris on all inspections with exception of the October inspection when grasses and other floating debris were recorded at the exit. One major change was initiated in the Left and Right fish ladder in May. A new video count system was installed in the exit section of each ladder (two video cameras at one weir, with the cameras viewing the two orifices of the underflow orifice of the ladder). The monitors were set up in a trailer near the exit of the fish ladder. The system appeared to work excellent. Although I observed only a few fish passing through the orifices via the camera monitoring system, the fish readily passed through the counting segment without hesitating or moving back downstream.

Right Bank Fishway

Auxiliary water for the Right Bank fishway is a gravity flow system that pulls water from the forebay of

the dam. This flow of water supplies water to the diffusers in the lower end of the fish ladder and to the main entrance gate, REW-2. This gate was targeted to operate with a head differential of 1.25 ft and within the range of 1.0 ft to 2.0 ft. Gate REW-2 is a continuous-open slotted gate and operated with head differentials ranging from 1.2 ft to 1.4 ft. All inspections were in the 1.0 ft to 2.0 ft range with the head normally operated between 1.2 ft and 1.3 ft. Staff gages were unreadable or difficult to read during the final two inspections making the readings somewhat questionable.

Fish Ladder: The right fish ladder operated with acceptable depth of water over the weir crests; the range was 1.0 ft to 1.2 ft for the season. The fish ladder exits were reported clear of debris for the 1998 season. As noted in the fish ladder section above (Left Bank), a video counting system was installed in both fish ladders. Another positive aspect of this installation was that no picketed leads are required in the ladder to guide fish through a small slot. This appears much more of a natural way to count fish, i.e., the fish find the orifice and pass right through it. This counting would likely be on a 24-h per day basis if adopted by the District.

Spill Patterns: The large prototype juvenile fish bypass system was not operated at the project in 1998. Spill for juvenile fish was used to pass fish downstream of the project. Changes to the spill schedule were coordinated through the fish agencies and tribes.

Overall, operation of the Wanapum adult fish facilities improved when compared to the 1997 season. Generally, the fish facilities were operating at acceptable criteria during 1998. Recommendations to improve fishway operations are listed:

- The project should complete installation of a computer-controlled fishway.
- As tailwater elevations drop during the summer/fall, many of the staff gages become unreadable. Either removable staff gages should be installed or bench markers placed that would allow use of a sensor tape to obtain accurate elevation readings for the main entrances.

ROCK ISLAND DAM

The Rock Island hydro-project is comprised of two powerhouses; an old powerhouse with 10 main turbine units and a new powerhouse with 8 main turbine units. The old powerhouse contains the Left Bank fishway and the Middle or Spillway fishway, with the Right Bank fishway located at the new powerhouse. Each fishway has a fish counting station located near the top of the fish ladder.

Ray Holtz, WDFW, inspected the adult fish facilities at Rock Island Dam on 7 occasions during the 1998 fish passage season beginning on April 21 and ending on October 21 (Table 7). Through the inspection season, few out of criteria conditions were found.

Left Bank Fishway

Gravity feed water is supplied from the forebay to the lower end of the Left Bank fish ladder through diffuser gratings. This auxiliary water supplies sufficient flow to allow Gates LO5 and LO6 to operate at 6.0 ft or greater depth and a corresponding head differential of 1.0 ft minimum through any tailwater elevation.

Gates LO5 and LO6 are normally operated at the same elevation or within a tenth of the other gate. Gate depths ranged from 6.3 ft to 7.4 ft while head differentials ranged between 1.1 ft to 1.4 ft. In 1998, the gate depth and head differential readings were found within acceptable criteria range through the inspection season.

Fish Ladder: Depth of water measured over the Left Bank fish ladder weirs was 1.1 ft on 6 of the 7 inspections with the depth during the July inspection being 1.0 ft. The exit trash racks located at the exit from the fish ladder and the picketed leads at the counting station were clear of debris during the fishway inspections.

Middle Fishway

Gravity feed water from the forebay of the dam supplies water to the lower end of the fish ladder through floor diffusers. Gate MO7 and a fixed-open side gate operate to attract adult fish from the spillway section of the dam. The end gate, MO7 is required to operate at 8.5 ft or greater depth below tailwater while the side gate is continually open and depends on head differential to be within acceptable criteria. The head differential required for both gates is the standard 1.0-ft to 2.0-ft range.

In 1998, the gate depths recorded during the inspections ranged from 8.2 ft to 9.0 ft. The 8.2-ft reading was during the final inspection of the season and was a result of the gate resting on sill; therefore, no further depth could be attained. This was similar to the proceeding season and occurred during the lowest flow and consequently when tailwater elevations were lowest for the year. The head differentials during the season ranged from 1.1 ft to 1.4 ft. All readings should have provided satisfactory passage for adult fish at the Middle ladder.

Fish Ladder: The depth of water over the fish ladder weirs was reported at 1.1 ft for the seven inspections, and as such, was within the criterion established for the ladder. The picketed leads and the ladder exit were clear of debris during the inspections. Specific spillgates at the project have been modified (notched) to improve passage for juvenile salmonids. Bays affected for the year were 1, 16, 17, 18, 25, 26, 29 through 32. Approximately 21 kcfs was for fish spill during the spring and 42 kcfs during the summer through these gates. The fishway inspector noted that the spill created poor looking conditions at the main entrance to Middle fishway during the May inspection.

Table 7. Pertinent Data for Fish Facility Inspections in 1998 at ROCK ISLAND DAM

CRITERIA ITEMS	DATE OF INSPECTION							
	21-Apr	14-May	16-Jun	22-Jul	19-Aug	22-Sep	21-Oct	
LEFT BANK FISHWAY								
Left Bank Entrance:								
Depth over entrance weir								
LO5 (Crit. = 6.0 ft or >)	ft	7.0	7.1	6.9	6.7	6.7	7.4	6.4
LO6 (Crit. = 6.0 ft or >)	ft	7.0	7.1	6.9	6.7	6.7	7.4	6.3
Head at LO5 & 6 (Crit. = 1-2 ft)	ft	1.1	1.2	1.2	1.4	1.3	1.2	1.2
Dep. over ladr. weir (Cr. = 1-1.2')	ft	1.1	1.1	1.1	1.0	1.1	1.1	1.1
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
CENTER FISHWAY								
Center Entrance:								
Depth over entrance weir								
MO7 (Criteria = 8.5 ft or >)	ft	9.0	8.7	8.9	8.9	9.0	8.9	8.2
Head at MO7 (Criteria = 1-2 ft)	ft	1.2	1.4	1.3	1.3	1.1	1.3	1.2
Dep. over ladr. weir (Cr. = 1-1.2')	ft	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Picket leads clean		yes	yes	yes	yes	yes	yes	yes
RIGHT BANK FISHWAY								
Right Bank Entrance:								
Head Differential (Crit. = 1-2 ft)								
LPE-1	ft	1.4	0.9	1.3	1.4	1.3	1.2	1.1
RPE-1 and RPE-2	ft	1.6	1.2	1.5	1.6	1.6	1.3	1.6
TRE	ft	1.2	0.8	1.1	1.1	1.1	1.1	1.3
Dep. over ladr. weir (Cr. = 1-1.2')	ft	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Channel velocity (Cr. = 1.5-4 fps)	fps	3.8	4.2	4.2	3.9	3.9	4.3	4.2
Picket leads clean		yes	yes	yes	yes	yes	yes	yes
Pumps operating		3	3	3	3	3	3	3
Comment number (if applicable)		1	2			3		4

Comments:

1. Juvenile fish sampling started April 1 with WDFW handling the fish in 1998.
2. Juvenile spill program w/41 kcfs through designated gates. Head differentials were low at the LPE and TPE gates.
3. Juvenile spill program cut off on August 13 at Rock Island Dam.
4. Gate MO3 was on sill, but was still near 8.5 ft and had 1.2' head out the entrance and flow was considered ok.

Right Bank Fishway

Auxiliary water is supplied to the Right Bank Fishway from three fish pumps that pull water from the tailwater and gravity-feed water from the forebay of the dam. Most of this flow enters the fishway in the lower end of the fish ladder through sidewall diffusers. The auxiliary water exits through the downstream end of the project, the left end of the powerhouse, and through 2 gates at the right end of the powerhouse. Each entrance gate is opened 3-ft, but its depth will increase as flow and tailwater elevation increases. The gates are operated to meet head differential criteria of 1.0 to 2.0 ft. In addition to the entrance flow, a high velocity flow of water is discharged below the water surface near the right powerhouse entrance gates. The purpose of this high velocity flow is to attract fish to the right powerhouse entrances from across the face of the dam. The gravity flow water was operated at 100% open on all inspections; the pumped water was at 100% open except during the first and last inspections.

