Study to Determine the Biological Feasibility of a New Fish Tagging System

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A STUDY TO DETERMINE THE BIOLOGICAL FEASIBILITY OF A NEW FISH-TAGGING SYSTEM, 1996-1997

ANNUAL REPORT

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ABSTRACT

This report covers work performed by National Marine Fisheries Service (NMFS) during 1996 and 1997 in cooperation with the Bonneville Power Administration (BPA). The project focused on expanding and improving PIT-tag technology throughout the Columbia River Basin (CRB).

During 1996 and 1997, NMFS developed and evaluated two- and three-way side-to-side fish diversion systems. Fish diversion systems are mechanical devices that redirect fish to predetermined destinations within CRB fish facilities. Two-way diverters were installed at two dams and have proven to be mechanically reliable and trouble free. Additional testing, however, is required for the three-way diverter before it can be deployed.

NMFS is coordinating development of a computer program, MULTIMON, that performs a number of functions that are essential to the overall operation of the PIT-tag system. To accommodate the needs of the fisheries research community for the 1996 and 1997 juvenile salmonid outmigration seasons, modifications were made to the computer program. An alpha version of the program was installed at three CRB dams in 1996 and used in six research projects. In 1997, a beta version of the program was installed at all of the PIT-tag interrogation facilities in the CRB. Modifications to the program are also being made to accommodate the needs of the 134.2-kHz ISO-based PIT-tag interrogation system to be deployed in the CRB.

A 400-kHz flat-plate (pass-by) PIT-tag interrogation system was installed at the terminus of the downstream migrant channel at Bonneville Dam First Powerhouse in 1996. The system consists of electronics and two excitation/receiving antennas that are installed in a movable carriage on the top of the existing fish trap. The flat-plate system was operated and evaluated during the 1996 and 1997 field seasons, with reading efficiencies determined directly using PIT-tagged juvenile salmon. Under normal water operating conditions, the fish tests yielded reading efficiencies for the antenna array (both antennas) of 97.3% for both years. Other flat-plate system performance information is presented in the report.

Development work started on a 134.2-kHz flat-plate system in 1997. The system will replace the current 400-kHz system at Bonneville Dam when the basin-wide transition to the 134.2-kHz PIT-tag technology occurs in 2000. The report also discusses other potential sites for installation of flat-plate systems to interrogate returning adult salmon and development work that needs to be completed prior to its deployment.

BPA plans to complete the transition to the new PIT-tag system based on 134.2-kHz tags for the 2000 outmigration season. Towards this end, BPA established teams to oversee various aspects of the transition. NMFS has representatives on each team, and general activities completed by the NMFS team representatives during 1996 and 1997 are outlined in this report.

Since NMFS personnel designed or helped develop many of the present PIT-tag system components, NMFS actively interfaced with other agencies on PIT-tag related matters. During 1996 and 1997, NMFS personnel were consulted on 1) facility designs to accommodate PIT-tag systems, 2) system maintenance, 3) using prototype equipment, and 4) using the MULTIMON program. In addition, NMFS personnel conducted several public outreach activities that are detailed in this report.

CONTENTS

EXECUTIVE SUMMARY

This report covers work performed by National Marine Fisheries Service (NMFS) during 1996 and 1997 in cooperation with the Bonneville Power Administration (BPA). The project focused on expanding and improving PIT-tag technology throughout the Columbia River Basin (CRB). The timely and accurate information derived from PIT-tag technology is critical in helping regional decision-makers address resource management questions raised by the Northwest Power Planning Council Fish and Wildlife Program, the NMFS 1995 Biological Opinion on operation of the Federal Columbia River Power System, and the NMFS proposed recovery plan for Snake River salmon. Work during 1996-97 was divided into two primary categories: 1) PIT-Tag System Development and Evaluation and 2) Technical Support Service and Technology Transfer. Each part consists of a number of work elements that are described in the report.

Fish diversion systems are mechanical devices that redirect fish to predetermined destinations within the CRB fish facilities. During 1996 and 1997, NMFS developed and evaluated two- and three-way side-to-side fish diversion systems. The new diverters can operate under a greater range of flow and elevation conditions than either the slide gates or rotational gates used previously in these systems. Two-way diverters were installed at Little Goose and Bonneville Dams and have proved to be mechanically reliable and trouble free. The 1997 mechanical evaluation of the three-way diverter revealed that the flexible hose failed at 24,390 cycles, far below the 80,000 cycle goal. The biological evaluation was inconclusive as to whether the diverter damaged fish, but it did suggest some modifications to ensure that fish would not be damaged. During 1998, NMFS will try to solve the hose fatigue problem with a new

polyurethane formulation and a longer hose. The new design will then undergo additional mechanical and biological testing. If the system meets the performance criteria established by NMFS for these tests, then the unit will be installed at Lower Granite Dam. The system would then undergo field testing in 1999.

