RESEARCH PACKET
AND
BONNEVILLE PROJECT IMPACTS DOCUMENT

NOAA FISHERIES RESEARCH ACTIVITIES
2013

VALIDATION OF CFD ANALYSIS AND EVALUATION OF FISH CONDITION AND GATEWELL RESIDENCE TIME FOR JUVENILE SALMONIDS IN A MODIFIED GATEWELL AT THE BONNEVILLE DAM SECOND POWERHOUSE

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EVALUATION OF CORNER COLLECTOR PIT-TAG DETECTION EFFICIENCY

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RECAPTURE OF PIT-TAGGED JUVENILE CHINOOK SALMON AND STEELHEAD FROM 2012 AND 2013 SNAKE RIVER STUDIES

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VALIDATION OF CFD ANALYSIS AND EVALUATION OF FISH CONDITION AND GATEWELL RESIDENCE TIME FOR JUVENILE SALMONIDS IN A MODIFIED GATEWELL AT THE BONNEVILLE DAM SECOND POWERHOUSE

BACKGROUND

In 2007, Bonneville Dam Smolt Monitoring Program data indicated that substantial Second Powerhouse mortality occurred during initial passage of Spring Creek NFH Chinook salmon released in March and April. Reducing turbine operation from upper 1% to lower levels within the 1% peak efficiency range reduced the incidence of mortality. Inspection of passage facilities did not identify problems nor did necropsy find evidence of fish health problems that could have contributed to the observed passage mortality. These mortality events led to further examination of fish condition effects related to turbine operational level.

In 2008 and 2009, NOAA Fisheries evaluated mortality, descaling, and bypass system passage timing for fin-clipped (2008 only) and PIT-tagged (2008 and 2009) juvenile Chinook salmon released and recaptured at Bonneville Dam Second Powerhouse. Test series were conducted using subyearling Chinook salmon obtained directly from Spring Creek NFH, run-of-river (ROR) yearling Chinook salmon, and ROR subyearling Chinook salmon. Baseline groups were released into the bypass system collection channel. Treatment groups were released into Gatewells 12A and 14A (2008 only) and into the "A" intake of Turbine Unit 14 (2008 and 2009). Comparisons of mortality, descaling, and timing were made between treatment groups released at low, lower-middle, middle, middle-upper, and upper 1% turbine operation. Target turbine unit flows corresponding with nominal 1% operations were as follows (in kcfs): low, 11.7; lower-middle, 13.5; middle, 14.7; middle-upper, 16.3; and upper, 17.8. Tests were designed to detect 3% additive differences in mortality and descaling ($\alpha = 0.05$, $\beta = 0.2$). Results provided consistent evidence that passage mortality in this stock increases in a stepwise manner as Second Powerhouse turbine operation is raised to higher levels within the 1% peak efficiency range.

In the years since 2009, computational fluid dynamics (CFD) modeling studies identified turbulent flow circulation patterns at each end of a Second Powerhouse gatewell during simulated operation within the upper end of the 1% peak efficiency flow range. Addition of turbulence reduction devices (TRDs) (formerly referred to as submersible traveling screen slot fillers) to the model greatly improved flow conditions. Proof-of-concept testing in 2013 will determine if TRDs reduce gatewell turbulence during turbine operation at the upper end of the 1% peak efficiency flow range, and if so, whether the turbulence reduction results in measureable fish condition improvements for juvenile Chinook salmon passing through the modified gatewells. This study contributes toward the long term goal of improving passage conditions for juvenile salmonids at Bonneville Dam Second Powerhouse.

OBJECTIVES

The current research summary includes four objectives for evaluation at Bonneville Dam Second Powerhouse in 2013. Field measurements of velocity magnitude and turbulence intensity will be made in selected gatewells of Turbine Units 14 and 15 to validate results from CFD modeling studies. Objectives 1 and 2 will be conducted by an engineering firm under contract to the U.S. Army Corps of Engineers.

Objective 1—Measure and compare water velocity and turbulence intensity in Gatewells 14A and 15A at turbine operations within the lower and upper 1% peak efficiency flow ranges. Gatewell 14A will be equipped with TRDs and Gatewell 15A will not.

Objective 2—Measure water velocity and turbulence intensity in Gatewell 14C with upper 1% flow and no TRDs installed. Measurements will be compared to those obtained under Objective 1. This comparison is intended to quantify hydraulic differences between A and B gatewells and the relatively lower flows of C gatewells.