The entrance gates, TPE, LPE, and the RPEs were reported with head differentials that ranged from 0.8 ft to 1.6 ft through the season. Head differentials were less than 1.0 ft only during May and that only at the LPE and TRE; the RPEs were reported with greater than 1.0 ft on all inspections. When tailwater elevations exceed or are near elevation 576 ft, the head differentials drop below the minimum 1.0 ft. The velocity estimated down the transportation channels was measured using a flow meter during the year. Velocity ranged between 3.8 to 4.3 fps during the inspections.

Fish Ladder: Depth of water measured over the ladder weirs was 1.1 ft on each inspection and was within acceptable range of 1.0 to 1.2 ft. The exit from the fish ladder was clear of debris, as was the picketed lead section at the fish counting station.

Overall, the fish passage facilities operated within criteria limits through the 1998 season. Areas of concern are listed below.

- Adult fallback should be assessed given the increased number of spillbay gates that are presently being used to pass juvenile fish at the project. Likewise, Chelan PUD should assess passage of adult fish through the Middle Ladder to assure that impacts are not occurring at the MO7 Entrance.
- The Right Bank Fishway cannot meet criteria at the main entrances when tailwater elevations increase above elevation 576 ft.
- The Right Bank fish counting station should be further assessed for passage delays of adult salmon and steelhead, especially during the summer and fall season.
- The project should inspect the diffuser gratings (wall and floor) on at least an annual basis to confirm that they are in satisfactory condition. During the winter maintenance season a floor diffuser was found dislodged in the Middle Fishway. This was similar to the 1998 winter season when another grating was dislodged in the Middle Ladder.

ROCKY REACH DAM

The Rocky Reach adult fish facilities are comprised of three turbine-driven propeller-type fish pumps that supply water for the powerhouse fishway entrances, most of the spillway entrance flow and the six orifice gates along the powerhouse collection channel. The fish pumps operated satisfactorily during 1998. Additional gravity-flow water from the forebay was supplied at the main spillway entrance to maintain the agreed upon criteria for the entrance. The powerhouse collection, left powerhouse, and spillway channels merge in the junction pool area to form the transportation channel. The transportation channel allows fish to move to the lower end of the fish ladder. The fish ladder exit is located on the Right Bank of the Columbia River.

Ray Holtz, WDFW inspected the adult fish passage facilities 7 times during the 1998 fish passage season with the initial inspection on April 23 and the final inspection on October 21 (Table 8). For the most part, the fishways were found near acceptable criteria ranges with some exceptions.

Powerhouse Entrances

The Right Powerhouse Entrances (RPE-1 and RPE-2) are rotary wing gates that should operate with a 3-ft opening, and a head differential of 1.0 ft to 2.0 ft. Only during the highest flow was the head differential less than 1.0 ft (May 14 inspection) with the remaining 6 inspections ranging between 1.0 ft to 1.1 ft. Six orifice gates along the channel operated satisfactorily this season.

The Left Powerhouse Entrances, LPE-1 and LPE-2, are located at the left end of the powerhouse nearest to Main Turbine #11. One entrance discharges its flow back toward the powerhouse with the other discharging its flow toward the retaining wall that separates the spillway flow from the powerhouse flow. The powerhouse flow discharges at a right angle to the spillway flow.

In 1998, gate depths ranged from 10.8 ft to 11.6 ft with head differentials ranging from 0.7 ft to 1.6 ft. Only on the September inspection was the “head” less than the required 1.0 ft. The system appeared to be out of calibration, and this helped create the out of criteria situation. The remaining 6 inspections resulted in adequate readings through the year. The sensor for the LPE should be cleaned during the winter maintenance period to assure that the sensor operates correctly for the 1999 season.

We measure the water velocity in the transportation channel by timing wood chunks along a 100-ft section. For the season, the velocity ranged from 1.5 to 2.0 fps and readings fell within acceptable range, i.e., 1.5 to 4.0 fps.

Spillway Entrance

The Spillway Entrance, MSE, discharges attraction water between spillbays 8 and 9. The spillway entrance opened on May 1. The MSE gate operated with depths ranging from 10.4 ft to 12.4 ft. Head

Table 8. Pertinent Data for Fish Facility Inspections in 1998 at ROCKY REACH DAM.

<u>CRITERIA ITEMS</u>	<u>DATE OF INSPECTION</u>							
	<u>21-Apr</u>	<u>14-May</u>	<u>16-Jun</u>	<u>22-Jul</u>	<u>19-Aug</u>	<u>21-Sep</u>	<u>21-Oct</u>	
ADULT FISHWAY								
<i>Left Powerhouse Entrance:</i>								
Depth over entrance weirs								
LPE-1 & 3 (Depend. On Tw Elev)	ft	10.8	11.2	11.4	10.8	10.9	11.3	11.6
Head at LPE-1 & 3 (Crit. = 1-2 ft)	ft	1.1	1.2	1.5	1.6	1.6	0.7	1.5
Depth over Ladr Weir (Crit = 1-2 ft)	ft	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Channel velocity (Crit. = 1.5-4 fps)	fps	2.0	1.5	1.8	1.9	1.7	2.0	1.8
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Turbine Unit 11 Operating (yes or no)		no	yes	yes	no	no	no	yes
<i>Right Powerhouse Entrance:</i>								
Wing gate opening (Criteria = 3.0 ft)								
RPE-1 and RPE-2	ft	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Head at RPE-1&2 (Crit. = 1-2 ft)	ft	1.0	0.9	1.0	1.0	1.1	1.0	1.0
Pumps operating		3	3	3	3	3	3	3
<i>Spillway Entrance:</i>								
Depth over entrance weir								
MSE (Dependent on Tailwtr Elev.)	ft	10.4	10.6	11.5	11.6	11.0	10.8	12.4
Head at MSE (Criteria = 1-2 ft)	ft	1.0	0.9	0.5	1.0	0.9	0.8	1.0
Comment number (if applicable)				1	2	3	4	

Comments:

1. The head differential at the spillway entrance was only 0.5 ft; the tailwater elevation at the MSE was > than 1.0 ft difference from the Left and Right ph entrances and resulted in out-of-criteria condition.
2. The inspector noted that adult fish were reluctant to move through the video counting station because of the intense light.
3. Juvenile bypass surface collector is shut down for the season.
4. Head differential less than minimum 1.0 ft at the MSE and LPE; it appeared that the tailwater sensor was incorrect in its reading. Adjustments were being made to correct it.

differentials ranged from a low of 0.5 ft on June 16 to 1.0 ft on three of the inspections. The “head” was less than the minimum 1.0 ft on 4 of the 7 inspections during the 1998 season. Part of the cause leading to the reduced “head” appears to be related to the tailwater elevation differential between the powerhouse and the spillway; for example, during the June inspection, greater than 1.0 ft difference was recorded. The result was the poor head differential.

Main Turbine Unit #11 was operating on 3 of the 7 inspections during the season. Also, as mentioned in the 1996 and 97 Report, when the project spills water, it appears that the flow into the LPEs from Turbine #11 has less impact than during lower flows.

Fish Ladder: The exit from the fish ladder was clear of debris during the 1998 inspections. The lower flow brought less debris down the Columbia River than the previous two years. The depth of water over the fish ladder weirs was 1.0 ft during each inspection and was within the criterion range of 1.0-1.2 ft.

Overall, the fishways were normally operating near criteria with some exceptions.

- Head differentials were less than 1.0 ft on one of seven inspections at the RPEs; 1 of 7 at the LPEs; and 4 of 7 at the MSE.
- The project needs to adjust the MSE and LPEs to meet 10 ft gate depth during the higher flow time frame. This will improve head differentials and allow the entrances to operate at closer to 1.0 ft or greater.
- The project should clean the tailwater sensor at the LPE to assure that accurate readings are taken.

WELLS DAM

Stewart Mitchell, WDFW completed 7 inspections of the adult fishways during the 1998. The initial inspection was April 21 and the final inspection on October 26 (Table 9).

