ISO Adult Pit Interrogation System Installations

Project 200100300

Response to ISRP Preliminary Review of Fiscal Year 2003 Mainstem and Systemwide Proposal

Date: August 23, 2002

To: ISRP

From: Sandra Downing, NOAA Fisheries (NMFS)

RE: Project 200100300 / ISO Adult Pit Interrogation System Installations

The ISRP review asked for more details on the monitoring and evaluation component of this project proposal. This response covers the following objective and tasks:

Objective: Evaluate performance of installed interrogations systems for adult salmonids

> Task a: Use the direct method to determine reading efficiencies for multiple species transiting the Washington Shore Ladder at Bonneville Dam for comparison to statistical models and information on fish behavior, annual fluctuations, etc.

> Task b: Analyze data from the PIT-tag interrogation systems installed into fish ladders to determine the accuracy of the data being collected and answer other questions. For example, determine if the orifice-based systems are sufficient for the ladders at Bonneville and McNary Dams or whether counting-window systems need to be installed.

Task a: Biologists and fisheries managers need to know the probability of detecting a PIT-tagged fish in a particular FCRPS fish ladder in order to plan and evaluate study plans and make management decisions. As part of the FY01 evaluation of the orifice-based interrogation system installed into the Washington Shore Ladder at Bonneville Dam, NMFS and BPA used both direct and indirect methods for deriving estimates of tag-reading efficiencies for that ladder. The direct method compares the number of tagged fish detected to that of the number of tagged fish released in a position where they have to pass the PIT-tag interrogation system. The indirect method of determining tag-reading efficiency is a statistical method based on the number of tagged fish detected while not knowing the actual number of fish passing through the system.

The tagging plan for 2001 was based on anecdotal evidence (reports and numerous discussions with researchers who work with adult salmonids), the video taping results by the U.S. Army Corps of Engineers (Corps), and on the results generated from the tagging done the previous year during the evaluation of the PIT-tag equipment in the exit ladder of the Adult Fish Facility. A main objective of this work was to determine if tag reading efficiencies for the eight-weir orifice-based interrogation system installed into the Washington Shore Ladder at Bonneville Dam were different for various run times – focusing on chinook salmon. Another objective was to determine whether the 8-weir system could yield 95% reading efficiency levels for the different runs and species. Nothing in the references or past results had suggested the degree of overflow use that was recorded in 2001. For the spring chinook salmon, the orifice-based system detected 97% of the fish while for the fall chinook salmon, the reading efficiency dropped to 90%. The test results also suggested that reading efficiencies were low for coho salmon (75-80%) and for A-run steelhead (90%), but fewer of these fish were tagged. In all cases, the statistical models yielded higher reading efficiencies (mostly 100%) for the entire fish ladder than the direct method; mainly because the models only use the fish that were read at least once (i.e., they have no way of accounting for fish missed entirely by the system). **It is important to emphasize that the lower reading efficiencies were not because the PIT-tag equipment was not detecting tagged fish using the orifices (individual orifices have reading efficiencies of 99+%), but because some species were choosing to use the overflows rather than the orifices more than expected.**

The results from NMFS' work were summarized in two documents available from NMFS or BPA. The documents (Adult_PIT_tests_2001_Part_1.pdf and Adult_PIT_tests_2001_Part_2.pdf) are also available on the Internet at http://www.psmfc.org/pittag/web/Adult/index.html.

These results are snapshots in time and place – they may only apply to the Washington Shore Ladder for 2001. They do suggest that we are not reading 95% for all of the species all of the time, which may mean that the fisheries community needs to investigate installing interrogation equipment into alternative locations (e.g., counting windows and vertical slots). Of course, 2001 may have been an atypical year as fish numbers at Bonneville Dam were at historically high values, which may have influenced fish behavior in the ladder. Certainly, the biologists working at Bonneville indicated that they were seeing more use of the overflows during the fall of 2001 than they could recall having seen before. Only time and more tagging will give us the knowledge of which trends observed this year are consistent from year to year. We did limit the number of days we tagged during 2001 because of the time it took for the video tapes to be analyzed; however, we were able to use the high numbers of spring and fall chinook salmon tagged to demonstrate the number of fish that need to be tagged to yield accurate estimates of reading efficiencies (Figure 1).