If effectiveness of the TRDs is verified by field measurements in Objectives 1 and 2, then potential benefits will be tested by release and recapture of PIT-tagged yearling and subyearling Chinook salmon. NOAA Fisheries will conduct the biological evaluations specified in Objectives 3 and 4.

Objective 3—Estimate mortality, descaling, and passage timing for juvenile Chinook salmon released into Turbine Intake 14A during unit operation at flows representative of upper and lower settings within the 1% peak efficiency range. Sample sizes will be calculated to detect a 3% additive differences in mortality and descaling rates at $\alpha = 0.05$. The objective specifies three treatment groups, defined as follows:

A. No turbulence reduction device and upper 1% unit flow.
B. Turbulence reduction device installed and upper 1% unit flow.
C. No turbulence reduction device and lower 1% unit flow.

Objective 4–Perform statistical comparison of upper 1% flow Treatments A (TRD out) and B (TRD in) with the lower 1% flow Treatment C (TRD out). Direct comparison of upper 1% flow Treatments A and B is not specified, but data will be sufficient to make this comparison if needed.

METHODS

Test fish will include subyearling Chinook salmon obtained directly from Spring Creek National Fish Hatchery (NFH) as well as run-of-river (ROR) yearling and subyearling Chinook salmon obtained from the Bonneville Dam Smolt Monitoring Program (SMP). Fish will be PIT tagged and released into the Turbine 14 "A" intake via a four-inch-diameter hose supported by a steel structure mounted on the trash racks. Test fish will be recaptured using programmable separation-by-code (SbyC) at the Second Powerhouse Juvenile Fish Monitoring Facility (JFMF), anesthetized, examined, and returned to the river. Passage effects, including descaling, mortality, and time from release to recapture will be estimated.

SCHEDULE

Between 6 and 18 March, a mechanical contractor will install the TRD guides in Gatewell 14A, followed by trial fit of the TRDs and water up of Turbine 14. From 25 March to 7 April an engineering firm will perform flow measurements in Gatewell 14A (study Objectives 1 and 2).

If the activities outlined above are completed on schedule, then NOAA Fisheries will begin testing on Monday 8, April. Test Series 1 (Spring Creek NFH fish) will take place from 8 April to 2 May. Test Series 2 (ROR yearling Chinook salmon) will be conducted from 13 May to 6 June. Test Series 3 (ROR subyearling Chinook salmon) will be conducted from 24 June to 18 July.

We have consulted with Jon Rerecich, Portland District COTR and with the Bonneville Project structural crew in order to develop consistent schedules for weekly activities. Fish releases, turbine load changes, and TRD placement and removal will take place between 0800 and 1000 hours. Tests are 24-hour duration. Work would be scheduled as follows:

<u>NOAA Fisheries</u>

- Saturday — Obtain test fish from Spring Creek Hatchery or Bonneville SMP
- Sunday — PIT tag test fish at the JFMF
- Monday — Release Treatment A, tag Treatment B, monitor recaptures
- Tuesday — Release Treatment B, tag Treatment C, monitor recaptures
- Wednesday — Release Treatment C, monitor recaptures
- Thursday — Monitor recaptures

<u>COE</u>

- Monday — Turbine Unit 14 brought to upper 1% operation
- Tuesday — Place TRDs in Gatewell 14
- Wednesday — Remove TRDs, Unit 14 to lower 1% operation
- Thursday — Clean VBSs, Unit 14 operating restriction removed

EVALUATION OF CORNER COLLECTOR PIT-TAG DETECTION EFFICIENCY

BACKGROUND

In 2006, BPA contracted Digital Angel (aka Destron Fearing) and PSMFC to install a PIT-tag system that DA designed into the corner collector. The corner-collector PIT-tag system is unique in many ways: 1) it has the largest antenna, 2) it has only one antenna instead of multiple antennas, and 3) it has a specialized transceiver designed specifically for this application.

NOAA Fisheries (aka NMFS) did some preliminary fish tests in 2006 to help Digital Angel in setting up their system. Since that time, they have run similar fish tests in 2007, 2009, and 2011 to evaluate new PIT tag models. During the 2011 tag evaluation, we also evaluated a prototype ogee transceiver that could detect normal ISO FDX-B tags that are detected in 31 msec as well as tags that can be read in 16 msec. The ogee transceiver gave us roughly 2% gain on the regular SST-1 tags compared to the BCC transceiver (Table). More interestingly, the 16 msec tags yielded a 9% gain, which would be significant.