The West and East Bank fishway entrances are similar in design and are normally operated with an end gate and a side gate open. The end and side gates are wing gates and can open to 8-ft at maximum width. The depth of water passing through the entrance gates extends from the floor of the fishway to the water surface elevation in the entrance pool. High velocity water discharge pipes normally operate near the side entrances. Two or three of them operate at different elevations (depending on tailwater elevation) and send flow out toward Unit 1 and Unit 10 discharge. This flow is supposed to attract adult fish to the side entrances. These jets operate only when the side entrances are open.

Water is supplied to the main entrances by two fish pumps (2 per side) that diffuse water into the lower end of the fish ladder through wall and floor diffuser gratings. The pumps operated satisfactorily throughout the fish passage season. The project can normally meet criteria at the main entrances through all tailwater and flow conditions.

The West and East fish ladders incorporate trapping facilities for adult brood collection. Trapping schedules are coordinated among the various agencies with WDFW doing the actual trapping and handling at the Project.

During a typical inspection of the fish facilities, the inspector normally goes to the Control Room to take the computer readings of the fishway main entrance gates, etc. These readings are then compared with staff gages and deck gages located at the entrances. Normally the readings should be within 0.2 ft. If the gages vary by more than the 0.2 ft to 0.3 ft, then the project would calibrate the deck or Control Room gage. This was valid as long as the tailwater and entrance staff gages could be easily read or the tailwater elevation was somewhat flat.

East and West Fishways

During the 1998 inspections, the side entrance was closed on one of the seven inspections due to the high spill levels or else the radio telemetry study. On this occasion, the end gate was opened 8-ft. The head differentials reported at the **East** entrances ranged between 1.1 ft and 1.6 ft for the season based on the staff gage reading when feasible. The staff gages were unreadable on a couple of occasions and resulted in using a combination of staff and deck or computer reads to complete the inspection. The head differential readings at the **West** fishway entrances ranged between 1.1 ft and 1.6 ft. The staff gages were unreadable on 3 of the 7 inspections.

The head differential target of $1.5 \text{ ft} \pm 0.1 \text{ ft}$ was met on 5 of the 7 inspections at the East fishway and 4 of 7 inspections at the West fishway entrances. The head differential was greater than 1.0 ft on every occasion during the 1998 season, and should have provided satisfactory adult passage conditions at the main entrances throughout the main fish run.

Fish Ladder: At both fishways, the exits from the fish ladder were monitored for differential between the last fish ladder pool and the forebay elevation. Normally, the differential ranges between about 0.5 ft to 0.8 ft depending on the forebay elevation. In 1998, differentials at the exits ranged from 0.5 ft to 1.0 ft. The exit from the fish ladder appeared clear of debris through most of the year; however, two or three inspections reported a differential of 0.9 ft to 1.0 ft. The project was asked to clean debris from the trash racks if needed. The picketed leads at the counting stations appeared clear of debris during the inspection dates. The depth of water over the ladder weirs ranged from 1.2 ft to 1.3 ft at the West and East ladders. Preferred depth over ladder weir readings should be nearer 1.0 ft than 1.3 ft.

Spill Basin: With the river Q much reduced from the previous season, spill was only provided through the juvenile bypass system during our inspections: bays 2, 4, 6, 8, and 10.

Table 9. Pertinent Data for Fish Facility Inspections in 1998 at WELLS DAM.

CRITERIA ITEMS		DATE OF INSPECTION						
		21-Apr	28-May	29-Jun	21-Jul	25-Aug	21-Sep	26-Oct
EAST FISHWAY:								
Head at main entrance (Target = 1.5ft)	ft	1.5	1.4	1.1	1.3	1.4	1.6	1.6
D/Stream entrance open (Criteria = 6-ft)	ft	8.0	6.0	6.0	8.0	6.0	6.0	6.0
Side entrance open (Criteria = 4-ft)	ft	4.0	4.0	4.0	Closed	4.0	4.0	4.0
Depth over ladder weir (Crit.= 1-1.2 ft)	ft	1.2	1.3	1.3	1.3	1.3	1.3	1.3
Ladder exit differential (Criteria = .6-.8ft)	ft	0.5	0.7	0.8	1.0	0.9	0.7	1.0
Staff gages clean/readable (yes or no)		no	yes	yes	yes	yes	yes	no
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	no	yes
Fishway entrance jets		2-open	2-open	2-open	Closed	2-open	2-open	2-open
WEST FISHWAY: (Criteria same as East)								
Head at main entrance	ft	1.5	1.3	1.2	1.1	1.4	1.5	1.6
Downstream entrance open	ft	8.0	6.0	6.0	8.0	6.0	6.0	6.0
Side entrance open	ft	4.0	4.0	4.0	Closed	4.0	4.0	4.0
Depth over ladder weir	ft	1.2	1.2	1.3	1.3	1.3	1.3	1.3
Ladder exit differential	ft	0.6	0.7	0.9	0.9	0.7	0.9	1.0
Staff gages clean/readable		yes	yes	yes	yes	no	no	no
Picket leads clean		yes	yes	yes	yes	yes	no	yes
Fishway entrance jets		2-open	2-open	2-open	Closed	2-open	2-open	2-open
Comment Number (if applicable)		1	2		3	4	5	6

Comments:

1. Spill for juvenile fish was occurring through Bays 2 and 6. The east fishway tw staff gage was unreadable; the Control Room reading was 1.5 ft versus the deck gage reading of 1.3 ft.
2. The controls for the East fishway were being rewired so no readings from the Control Room were taken.
3. The project was checking on the excessive head measured at the exit from the fish ladder and would clean as necessary.
4. Staff gages were dirty and required cleaning; West bank fishway gages required calibration.
5. Differential measured at W exit from fish ladder appeared excessive. Staff gages were dirty at some locations. Depth of water over the ladder weirs was high (1.3 ft). A new rod for measuring the width of the gates is needed.
6. Same problems as noted in Comment 5 above. Glass was broken in the West deck gage; it required repair. The exit differential was 1.0 ft on both fish ladder and appeared excessive; normal is 0.6-0.8 ft differential.

Overall, it appeared that the main fishway entrances at Wells Dam performed satisfactorily throughout the adult fish passage season. Some changes or improvements should be taken by the project include:

- Staff gages at the project should be changed to be removable ones if possible as they were unreadable on several inspections. Either that or the gages should be cleaned at a regular basis, especially during periods of low tailwater.
- Hydraulic evaluation or flow measurements should be taken to determine velocities through the side and wall diffusers.
- A determination should be made whether to operate the side entrances in future years.
- Operating the fish ladder at reduced depth of water over the ladder weirs; a target might be 1.1 ft \pm 0.1 ft.

ICE HARBOR DAM

During fall 1997, a contracting firm installed four more flippers for a total of eight installed prior to the 1998 spill season. The outside end bays had flippers installed during fall/winter 1998/99. These new flippers reduced dissolved gas levels in the Snake River below Ice Harbor Dam.

Steve Richards, WDFW, inspected the adult fishways at Ice Harbor Dam seven times during the 1998 fish passage season (Table 10). Normally, a fishway inspection was completed as follows: The inspector reports into the Operations office, obtains hydraulic information including river Q, spill patterns, and turbine operation from the control room. The inspector also receives a computer printout of the elevations of the entrance gates, corresponding head differentials, etc. Site readings were taken to compare how well the computer system correlates to the site readings. Generally, readings were fairly close between the computer and the on-site elevations especially during lower flows when tailwater elevations were more stable and spill levels were reduced.

South Shore Fishway Inspections

Attraction flow to the south fishway is supplied by up to eight electric pumps and about 200 cfs flow from the juvenile bypass system. Normally 5 to 8 fish pumps operate depending on the tailwater elevation. Under most river flow conditions, the project can maintain the fishway within acceptable criteria. In 1998, 8 fish pumps were operating on 6 of the 7 inspections.

The south shore entrance gate (SFEW-1) was on sill 1 of the 7 inspections with the remaining 6 inspections having flexibility to lower the gate and rest on sill if required. Existing criteria require that Gate SFEW-1 be submerged 8 ft or greater or rest on sill as tailwater elevations drop to where 8' can not be achieved. On 2 of the 7 inspections the Gate was submerged 8 ft with the remaining inspections having less than 8 ft depth. In 1998, the gate depths ranged from a low of 5.9 ft to a high of 8.4 ft. The head differential measured at SFEW-1 ranged from 1.1 ft to 2.3 ft. The May 29 inspection had 1.1 ft of head measured at SFEW-1, with the remaining inspections having 1.5 ft to 2.3 ft of head. With the higher

Table 10. Pertinent Data for Fish Facility Inspections in 1998 at ICE HARBOR DAM.