Figure 1. The two graphs show the relationship between numbers of chinook salmon tagged and how accurate the reading efficiency values are for different number of weirs. The data displayed in the top graph are from the spring chinook salmon data collected during April 2001 and data displayed in the bottom graph are from the fall chinook salmon data collected during September 2001.
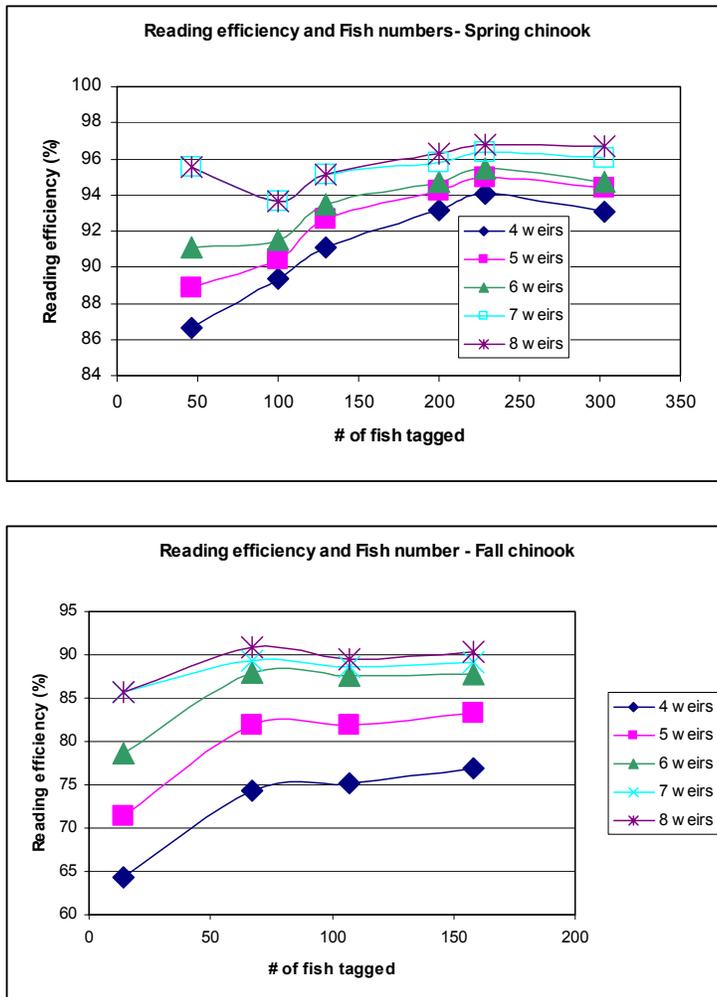
Figure 1 suggests that not much is gained with tagging more than 200 spring chinook salmon as the reading efficiency values started to level off; that asymptotic value was reached at closer to 75 for the fall chinook salmon. These results suggest that for other species in the future we should try to tag at least 100 fish for each species and 200 if possible. Figure 1 also suggests that low numbers of fish tend to underestimate the true efficiency of the interrogation system. Data from the other species also indicate the effect of tagging low numbers - for example, with the steelhead in the spring, had we detected one more fish, reading efficiency would have increased from 84.6 to 92.3%. Therefore, in future years, we plan on tagging more fish and covering more of the run time. This should be easily accomplished because we do not plan on using video taping to verify the passage of fish past a specific location.

Fish were not tagged during the spring and summer of 2002 because BPA was worried that the identified leaking antennas might affect the performance of the orifice-based system. Evidence collected during 2002 has shown the leaking and non-leaking antennas are performing equally well and so tagging will resume in the fall. During this fall as well as in the tagging efforts planned for FY03-05 at the Washington Shore Ladder, we will tag 100-200 fish for as many species as possible and cover their entire run times. We were able to increase the numbers of fish that could be tagged in these future efforts for some species by modifying permit restrictions – and we are now able to tag both clipped and unclipped coho and steelhead. Because of the low numbers of fish we tagged, we had already received permit modifications in 2001 for fall chinook salmon. This multiple year tagging program will also give the fisheries community a better estimate of how much the statistical models are overestimating the probability of detecting a tagged fish in a ladder. Only time and more tagging will give us the knowledge of which trends observed this year are consistent from year to year.

Task b: One objective of this evaluation is to determine whether the 8-weir interrogation systems installed at Bonneville and McNary Dams will be sufficient during future years without having to add antennas into the counting stations or vertical slots. Since almost all of the migrating species experienced historically large returns in 2001, the shear numbers of fish in the ladder may have impacted fish behavior. Since the data collected at Bonneville Dam is so critical for the statistical models used by the fisheries community, the community has indicated it wants this site to have minimally a 95% reading efficiency level for all of the species if possible. A decision needs to be made by the end of 2003 on whether to install additional antennas into Bonneville and McNary Dams. The 8-weir interrogation systems may well be satisfactory for the Washington Ladder at McNary Dam because Bonneville Dam has twice as many fish at twice the density as McNary Dam. We will use different groups of fish to help with this analysis. For example, we will use fish that are recorded at Lower Granite Dam (and McNary Dam) and fish that are both PIT and radio tagged. For example, an analysis using spring chinook salmon that should have returned to Dworshak Hatchery was conducted in June 2002. Of the 189 ISO-tagged adult fish detected at Lower Granite Dam, 95% were detected by the orifice-based systems installed at Bonneville Dam while 100% were detected at McNary Dam (to emphasize why this site is so critical, there were around 90 fish seen only at Bonneville Dam). Similar analyses need to be conducted with different stocks and species of fish. This is an example of the type of work that will be performed under this task to help evaluate how well these systems are performing.