Group	# detected	# released		RE %
SST-1 (bcc transceiver)	738	947		77.9
SST-1 (ogee transceiver)	782	975		80.2
16msec tag (ogee transceiver)	726	835		86.9

In July 2011, Destron Fearing was bought by its competitor Allflex Corporation. Allflex already had bought an interest in Biomark Incorporated. Allflex put Biomark in charge of all the fisheries work – tags, transceivers, and development work. We requested that they revamp the prototype ogee transceiver for the 2012 season, but Biomark could not fulfill that request as they were finishing up two other transceivers. Therefore, this request was postponed for 1 year. Biomark will be delivering the new BCC ogee transceivers to PSMFC in February 2013, who will evaluate them in the laboratory and then install one into the BCC site in March. BPA has requested that NOAA Fisheries evaluate the new transceiver along with the new 9-mm and 16 msec tags. We will use 4,800-5,000 yearling Chinook Salmon for this evaluation. Test fish will be obtained from Little White Salmon NFH.

Importance to Region

This work is critical to the region for several reasons. For one, the original BCC transceivers appear to be on their last legs and so we need to determine if the new ogee transceivers are an acceptable replacement. Hopefully, they will be an improvement. Since BPA is now buying the new PT300 9-mm tags, it is important to know how well the production tags perform. The region is supporting the development of a PIT-tag detection system for spillways and 16msec tags may well be essential for collecting tag data in water that is moving at 60-70 fps. This test under water moving at ~35 fps will provide some solid data to help us move forward with the development work.

METHODS (CORNER COLLECTOR EVALUATION)

We will use 800 fish tagged with the SST-1 tags with the original BCC transceiver as the control to compare this set of tests with previous fish test results. With a detection rate of 75-80%, the 800 fish will yield an accurate estimate of reading efficiencies within ±3%. The 9-mm tag yielded a detection rate of 54% in the 2011 fish test. Therefore, a sample size of 800 would yield an accurate estimate of reading efficiencies within ±3.5%.

To start this evaluation, we will first release 400 fish tagged with SST-1 tags and 400 fish tagged with 9-mm tags (model PT300) through the BCC transceiver. We will alternate releasing small groups of fish tagged from the two tag models. We will then install the ogee transceiver to the corner-collector antenna and release 800 fish for each of the four tag models: SST-1 tags, PT300 tags, 16-msec 12-mm and 9-mm tags. We will alternate releasing small groups of fish tagged from all four tag models. After we have released all the fish tagged to be tested with the ogee transceiver, we will then reinstall the BCC transceiver and release the other 400 fish tagged with SST-1 tags and 400 fish tagged with 9-mm tags.

Number of Fish	Tag Model	Transceiver Model
800	32-msec, SST-1,12-mm	BCC transceiver
800	32-msec, PT300,9-mm	BCC transceiver
800	32-msec, SST-1,12-mm	Ogee transceiver
800	32-msec, PT300,9-mm	Ogee transceiver
800	16-msec, SST-1,12-mm	Ogee transceiver
800	16-msec, PT300,9-mm	Ogee transceiver

Tagging fish

We plan to run the fish tests in early April 2013 (probably the week of 14-20 April, soon after the corner collector is opened full time for the year) because the hatchery will be releasing its fish around that same time. We are planning on using yearling Chinook salmon that we will collect from Little White Hatchery or whichever hatchery USFWS grants us fish from for our evaluation. The fish will be picked up by NOAA Fisheries and trucked to Bonneville Dam. We will then tag them in the juvenile fish facility.

Installing the two transceivers

PSMFC will be in charge of installing and removing the transceivers for the fish tests. If need be, we will bring in engineers from Biomark to help with the installation of the ogee transceiver.

Releasing the fish

Once a transceiver has been installed, the tagged fish from the appropriate groups will be trucked up to the deck above the entrance to the corner collector. Before the fish are released, they will be scanned so that their PIT tag codes can be recorded. The Chinook salmon will be released individually in front of the entrance to the corner collector through a 4" hose. This same apparatus was used in the previous evaluations of the corner-collector detection system. By releasing PIT-tagged fish within the capture velocity area in front of the entrance, we will know precisely how many tagged fish have passed through the corner-collector system during the testing. All of the fish released will continue down the Columbia River after they have been released at the entrance of the corner collector.

Analyses

The calculation of reading efficiencies is straight forward – divide the number of tags detected by the number of tags released. We will also examine number of reads per tagged fish. Noise measurements will be taken on a regular basis (every 30 minutes) to record how it changes over the week as high noise levels can impact tag detection.