CRITERIA ITEMS		DATE OF INSPECTION						
		30-Apr	19-May	24-Jun	28-Jul	26-Aug	9-Sep	19-Oct
SOUTH SHORE FISHWAY								
South Shore Entrance:								
Depth over entrance weir								
SFEW-1 (Crit. = 8 ft or >)	ft	7.8	8.3	8.4	7.6	6.2	5.9	7.6
Head at SFEW-1 (Criteria = 1-2 ft)	ft	2.0	1.1	1.7	1.5	2.2	2.3	1.9
Dep. over ladr. weir (Cr. = 1-1.3 ft)	ft	1.1	1.1	1.1	1.1	1.1	1.0	1.1
Channel velocity (Crit. = 1.5-4 fps)	fps	>2.0	>2.0	>2.0	2.7	>2.0	>2.0	>2.0
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	no	yes	no
Pumps Operating (8 available)		8	8	7	8	8	8	8
North Powerhouse Entrance:								
Depth over entrance weir								
NFE-2 (Criteria = 8 ft or >)	ft	9.0	8.2	8.1	10.0	6.9	5.9	7.3
Head at NFE-2 (Criteria = 1-2 ft)	ft	1.0	1.7	1.2	0.8	1.3	1.7	1.3
Staff gages clean	ft	yes	yes	yes	yes	yes	yes	yes
NORTH SHORE FISHWAY								
North Shore Entrance:								
Depth over entrance weir								
NEW-1 (Criteria = 8 ft or >)	ft	9.6	8.2	9.0	7.5	4.9	4.4	6.1
Head at NEW-1 (Criteria = 1-2 ft)	ft	1.1	1.9	1.5	1.8	1.2	2.2	1.7
Dep. over ladr. weir (Crit. = 1-1.3 ft)	ft	1.1	1.1	1.1	1.1	1.0	1.0	1.0
Ladder exit clean		yes	yes	yes	yes	yes	yes	yes
Staff gages clean		yes	*1	yes	yes	yes	yes	yes
Picket leads clean		yes	yes	yes	yes	no	yes	yes
Pumps Operating (3 available)		3	3	3	3	3	3	3
Comment Number (if applicable)			1	2	3	3	4	

Comments:

1. The north shore collection channel staff gage was under water. The reading taken from the digital meter. The south shore channel velocity meter is out of service. Surface velocity is estimated by the inspector.
2. There is an approximate 2' tailwater differential between the n shore and n powerhouse; the COE was asked to verify it.
3. Spill conditions and the absence of a functional tailwater staff gage on the north shore made it difficult for the inspector to determine precise tailwater levels for the north shore entrance. The north shore tailwater reading was taken from the digital display located on the north shore tailwater deck.
4. It appeared that the control system needed calibrating to make it closer to the staff gage readings. No staff gages present in the north shore entrance and tailwater.

head differential reported at this Gate, flow volume from the Gate should have resulted in satisfactory passage through that Entrance although the 2.2 ft and 2.3 ft was above the normal criteria range of 1.0 ft to 2.0 ft.

The north powerhouse entrance gate (NFE-2) has similar criteria relating to gate depth and head differential as the south entrance. From April through July, the weir depths ranged between 8.1 ft and 10.0 ft. The August, September, and October inspections had weir depths of 6.9 ft, 5.9 ft, and 7.3 ft, respectively with head differentials for the same inspections of 1.3 ft, 1.7 ft, and 1.3 ft. The overall range for head was 0.8 ft to 1.7 ft. The July inspection reported the low head of 0.8 ft, but the gate depth was 10.0 ft. Balanced out, it appears there was sufficient flow out the entrance during the July inspection.

It appeared from the inspection reports that on several occasions, sufficient water was available to meet criteria, but that the control system was not functioning properly to allow the gate depth or head differential to be within the proper range. The Ice Harbor project should continue to work on their control system and make it workable prior to and during the 1999 fish passage season. The 1998 season appeared to have very similar results as in 1997 when flow was sufficient, but the system was not balanced properly between head and gate depth.

Across the powerhouse, 7 floating orifice gates operated throughout the fish passage season. It appeared from the inspections that they worked satisfactorily during 1998. The collection channel velocity was reported as greater than 2.0 fps on each inspection and was within the criteria range of 1.5 to 4.0 fps during the inspections.

Fish Ladder: The inspector reported that the exit from the fish ladder, and gatewells (juvenile fish bypass system) across the powerhouse forebay deck were clear of debris during the season. The maximum differential measured across the fish ladder exit trashracks was only 0.1 ft so the project did an excellent job of keeping the fish ladders free of debris again in 1998. The picketed leads had a buildup of debris (head loss across the picketed leads was 0.3 ft) on two occasions.

North Shore Fishway Inspections

Three electric fish pumps supply attraction water to the north shore fishway. The pumps appeared to work satisfactorily this season.

Gate NEW-1 operated throughout the season with this Gate reported at 8.0 ft or greater depth during most of the high flow period (through July). The gate depths ranged from 7.5 ft to 9.6 ft from April through July and then gate depths dropped to 4.9 ft, 4.4 ft, and 6.1 ft for the final three inspections. Head differentials were greater than the 1.0-ft minimum on all 7 inspections. Whenever the gate reaches sill, no further depth can be attained and the project then needs to assure that the head differential is

achieved. The inspector asked that the north shore control system be calibrated to make them closer to the staff gage readings.

Fish Ladder: The exit from the north shore fish ladder and also the picketed leads at the counting station were reported clear of debris through the inspection season. The tailwater staff gage was not usable for calibration or calculation through much of the inspection season.

Overall, the inspections completed during 1998 showed the following items that required action on part of the project to improve fish facilities and inspections.

- Higher flows and spill experienced during the spring and early summer affected operation of the gates or else the computer-controlled system was unable to properly keep the head differential or gate depth at the correct elevation. Normally the system was found to be out of criteria for a short time before it could catch up and be found back in proper criteria. Same problem as noted in 1997.
- The project needs to place staff gages or assure that electronic measuring devices are calibrated and accurate. Normally it was impossible to obtain best data at the north shore and north powerhouse during spill periods.

LOWER MONUMENTAL DAM

The adult fish passage facilities at Lower Monumental Dam were inspected seven times by Steve Richards, WDFW inspector during 1998. The first inspection was April 30 and the final inspection on October 19 (Table 11).

Three turbine driven pumps operated to supply water to a conduit that distributed flow to the diffuser system along the collection channel and the north and south shore collection systems. About 200 cfs of excess water from the juvenile bypass system was also supplied to the north shore supply diffusers. The water supplied from the juvenile bypass system operated from approximately March through December.

River Q was about average for the Snake River in 1998 and problems with debris in the fish pumps were not evident. The pumps normally operated at higher rpm in 1998, and as such, the main entrances and velocities in the collection channel were kept within acceptable criteria range.