Over the next few years, the radiotelemetry study supported by the Corps includes plans to insert radio tags into approximately 1000-3000 fish annually, most of which will have ISO tags in them. Thus, this group of fish can be used to evaluate the performance of the PIT-tag interrogation systems installed into the fish ladders. For example, this group of fish is currently being used to compare the performance of the orifice-based system and prototype counting-station system installed into the Oregon Ladder at McNary Dam because we can use the radiotelemetry data to confirm if a tagged fish should have been detected by a particular system. At the same time, the PIT-tag data help the telemetry investigators confirm if a fish has a lost or dead radio tag. The overlap of the two monitoring systems will also enable

the fisheries community to develop definitions (e.g., what is a fall back) so that in the future, the PIT-tag systems can take over producing this information for the fish managers. The fish managers are also planning on using the orifice-based systems in the individual ladders at Bonneville Dam to monitor how powerhouse operational conditions and spill conditions affect fish behavior in the ladders and ladder use. At this dam, it would not be possible to conduct this analysis if only the counting stations had interrogation systems.

As part of this task, NMFS and PSMFC personnel will periodically evaluate how well the interrogation systems in the different ladders are performing by examining number-of-reads per fish over time and other transceiver parameters. This was done during 2001, where it identified some leaking antennas where water had reached the high voltage side. The process was repeated in May 2002 to determine how the identified leaking antennas were reading tags and maintaining tune relative to the non-leaking antennas (Spring_2002_Performance_Update.pdf on the PSMFC web site). There was no statistical difference with all of the units averaging over 15 reads per fish, indicating that solid data were being collected and that water had not reached the high voltage areas in any of the leaking antennas. This monitoring will continue over the years so that PSMFC can identify antennas in which the ability to collect solid data is compromised. With a badly leaking antenna, eventually one will not be able to compensate with adjustments to the transceiver and a decision will need to be made on whether to replace the antenna or to remove that weir from the system. That situation has not occurred yet and except for the obvious situation of a "dead" or unusable antenna, until we learn more about how well the installed systems interrogate different species, it is impossible to establish which is the correct solution.

We are still learning about fish behavior in ladders and the effectiveness of the different types of interrogation systems being installed in fish ladders. The above types of evaluations need to be performed over multiple years to yield the necessary information to determine whether these systems will be the proper technology for answering some of the management and biological issues raised in the Biological Opinion.

ISRP: The power to detect important "failures", etc. should also be given. Are there quality control standards in place for performance of such devices?

Yes. Quality control standards, and processes, are in place for performance of the transceiver systems. The Columbia Basin PIT Tag Information System, Northwest Power Planning Council Fish and Wildlife Program number 199008000 (reference further information at www.ptagis.org) operates and maintains the devices.

Detection System Monitoring
As data from an interrogation site is validated and loaded PTAGIS process inspect and analyze the data in order to identify potential issues that could relate to degraded detection efficiency at the interrogation site. A number of methods are used to perform these analyses. These methods include monitoring each interrogation transceiver for diagnostic anomalies and monitoring for the *absence* of 'fixed reference' tags (also called timer tags). In addition, direct and indirect methods are used to determine the efficiency of each PIT tag interrogation coil.

Monitoring Transceiver Diagnostics

There are over 300 PTAGIS supported interrogation coils (one transceiver 'drives' one coil or antenna) within the Columbia River Basin. The Transceiver Analysis System and Statistics (TASS) subsystem monitors diagnostic messages from each transceiver as interrogation files arrive and are dispatched by the PTTP Server. This is available on the internet to PTAGIS O&M staff at
http://www.psmfc.org/pittag/maint_op/TASS/TASS_All_MinList_Policy_Annunciator.html .

TASS provides a visual user interface for use by the PTAGIS staff to provide alert information from any transceiver at any interrogation site. This is illustrated in Figure 3. This user interface utilizes a red light / green light system to alert PTAGIS O&M staff of potential problems with any transceiver / coil at any interrogation site. The O&M staff can click on the associated red light and view details of the red light event.

After corrective action has been taken, PTAGIS O&M Staff document any action taken and submit it to the "Event Log".

Figure 1: TASS Coil Diagnostics and Alarm Response Interface

In addition to providing alert triggers based upon transceiver diagnostics, TASS also generates graphical 'strip-charts' of key transceiver parametric information. By reviewing the trends depicted on the strip-charts, potential problems can be identified based upon a given trend. Quality control standards for operation of the PIT tag detection transceivers are provided by the Manufacturer, Digital Angel Corp (DAC).

Monitoring Fixed Reference Tags

A specialized PIT tag is associated with each interrogation coil throughout the system. These fixed reference tags are usually called timer tags, because they are triggered automatically every four hours (or as programmed by PTAGIS O&M personnel).
Every interrogation file should contain at least one timer tag for each coil at an interrogation site. The absence of a timer tag record for a given coil indicates a potential problem. Each time the IDL process runs, a Timer Tag Exception report is created that lists any coil that has not read a timer tag. O&M action may be necessary in this event.

Timer tag data is stored in the PTAGIS dataset for future reference. The presence of continuous timer tag information is a good indication of the continuity of the data set for each coil throughout the system.

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