RECAPTURE OF PIT-TAGGED JUVENILE CHINOOK SALMON AND STEELHEAD FROM 2012 AND 2013 SNAKE RIVER STUDIES

PIT-tagged Juvenile Chinook salmon and steelhead will be automatically separated from the migrant population at the JFMF by the separation-by-code system at this location. Fish will be anesthetized, weighed and measured, examined for condition, and then allowed to recover prior to release to the river. The SbyC system will be programmed to separate target fish five days each week from March through mid August. The number recaptured will be capped by the separation programming to avoid capture of excessive numbers of target fish and bycatch. Conducting this activity with our local Bonneville staff allows for efficient use of personnel and reduces travel expense.

FACILITIES AND EQUIPMENT REQUIREMENTS (ALL ACTIVITIES)

Acquisition, holding, tagging, and recapture of test fish will require use of existing JFMF facilities. Temporary provisions for holding fish, e.g., containers, water supply plumbing, and drainage piping, will be set up at the JFMF.

Release of test fish at the Second Powerhouse will require access to the bypass system collection channel (DSM) and to the Second Powerhouse intake deck. Within the DSM, test fish will be held in an aluminum tank near the 14A south orifice discharge. We will need to drop a small submersible pump into the channel to provide life support water to the holding tank. The pump is 110V, single phase, and is rated at 4.0 A. In 2008-09, we obtained power from an orifice light receptacle by installing a "triple tap" into the receptacle and plugging both the pump and orifice light into the tap. On the intake deck, use of the river water supply will be necessary to provide flushing water during morning fish releases and also to provide holding and release hose water during the one-week evaluation of corner collector tag reading efficiency.

PROJECT IMPACTS (ALL ACTIVITIES)

Project Services

Crane service to place and install TRDs during testing will be coordinated by the Portland District COTR for the study. If further needs arise, we will notify the COTR, who will make arrangements to reimburse Bonneville Project.

Security

Although most activities will occur during daylight hours, we anticipate study personnel may need to be on the Bonneville Project grounds outside of normal working hours, on weekends, and on holidays. Since most tasks will take place in secure project locations, contact with the public will be limited to transit between the Second Powerhouse and the juvenile facility.

Partial lists of personnel and vehicles are shown in Tables 1 and 2. Other employees and vehicles will be added prior to start up. First aid and CPR certifications will be updated as necessary. Updated information will be communicated to the Bonneville POC. No boat work is involved with the project.

Table 1. Study personnel, affiliation, activity, and certifications. Activity abbreviations: PH2-FC = PH2 Fish Condition; Corner Collector Efficiency = CC-E; Recapture Monitoring = RM

NAME	AGENCY	ACTIVITY	FIRST AID	CPR
GILBREATH, LYLE	NOAA-F	PH2-FC, CC-E, RM	2/15/13	2/15/13
CHARLTON, LILA	NOAA-F	PH2-FC, CC-E, RM	2/15/13	2/15/13
ABSOLON, RANDY	NOAA-F	PH2-FC, CC-E, RM	1/24/13	1/16/13
DOWNING, SANDY	NOAA-F	CC-E	1/24/13	1/16/13
SANDFORD, BEN	NOAA-F	PH2-FC, CC-E	1/24/13	1/16/13
MARR, RON	NOAA-F	PH2-FC, CC	1/24/13	1/16/13
DAVIDSON, SCOTT	NOAA-F	PH2-FC, CC	1/24/13	1/16/13
WASSARD, BILL	NOAA-F	PH2-FC, CC-E	1/24/13	1/16/13
LAMB, JESSE	NOAA-F	PH2-FC, CC	1/24/13	1/16/13

Table 2. Vehicles.

LICENSE	ST	DESCRIPTION	COLOR	AGENCY	OWNER	POC/CREW
G63-2099B	US	05 CHEVY PU	WHITE	NOAA-F	US GOV'T	GILBREATH, LYLE
25497N	WA	02 CHEVY PU	SILVER	NOAA-F	GILBREATH, LYLE	GILBREATH, LYLE
680YRR	WA	09 SUBARU	GREEN	NOAA-F	CHARLTON, LILA	GILBREATH, LYLE
G63-2115G	US	08 FORD PU	BROWN	NOAA-F	US GOV'T	ABSOLON, RANDY
	US			NOAA-F	US GOV'T	DOWNING, SANDY
G63-1935H	US	06 CHEVY SUV	TAN	NOAA-F	US GOV'T	SANDFORD, BEN
G63-1277L	US	11 CHEVY PU	WHITE	NOAA-F	US GOV'T	MARR, RON
G63-2107G	US	08 FORD PU	WHITE	NOAA-F	US GOV'T	DAVIDSON, SCOTT
G63-1924D	US	06 CHEVY PU	BROWN	NOAA-F	US GOV'T	WASSARD, BILL
G63-1459M	US	12 CHEVY PU	WHITE	NOAA-F	US GOV'T	LAMB, JESSE