North Shore Fishway

The north shore fishway entrance gates, NSE-1 and NSE-2, were operated with gate depths ranging from 7.9 ft to 8.5 ft during the inspections. The depth criterion was 8.0 ft or greater submergence below tailwater elevation for the two gates. The head differentials ranged from 1.2 ft to 1.9 ft; all readings

Table 11. Pertinent Data for Fish Facility Inspections in 1998 at LOWER MONUMENTAL DAM

CRITERIA ITEMS		DATE OF INSPECTION						
		30-Apr	21-May	29-Jun	28-Jul	26-Aug	9-Sep	19-Oct
NORTH SHORE FISHWAY								
North Shore Entrance:								
Depth over entrance weir								
NSE-1 (Criteria = 8 ft or >)	ft	8.2	8.0	8.1	8.1	8.4	8.1	8.2
NSE-2 (Criteria = 8 ft or >)	ft	8.2	7.9	8.1	8.1	8.5	8.1	8.1
Head at NSE-1 & 2 (Crit. = 1-2 ft)	ft	1.3	1.9	1.3	1.3	1.2	1.5	1.6
Dep. over ladr. weir (Cr. = 1-1.3 ft)	ft	1.1	1.0	1.1	1.1	1.1	1.1	1.0
Channel velocity (Crit. = 1.5 - 4 fps)	fps	>2.0	1.2	3.1	4.2	>2.0	2.2	>2.0
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
South Powerhouse Entrance:								
Depth over entrance weir								
SPE-1 (Criteria = 8 ft or >)	ft	8.1	8.1	8.1	8.2	7.4	6.7	6.3
SPE-2 (Criteria = 8 ft or >)	ft	8.2	8.2	8.1	8.1	7.4	6.7	6.3
Head at SPE-1 & 2 (Crit. = 1-2 ft)	ft	0.9	1.0	1.0	1.0	1.0	1.3	1.2
Staff gages clean/readable (yes or no)		yes	yes	yes	yes	yes	no	yes
SOUTH SHORE FISHWAY								
South Shore Entrance:								
Depth over entrance weir								
SSE-1 (Criteria = 8 ft or >)	ft	8.3	8.1	8.4	8.1	8.2	7.7	7.5
SSE-2 (permanent) 6-feet	ft	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Head at SSE-1 & 2 (Crit. = 1-2 ft)	ft	1.2	1.2	1.2	1.3	1.1	1.1	1.1
Dep. over ladr. weir (Crit. = 1-1.3')	ft	1.0	1.0	1.1	1.1	1.1	1.1	1.0
Ladder exit clean		yes	yes	yes	yes	yes	yes	no
Picket leads clean		yes	yes	yes	yes	yes	yes	yes
Pump speed	rpm	72-74	72	69-71	73-74	73	73-75	73-75
# of Pumps Operating (3 available)		3	3	3	3	3	3	3
Comment Number (if applicable)		1						2

Comments:

1. The inspector could not access the north shore picketed leads on this inspection.
2. The s shore exit measured 0.5 ft of head across the trashrack and required cleaning. The n shore exit was clear of debris across the trashracks but had a lot of floating debris near the exit.

were in the acceptable range of 1.0 to 2.0 ft. When gate NSE-2 read 7.9 ft, the head differential measured 1.9 ft so there was sufficient flow and velocity from the main entrance.

The inspector recorded that the water velocity in the collection channel was satisfactory through the season. An electronic velocity meter was present in the channel to record velocities in the north end of the collection channel. On one occasion, (May inspection) the meter appeared to read low as it recorded 1.2 ft; however, the inspector indicated that the velocity appeared satisfactory. For the season, the velocity in the channel was recorded with a range of 1.2 fps to 4.2 fps. Along the collection channel 5 floating orifice were operated. All worked satisfactorily during the 1998 season.

The south powerhouse entrances, SPE-1 and SPE-2, were operated with gate depths ranging from 6.3 ft to 8.2 ft. Gate depths were above 6.0 ft on all inspections; above 8.0 ft on the first 4 inspections when tailwater elevation allowed the project to operate the gates off sill. During the final 3 inspections, the gates were on sill so no further depth could be attained. The head differentials measured at the entrances ranged from 0.9 ft on the initial inspection to a high of 1.3 ft. Again, the readings were improved from the previous season.

Fish Ladder: The depth of water over the north shore fish ladder weirs ranged between 1.0 ft to 1.1 ft. All readings were acceptable. The actual differentials reported at the fish ladder exit and at the picketed leads at the fish counting facility were reported within acceptable ranges. The inspector reported that debris was accumulating on the outside of the exit on several inspections. Normally air is used to (continual bubbling) to keep debris from the exit.

South Shore Fishway

Two south shore entrances are operated (both downstream, no side entrance) to attract fish to the spillway or south fish ladder. All auxiliary water is supplied from the north shore turbine driven pumps except for the 80 cfs flow that enters from the fish ladder. Gate SSE-2 is a fixed-open gate that remains 6-ft open while Gate SSE-1 is to be submerged 8 ft or greater during normal operation. Gate depths at SSE-1 ranged from 7.5 ft to 8.4 ft with the gate on sill during the final two inspections. The head differentials at the south entrances ranged from 1.1 ft to 1.3 ft during the 7 inspections and were within acceptable criteria.

Fish Ladder: The south shore exit was within acceptable criteria range on all inspections except for the final one when the differential measured across the trash rack was 0.5 ft and required cleaning. The picketed lead section at the fish counting station was reported clear of debris throughout the fish passage season. The depth of water over the ladder weirs ranged from 1.0 ft to 1.1 ft so the readings were acceptable throughout the inspections.

Overall, inspections at the project were much improved over the previous year when debris was a serious problem and caused the pump output to be reduced. All fishway entrance conditions, i.e., gate depths and head differentials were considered satisfactory for the 1998 fish passage year. The computer-controlled fishway performed very well and readings from the computer were normally close to the site readings obtained by the inspector.

- When high debris loads are present, one solution would be to modify the racks in front of the fish turbines to allow for cleaning of the intake system.

LITTLE GOOSE DAM

Shawn Rapp, ODFW, completed 7 inspections of the adult fish facilities at Little Goose Dam in 1998 (Table 12). Overall, river Q was closer to normal for the Snake River with only the May inspection recording high flow and spill, (200 kcfs flow). Flow then tapered off to a low of about 16 kcfs during the late summer and fall. Spill was as high as 100 kcfs during the May inspection.

The turbine-driven pumps that supply auxiliary water to the fishway worked satisfactorily throughout the fish passage season. The project operated the pumps with the rpm level between 71-75 rpm through the year. There were no indications that debris caused any problem with operation of the pumps, i.e., reduced rpm from any pump.

Fishway Inspections

The two South Shore entrances (SSE-1 and SSE-2) are operated to allow 8.0 feet or greater weir submergence with a head differential between 1.0 ft to 2.0. The project actually operated the south shore entrances to achieve 9.0 ft or greater depending on the tailwater elevation. Through the inspection season, the gate depths ranged from 8.8 ft to 10.0 ft with head differentials that ranged from 1.2 ft to 1.5 ft. All readings were well above the minimum of 8.0 ft and were satisfactory through the year.

The two north powerhouse entrances, NPE-1 and NPE-2 were operated to meet the depth criteria of 7.0 ft or greater submergence below tailwater. Through the inspections, the depths ranged from 5.8 ft to 7.5 ft. The NPE gates were on sill or within 0.2 ft of being on sill during the fishway inspections we conducted in 1998. The project kept the head differential at 1.0 ft or greater for the entire season with the range from 1.0 ft to 1.2 ft. With the gates on sill, and the “head” greater than 1.0 ft, the gates were operated at acceptable criteria throughout the season.

The velocity through the collection channel and to the north shore generally was estimated near 0.5 to 1.0 fps on the south end of the channel (electronic meter) and increases to >2.0 fps at the northern end of the powerhouse channel. At the north shore entrance transport channel, a visual measurement of the surface velocity (floating chunk of wood) ranged from 1.2 to 2.2 fps. Along the collection channel, 4

Table 12. Pertinent Data for Fish Facility Inspections in 1998 at LITTLE GOOSE DAM.

CRITERIA ITEMS	DATE OF INSPECTION							
	30-Apr	28-May	1-Jul	30-Jul	27-Aug	1-Oct	22-Oct	
SOUTH SHORE FISHWAY								
<i>South Shore Entrance:</i>								
<u>Depth over entrance weir</u>								
SSE-1 (Criteria = 8 ft or >)	ft	9.1	9.1	9.2	8.8	8.9	9.9	10.0
SSE-2 (Criteria = 8 ft or >)	ft	9.1	9.1	9.2	8.8	8.9	9.9	10.0
Head at SSE-1 & 2 (Criteria = 1-2 ft)	ft	1.5	1.2	1.2	1.5	1.3	1.3	1.3
Dep. over ladr. weir (Crit. = 1-1.3 ft)	ft	1.1	1.1	1.0	1.1	1.1	1.1	1.2
Channel velocity (Criteria = 1.5-4 fps)	fps	0.5-1.9	0.9-1.7	0.4-1.2	0.3-2.2	0.5-2.7	0.3-1.5	0.8-1.7
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gages clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (Criteria = 0.3' max)		yes	yes	yes	yes	yes	yes	yes
<i>North Powerhouse Entrance:</i>								
<u>Depth over entrance weir</u>								
NPE-1 (Criteria = 7 ft or >)	ft	6.8	6.9	6.7	5.8	5.9	7.3	7.5
NPE-2 (Criteria = 7 ft or >)	ft	6.8	7.0	6.7	5.7	5.9	7.3	7.4
Head at NPE-1 & 2 (Criteria = 1-2 ft)	ft	1.1	1.2	1.0	1.1	1.2	1.1	1.0
Staff gages clean		yes	yes	yes	yes	yes	yes	yes
Pump speed	rpm	72-73	74-75	72-75	71-73	72-75	73-74	73
Pumps Operating (3 available)		3	3	3	3	3	3	3
<i>North Shore Entrance:</i>								
<u>Depth over entrance weir</u>								
NSE-1 (Criteria = 6 ft or >)	ft	5.9	6.5	6.4	6.6	6.6	6.6	6.5
NSE-2 (Criteria = 6 ft or >)	ft	5.9	6.5	6.4	6.6	6.5	6.6	6.5
Head at NSE-1 & 2 (Criteria = 1-2 ft)	ft	1.6	1.3	1.3	0.9	1.1	1.3	1.3
Staff gages clean		*1	1	1	1	1	1	1
Comment number (if applicable)		1	1	2	3			

Comments:

1. All weir depth readings were taken from the panel board in the powerhouse. The tailwater staff gage was unusable for season.
2. The flow meter does not appear to be calibrated correctly, albeit it probably measures the slowest spot in the channel.
3. The meter on pump #3 was not working so no rpm was taken.

floating orifice gates were operated, and through the season, all operated in proper sequence and above the water surface.

The North Shore entrances were set to operate at 6.0 ft or greater depth below tailwater with the head differential to be between 1.0 ft to 2.0 ft. Gate depths at NSE-1 and NSE-2 ranged from 5.9 ft to 6.6 ft for the season with head differentials ranging from 0.9 ft to 1.6 ft. The gate depths at the north shore were rated satisfactory with only the initial inspection having a depth of less than 6.0 ft when 5.9 ft was recorded. During that inspection, the “head” was 1.6 ft so flow and velocity through the gates were considered within acceptable criteria. The gate depth was 6.6 ft when the “head” was 0.9 ft, and still should have provided satisfactory flows through the entrances.

Fish Ladder: The fish ladder at the project is located on the southern end of the dam with the exit from the ladder located between Unit 1 and the navigation lock. The spill basin is located on the far end of the project. The fish ladder exit was reported with just a small amount of floating debris in the forebay this season. Head measured across the trash racks indicated that there was little debris building on the racks. Also, the picketed leads at the count station were clear of debris through the season with a maximum head differential measured across the leads of 0.1-ft. The depth of water over the fish ladder weirs ranged from 1.0 to 1.2 ft for the season and readings were all within acceptable range.

Overall, the project operated the main fishway entrances within acceptable limits during the 1998 fish passage season. Areas that should be improved follow:

- The staff gages should be replaced where necessary and calibrated so that readings can be compared between the computer and the on-site record.
- Currently, all weir depth readings are taken from the panel board in the powerhouse. An on-site comparison would be helpful to assure the computer settings are correct.
- The flow meter should be calibrated to assure accuracy.

LOWER GRANITE DAM

Shawn Rapp, ODFW completed 7 fishway inspections at Lower Granite Dam during the 1998 fish passage season (Table 13). All tailwater elevations from the north shore were again taken from the FSC Board as the tailwater staff gages were not re-installed during the 1998 winter maintenance period. River Q during the inspections ranged from greater than 200 kcfs during the spring to less than 20 kcfs during the late summer and fall. High spill levels were also present this spring with greater than 100 kcfs spill during the May inspection.

Fishway Inspections

The South Shore fishway entrances, SSE-1 and SSE-2, operated with gate depths that ranged from 7.9 ft to 8.4 ft and head differentials that ranged from 1.2 ft to 1.7 ft. Normally, the gate depths were near

Table 13. Pertinent Data for Fish Facility Inspections in 1998 at LOWER GRANITE DAM.

<u>CRITERIA ITEMS</u>	<u>DATE OF INSPECTION</u>							
	<u>30-Apr</u>	<u>27-May</u>	<u>30-Jun</u>	<u>30-Jul</u>	<u>28-Aug</u>	<u>30-Sep</u>	<u>22-Oct</u>	
SOUTH SHORE FISHWAY								
<i>South Shore Entrance</i>								
<u>Depth over entrance weirs</u>								
SSE-1 (Criteria = ft or >)	ft	7.9	8.0	7.9	8.4	8.0	8.1	8.2
SSE-2 (Criteria = 8 ft or >)	ft	7.9	8.1	8.0	8.4	7.9	8.1	8.0
Head at SSE-1 & 2 (Crit. = 1 - 2 ft)	ft	1.7	1.2	1.7	1.3	1.7	1.7	1.5
Depth over ladr. Weir (Crit.= 1-1.3 ft)	ft	1.0	0.8	1.0	1.0	1.0	0.9	0.9
Channel velocity (Crit. = 1.5-4 fps)	fps	1.3	1.3	1.4	1.0	0.6	1.0	1.2
Ladder exit clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Staff gauge clean (yes or no)		yes	yes	yes	yes	yes	yes	yes
Picket leads clean (yes or no)		yes	0.2'	0.2'	yes	0.2'	0.2'	0.2'
<i>North Powerhouse Entrance:</i>								
<u>Depth over entrance weir</u>								
NPE-1 (Criteria = 8 ft or >)		6.5	8.6	7.5	6.1	5.4	8.3	8.2
NPE-2 (Criteria = 8 ft or >)		6.5	8.6	7.5	6.1	5.4	8.2	8.2
Head at NPE-1&2 (Criteria = 1-2 ft)		1.0	0.8	1.3	1.3	1.3	1.1	1.2
Staff Gauge clean		yes	yes	yes	yes	yes	yes	yes
<i>North Shore Entrance:</i>								
<u>Depth over entrance weir</u>								
NSE-1 (Criteria = 7 ft or >)		6.8	10.7	6.4	5.6	5.5	5.7	5.7
NSE-2 (Criteria + 7 ft or >)		6.8	10.6	6.5	5.6	5.6	5.7	5.7
Head at NSE-1&2 (Criteria = 1-2 ft)		1.0	1.2	0.9	0.9	1.5	1.2	1.3
Staff Gauge clean		TW staff gage broken for season						
Comment number (if applicable)		1	2	3	4			

Comments:

1. The n shore tailwater staff gage was not replaced in 1998 (broken since 1996 floods). The spill pattern was off from the FPP but had been coordinated as part of the research commitment for the surface bypass collector work.
2. Readings taken from FSC board due to high spill at the NSEs. Tailwater differences allow the NSEs to be in criteria while the NPEs cannot meet head differentials during periods of high spill.
3. North Shore Entrances not checked as the COE project was turning the power on and off to the elevator.
4. The gages required calibration as they are about 0.4 ft off from the FSC board and the staff gages.

8.0 ft and “head” near 1.5 to 1.7 ft. Although the gate depths were 0.1 ft below the 8.0 ft required minimum, Q from the entrances should have been satisfactory with the “head” that was recorded during the inspections.

The water velocity was recorded via an electronic meter at the southern end of the collection channel. For the season, the water velocities ranged between 0.6 fps to 1.4 fps. The velocity meter is located at the start of the collection channel and obviously in the slowest part of the channel. All readings were below the desired 1.5 fps minimum acceptable criteria. This is an area that should be further evaluated based on fish behavior at the transition into the junction pool and turn pool.

The North Powerhouse entrances, NPE-1 and NPE-2 are to operate with gate depths of 8.0 ft or greater and head differentials between 1.0 ft and 2.0 ft. Based on inspections made with higher spill levels during the previous 2 seasons, it was expected that head differential of 1.0 ft would not be met with the high spill that occurred on the May 27 inspection. In fact, only 0.8 ft “head” was recorded at the NPEs. About 0.7 ft difference between the south powerhouse and north shore tailwater elevation readings was evident during the inspection. Normally the tailwater is near even across the powerhouse to the north shore. Gate depths for the season ranged from 5.4 ft to 8.6 ft. The gates were on sill during four inspections (April, June, July and August). Head differentials ranged from 0.8 ft to 1.3 ft for the season. Only the May 27 inspection reported a “head” of less than 1.0 ft.