Safety

All personnel will be made aware of applicable provisions of the Safety Requirements Manual #385-1-1. In addition, monthly safety meetings will be held and the list of topics covered will be provided to our Bonneville Project POC. The Activity Hazard Analysis and the Job Hazard Analyses are attached.

ACTIVITY HAZARD ANALYSIS

ACTIVITY: NOAA FISHERIES - RESEARCH Lyle Gilbreath
LOCATION: PH2 JFMF, INTAKE DECK, DSM **ANALYZED BY/DATE:** 3 March 2013 **REVIEWED BY/DATE:** _____

PRINCIPAL STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS (FROM EM 385-1-1)
1. Setup equipment at work sites. 2. Conduct the work. 3. Removal equipment.	• Foot injury • Hand injury • Eye or face injury • Noise exposure • Head injury • Hazardous substances • Material handling • Housekeeping • Fire	• Steel-toed safety shoes (05.A.08) • Appropriate hand protection (05.A.10) • Protective equipment (05.B.01, 02, 06) • Hearing protection (05.C.01, 04, 07) • Protective headgear (05.D.01, 02, 04) • Material Safety Data Sheets to be maintained on site (06.B.01) • Use of lifting devices and handling aids (14D.A.01-06) • Safe and orderly work areas (14.C.01-04, 08) • Flammable liquids handling and storage (09.b.01-04, 08, 10, 12, 14, 16, 21) Fire extinguishers (09.3.01-04)

JOB HAZARD ANALYSIS

JOB TITLE: PIT Tag Juvenile Salmonids
LOCATION: PH2 Juvenile Fish Facility **ANALYZED BY/DATE:** Lyle Gilbreath 3 March 2013 **REVIEWED BY/DATE:** _____

PRINCIPAL STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS (FROM EM 385-1-1)
1. Inject tags	• Minor personal injury • Blood-borne pathogens	• Care with injector and awareness of surroundings. • Designated, responsible employees know location and use of clean-up kit (03.A.06).
2. Disinfect tagging needles	• Minor personal injury • Blood-borne pathogens • Flammable liquid (ethanol) handling • Eye injury	• Care with injector and awareness of surroundings. • Designated, responsible employees know location and use of clean-up kit (03.A.06). • Flammable liquids handling and storage (09.B), fire extinguishers (09.E), Material Safety Data Sheets to be maintained on site (06.B.01 c). • Protective equipment (05.B.01, 02)
3. Reload tagging needles	• Minor personal injury • blood-borne pathogens	• Care with injector and awareness of surroundings. • Designated, responsible employees know location and use of clean-up kit (03.A.06).

JOB HAZARD ANALYSIS

JOB TITLE: Release test fish
LOCATION: PH2 JFMF, Intake deck
ANALYZED BY/DATE: Lyle Gilbreath 3 March 2013
REVIEWED BY/DATE:

PRINCIPAL STEPS	POTENTIAL HAZARDS	RECOMMENDED CONTROLS (FROM EM 385-1-1)
1. Load fish for transport	• Personal injuries	• Foot injury. Steel-toed safety shoes (05.A.08). Hand injury. Appropriate hand protection (05.A.10). Noise exposure. Hearing protection (05.C.01, 04, 07). Head injury. Protective headgear (05.D.01, 02, 04). Lifting injury. Use of lifting devices and handling aids (14D.A.01-06).
2. Vehicle operation	• Accident	• Seat belt use (18.B.09). • Backing (08.C.04). • Vehicle inspection (18.A.03) • Operation (18.C).
3. Release fish	• Personal injuries	• Foot injury. Steel-toed safety shoes (05.A.08). Hand injury. Appropriate hand protection (05.A.10). Noise exposure. Hearing protection (05.C.01, 04, 07). Head injury. Protective headgear (05.D.01, 02, 04). Lifting injury. Use of lifting devices and handling aids (14D.A.01-06).