North Shore entrances, NSE-1 and NSE-2, had gate depths that ranged from 10.7 ft to 5.6 ft and head differentials that ranged 0.9 ft to 1.5 ft. During the high spill day (May 27), the gates were submerged 10.6 and 10.7 ft with the head differential at 1.2 ft. To the extent possible, the project attempts to maintain a minimum head differential of 1.0 ft while allowing the gate depth adjust to meet the “head”. The project maintained a “head” of 1.2 ft to 1.5 ft for the final 3 inspections with gate depths of near 6.0 ft.

Fish Ladder: Adult fish exit the fish ladder at the south shore of the project. The ladder exit was reported clear of debris on all inspections during the 1998 fish passage season. The picketed leads were reported with 0.2 ft of head on 5 of 7 inspections rather than 0.1 ft that would be considered clear of debris. The depth of water over the fish ladder weirs ranged between 0.8 ft and 1.0 ft and was reported at 0.9 ft during the final two inspections. I do not consider the latter condition detrimental to adult fish passage.

Overall, the adult fish facilities performed better in 1998 than the previous season. During the April inspection, the spill discharge was different from the FPP schedule. According to the operator, this was due to the Surface Bypass Testing. A copy of the spill schedule was provided the inspector and the FPC for reference. Several recurring problems still remain with the adult fish facilities at Lower Granite Dam:

- The project has 3 fish pumps, but only two can be operated due to hydraulic limitations of the system. As a result, the north shore fishway cannot meet gate depth criteria under most conditions, even though the gates could be lowered further in the gate slot.
- The project should reinstall the broken staff gage(s) at the north shore. There has been no way to obtain a reliable tailwater elevation reading for several years. Either that or a stillwell should be installed to allow a tailwater reading. It has been nearly impossible to tell whether the north shore is calibrated correctly.
- Water velocity through the beginning of the southern end of the powerhouse collection channel was less than desired for most of the fish passage season. A review of the radio telemetry study relating to fish passage through this section of the channel would be helpful in determining what effect this might have on adult fish.
- Based on initial radio telemetry study results, one of the two south shore entrance gates has a net fallout rate. It would appear that the downstream gate could be closed and the other SSE gate operated at a deeper depth to achieve better passage for adult fish. Passage of adult fish through the south shore entrances should be further assessed from the radio telemetry results.

SUMMARY OF RECOMMENDATIONS

General Recommendations

In reviewing recommendations from previous inspection reports completed during the past few years, a number of the recommendations remain the same. Through the 1990's, adult fish passage research relied mainly on studies that used marked adult salmon to assess travel time, survival, passage through the dams, fallback, and other indices. Adult fish were normally captured at Bonneville Dam or other given site, a radio tag placed in its gut, pertinent data about the fish recorded, and then released to migrate to its spawning area. This has proven to be a valuable tool throughout the years; however, it appeared the weak link has been receiving the data in an analyzed form where management decisions can be applied that relate to adult passage at the dams in a timely fashion. Most of the data will be in report form this upcoming year.

- Review adult radio telemetry study results; implement agreed-upon changes that would improve adult fish passage through the mainstem dams. Some key elements include passage through floating or fixed orifices along the powerhouse collection channels, fallback at the dams, passage through main entrances and the fish ladders.

Other recommendations relating to adult fish passage have been reported at the FPOM committee meetings or in MCOL committee meetings during the 1998 season. Main issues relating to passage of adult fish continue to include.

- Projects should assure that screening systems for the auxiliary water systems are adequate to reduce impacts that might occur when large amounts of debris are in the river.
- Projects should seal bulkhead slots along the powerhouse channel or at backup entrance gates where possible. This would reduce amount of water that is basically wasted rather than going to the main entrances for example.
- Projects should assure that water-measuring devices are easy to read, and that includes at all water elevations during the year. Preferred staff gages would be those that can be cleaned easily or else have bench marks available so sensor readings can be taken.
- Projects should automate and computerize fishway operations so that fish facilities can be kept within criteria limits through all ranges of flows and changes in operations.
- Projects should evaluate backup water supply sources to assure that adequate water is available to attract adult fish should the main water supply fail.
- Projects should complete approved spill schedules prior to the fish passage season.
- Prior to the adult/juvenile fish passage season, a preseason meeting should be held to discuss previous year's inspections and assess readiness for 1999. Issues at COE projects should continue to be discussed at the FPOM monthly meetings and individual meetings set with Douglas, Chelan, and Grant PUDs (tentatively set for Jan 19-21, 1999).

Project Specific Recommendations relate to particular items in fishways that require action to improve fishway operations or to aid the fishway inspection program.

Bonneville Dam

- During the 1998 season, the new powerhouse fishway was not operated at full criteria for the first 3 months of the fish passage season due to the problems relating to one of the fish turbines. The District was unable to obtain the parts required from the manufacturer to repair the turbine. Consequently the powerhouse was operated with one fish turbine idle during the spring chinook migration. The District must assure that spare parts or other parts required to operate the fish turbines are secured and the equipment repaired prior to the fish passage season. This is especially critical at lower Columbia River projects such as Bonneville Dam where adult fish are arriving at their first dam in the upstream migration.
- Based on fallback of adult salmon from radio telemetry studies, efforts should be taken to reduce numbers of salmon that are “recycled” at the dam, mainly fish from the Bradford Island fish ladder.
- Keep debris from the new powerhouse fish turbine units and trashracks. This remains a problem at the project. Throughout 1998, the fish turbines were taken off-line for about three hours per evening to reduce buildup of debris on the trashracks. There should be a better solution to the problem than shutting down auxiliary water flow.
- The project should maintain a minimum depth of 6.0 ft at the south powerhouse entrances at the old ph to assure that velocity through the powerhouse channel remains above 1.5 fps and adequate flow is passing through the South Gate.
- The project should build a large holding tank that would allow volitional exit for adult fish that have been anesthetized and are coming out of the effects of the anesthetic. Currently, the partially awakened fish are placed in a location of fairly high velocities that could injure the adult fish.

The Dalles Dam

- With the new rewind of the fish turbines, outflow from the turbines could be increased when the units were operated at higher amperage level. This would allow the project to maintain the entrance gates at the proper depths and “head” even during the summer, low tailwater conditions. This should be further tested and the turbines operated at the higher amperage during the summer and fall.
- Velocity should be increased through the eastern end of the powerhouse collection channel; this has been an on-going problem area.
- Spill should be evaluated prior to the season to assure that conditions are favorable for adult fish as well as juvenile fish.

John Day Dam

- Improvements are required at the north shore counting station to reduce fallback through the counting slot. This has been an on-going problem and should be corrected by the District.
- The project should continue working on the North Shore auxiliary water supply. It was improved in 1998, but still only 4 of the 6 pumps can operate at one time and it is very difficult for the project to meet criteria at the north shore entrances during the summer and fall months when tailwater elevations are minimal.
- Hydraulic conditions have not changed at the fish ladders resulting in fish jumping and residing in the fish ladders. Fish have landed on the concrete weirs, jumped through the netting, and likely many fish are injured in the John Day fish ladders.
- Although satisfactory in 1998, the trashracks at the upstream auxiliary water supply for the fish pumps should be changed to allow cleaning of the racks without shutting down the pumped water supply.
- Again, debris was not a major problem in 1998, but it has been in past years. Some type of debris excluder should be placed to reduce accumulation of debris in the forebay of the project.

McNary Dam: Although the Oregon fishway system including the pumps and gates are old, they appeared to function satisfactorily through most of the adult fish passage season. The newer WA shore fishway worked satisfactorily as well.

- The District should concentrate on improving their juvenile bypass system, mainly the screening system at the downstream end of the bypass collection channel. Many failures have occurred throughout the years.
- The District should keep debris away from the project as much as possible; this would reduce amount of debris in the juvenile bypass system.

Priest Rapids Dam

- The project should either remove or modify the fallout fence that is located near LEW-2. Currently the fence does not reduce the number of fish that drop out the LEW-2 gate.
- Overall, the right bank water supply should be separate from the left bank system to allow better flexibility in operating the fishway. Currently, the right bank cannot operate with the left bank auxiliary water system down. At Wanapum Dam, the water supply systems are separate and independent of the other sides operation.
- The adult fish trapping site located in the left bank fish ladder will slow passage of fish when it is operated. It would be better if the trap were changed to an off-ladder trapping system similar to the Bonneville trap site. Although any trapping site will affect passage of fish, an off-ladder trap provides less passage or delay problems than in-ladder traps.

Wanapum Dam

- The project should complete computerized automation of the adult fishway facilities. This was initiated several years ago but never completed.
- With the higher volume spill that occurs at Wanapum and Priest Rapids dams, fish counts should be assessed at each project to assure that spill schedules are not affecting passage at the spillway (Right Bank Entrances). This would require that fish counting be continued at Wanapum Dam.

Rock Island Dam

- Assess adult fish passage through the Spillway ladder in light of the spill schedule changes that have occurred during the past few years. Assure that adult fish passage will not be impacted at the spillway entrance during 1999.
- An assessment of passage through the Right Bank fish counting station should be completed for the late summer and fall chinook, and the steelhead. Observation of the window shows that these fish appear to hesitate when swimming across the ramp (counting window area). This counting area should be changed if required.

Rocky Reach Dam

- The project should maintain a head differential of at least one ft at the MSE and LPE gates during all times of the year. The Gates should be adjusted to 10-ft to maintain the required head differential as the tailwater elevation increases: generally this applies to May through June or when tailwater downstream entrance gates at 8-ft open and with 1.5 ft of “head” if studies show this to be best operating condition.

Wells Dam

- Douglas County PUD should develop a spill schedule for levels of spill above the juvenile by-pass-spill requirement and approved by the Wells Coordinating Committee.
- Operate the downstream entrance gates at 8-ft open and with 1.5 ft of “head” if studies show this to be best operating condition.
- The project should operate the fish ladder with depth over the weirs between the range of 1.0-1.2 ft rather than at the higher depths, 1.3 ft on several occasions during the past two inspection seasons.
- Passage of fish through the entrance section and to the lower end of the fish ladder should be improved based on adult radio telemetry studies.
- The project should modify their staff gages to make them more easily accessible, i.e., removable and easily cleaned so that they can be read at all elevations.

Ice Harbor Dam

- We noted discrepancies between the computer printout and the on-site readings and believe that there needs to be better correlation between the two readings. We appeared to find the differential greatest on the north spill entrances. The staff gage on the north shore was not usable all season and the north powerhouse gage was also questionable during periods of heavy spill. This made it difficult for the inspector to interpret some readings. Basically, the project should provide good staff gages or an area to take a sensor reading that will be accurate.
- On several occasions, it appeared sufficient flow was available, but the computer was not controlling the system as designed. This problem needs to be remedied.

Lower Monumental Dam

- As at John Day Dam, the turbine pumps at Lower Monumental Dam are susceptible to debris lodging in the wicket gates and other areas in the pumps. The trashrack section of the pumps should better exclude debris or else be self-cleaning or easily cleaned manually. This would help make the auxiliary water supply more reliable during periods of high debris flow in the Snake River. The District should budget to include modifications to this critical passage element.

Little Goose Dam

- Same recommendation as Lower Monumental Dam & John Day Dam.
- Replace all broken staff gages and install this upcoming winter maintenance period.

Lower Granite Dam

- The 2 electric pumps are unable to supply enough flow to meet gate depth and head differential criteria at main fishway entrances during high and low flow periods. The District should address the problem and modify the fishway to improve adult fish passage.
- Replace all broken staff gages and install this upcoming winter maintenance period.

Appendix 1.

Summary of fishway criteria for mainstem dams on the Columbia and Snake River.

Detailed criteria for COE and PUD projects can be found in the COE's Fish Passage Plan or in Detailed Fishery Operating Plans (Adult criteria). This Appendix summarizes the general standards for the fishways at each project.

Entrance Head Differentials: 1.0 to 2.0 feet standard at all projects.

Wells, Wanapum, Priest Rapids, and Bonneville dams target 1.5 ft at some entrances, other projects target 1.25 ft.

Entrance Weir Gate Depths:

Bonneville - At the old powerhouse, maintain 8.0 ft or greater depth at Gate 64/65; maintain 1.0' minimum head at Gate 1 and 2, no minimum Gate depth; at the new powerhouse maintain 13' or > depth when tailwater elevation is above elevation 14 (sill = elev 1.0'). The spillway entrances target 1.5' head with free-flowing slots.

The Dalles, John Day (OR fishway), McNary (north shore), Ice Harbor, Lower Monumental, Little Goose, and Lower Granite - 8 ft or greater depth at Entrance Gates.

McNary (OR fishway) - 9.0 ft or > gate depths.

Rock Island (spillway entrance) - 8.5 ft or > gate depth.

Priest Rapids (LEW-2) - 8.5 ft \pm 0.5 ft gate depth; change in 1999 to fixed open gate.

Priest Rapids (LEW-4) - 8.8 ft \pm 0.5 ft gate depth; change in 1999 to fixed open gate.

Priest Rapids (REW-2) - 7.5 ft \pm 0.5 ft gate depth; change in 1999 to fixed open gate.

Rock Island left bank, Little Goose north shore, and John Day (WA fishway) - 6.0 ft or > gate depth.

Lower Granite north shore - 7.0 ft or > gate depth.

Rocky Reach left powerhouse & spillway - 10' or > gate depth.

Entrance Wing Gate Openings:

Wells - 6.0 ft open end gate, 4.0 ft open side gate; **may change in upcoming seasons.**

Rock Island - 2.0 ft open on center fishway side gate; 3.0ft open on all right powerhouse entrance gates.

Rocky Reach - 3.0 ft open on right powerhouse gates.

Entrance (fixed-open) Gates:

Bonneville (spillway entrances), **Wanapum** and **Priest Rapids** (all entrances), and **Lower Monumental** (south shore, SSE-2 is a permanent fix 6-ft open gate).

Turbine Unit Operating Priority: Specific to each dam (See 1998 FPP).

Spillway Operation: Specific to each dam (See 1998 FPP and DFOP).

Collection or Transportation Channel Velocities: 1.5 to 4.0 fps at all projects.

Staff Gages or other Elevation Gages: At all projects, gages must be maintained throughout the fish passage season and readable at all elevations.

Fish Ladder

Depth of Water over Fish Ladder Weirs: 0.9 ft to 1.4 ft; most project use a 1.0 ft to 1.2 ft or 1.3 ft; John Day has a 1.0 ft \pm 0.1 ft during non-shad passage period.

Head on Picketed Leads: Maximum of four inches at most projects (0.3 ft); 6.0 inches is required at Chelan PUD projects.

Head on Exit Trash Racks: Maximum of 0.5 ft greater than reading with a clean trash rack. Debris should be removed when significant amounts accumulate.

ACKNOWLEDGMENTS

State and Federal fish agencies provided personnel to inspect adult fishways during the 1998 fish passage season. The Fish Passage Center has appreciated the Agencies' commitment of providing fishway inspectors during the year. We recognize the time and commitment it takes from the individual inspector's normal activities to assure that fishways at the mainstem dams were inspected each month. Fishery agency personnel who participated in the inspection program during 1998 are listed. For the 1998 season, there were two new inspectors for the year, Larry Swenson of NMFS and Shawn Rapp of ODFW. This will be the final season for Ray Holtz, WDFW who will be retiring. Others listed have completed inspections from two to eight years.

<u>AGENCY</u>	<u>INSPECTOR</u>	<u>DAMS INSPECTED</u>
NMFS	Bryan Nordlund	Priest Rapids & Wanapum
NMFS	Ed Meyer	Bonneville
NMFS	Larry Swenson	McNary
ODFW	Doug Case	The Dalles & John Day
ODFW	Shawn Rapp	Little Goose & Lower Granite
WDFW	Ray Holtz	Rock Island & Rocky Reach
WDFW	Stewart Mitchell	Wells

Project operations personnel and biologists from Portland and Walla District Corps of Engineers provided on-site assistance whenever necessary to assure that the agency inspector could thoroughly inspect the adult and juvenile fishways. The inspectors were appreciative of assistance provided by the Corps of Engineers.

Grant, Chelan and Douglas Public Utility Districts were also very helpful in providing access and assistance for the fishway inspectors at the individual projects. This cooperation and assistance provided by PUD project personnel, fish biologists, fishway attendants and others were appreciated by the inspectors and the Fish Passage Center.

Funding for the FPC staff coordination of the inspections was provided by the following fishery agencies: WDFW, ODFW, IDFG, USFWS, and NMFS.