NMFS is coordinating development of a computer program, MULTIMON, that performs a number of functions. These functions include the ability to 1) record tag code information, 2) control the separation of PIT-tagged fish by applying different sampling or separation protocols to a set of coils and fish diversion mechanisms, 3) control or monitor a timed subsample, during which all fish transiting particular coils are collected over a given amount of time, and 4) communicate diagnostic messages with 134.2-kHz International Standards Organization (ISO) FDX-B stationary transceivers. Modifications were made to the computer program to accommodate the needs of the fisheries research community for the 1996 outmigration season. An alpha version of the program was installed at three CRB dams in 1996 and used in six research projects. In 1997, a beta version of the program was installed at all of the PIT-tag interrogation facilities in the CRB. It was also used to control separation by code at Lower Granite Dam juvenile and adult facilities. This was the first time the program had been used to control separation of adult salmon.

In 1996, many modifications were made to the computer program in order to evaluate three different prototype 134.2-kHz transceivers based on ISO documents. These modifications included making changes to record the ISO tag codes (each prototype communicates differently) and to interpret the ASCII diagnostic messages originating from the ISO-based transceivers. A communication protocol was established for the ISO-based transceiver systems in 1996 to reduce

the need for future changes. During 1997, MULTIMON performed admirably at both the 400-kHz sites and the ISO test site at McNary Dam. Therefore, most of the modifications planned for 1998 are intended to increase the flexibility of the program for future use. In addition, the user manual will be finalized for the 1998 season. The program should be ready to transfer to Pacific States Marine Fisheries Commission (PSMFC) after the 1998 season.

A 400-kHz flat-plate (pass-by) PIT-tag interrogation system was installed at the terminus of the downstream migrant channel at Bonneville Dam First Powerhouse in 1996. The system consists of prototype electronics and two excitation/receiving antennas that are installed in a movable carriage on the top of an existing fish trap. Each antenna is housed in a watertight enclosure (2.2-m wide by 0.51-m long by 0.1-m deep). Water flows at right angles to the longest dimension.

The flat-plate system was operated and evaluated during the 1996 and 1997 field seasons, with reading efficiency determined directly using PIT-tagged juvenile salmon. Under normal water operating conditions, the fish tests yielded reading efficiencies for the antenna array (both antennas) of 97.3% for both years.

Indirect estimates of reading efficiencies for the individual and combined antennas were calculated during 1996 and 1997 using a statistical procedure based on the total number of migrating PIT-tagged fish detected during the season on the two antennas. For 1996, reading efficiency of the antenna array was estimated at 98.0% based on the interrogation of 4,371 PIT-tagged fish. For 1997, reading efficiency of the antenna array was estimated at 99.2% based on the interrogation of 12,298 PIT-tagged fish.

The functionality of the flat-plate system was monitored daily using PIT-tagged wooden

test sticks that were passed over its antenna array. The presence or absence of tag readings was an indicator of the system's operational status. The flat-plate system had few electronic problems during the two field seasons, with little data lost due to down time for repairs. The advantages of this system compared to pass-through systems is that fish can be interrogated for PIT tags without restricting their movements or forcing them to pass through a tunnel.

Development work started on a 134.2-kHz flat-plate system in 1997. The system will replace the current 400-kHz system at Bonneville Dam when the basin-wide transition to the 134.2-kHz PIT-tag technology occurs in 2000. The report also discusses other potential sites for installation of flat-plate systems to interrogate returning adult salmon. System development involves 1) development of the analog excitation and detection circuitry including the antenna design, 2) development of the digital detection/control circuit and its firmware, and 3) building and testing the engineering design model or prototype. NMFS contracted an engineering firm to develop and produce a prototype unit for testing. Preliminary testing indicated that the prototype generally delivered an adequate reading range for its intended application; however, mechanical vibrations sometimes caused interference that masked the return signal of the tag. Remedies for this problem are being investigated. A full laboratory evaluation is scheduled for early 1998 at the NMFS Manchester (WA) Field Station.

BPA plans to complete the transition to the new PIT-tag system based on 134.2-kHz tags for the 2000 outmigration season. In order to provide for a smooth transition and to ensure that CRB salmon research is not adversely affected, the entire system must be thoroughly tested and evaluated prior to the deployment of the new equipment. Toward this goal, BPA established the following technical and advisory teams: a "Transition Planning Team" to oversee the entire

transition; a "Transceiver Technical Evaluation Team" to oversee the development of the stationary readers that will be installed at the dams; a "Portable Technical Evaluation Team" to oversee the development of the portable reader; and a "Tag Development Team" to oversee the development of suitable PIT tags. BPA also established an “Infrastructure Team” to oversee necessary construction for the transition at the dams, the installation of stationary transceivers, and the necessary changes to the tagging software and PSMFC’s PTAGIS database for implementing the 134.2-kHz system. NMFS has representatives on each team, and general activities completed by the NMFS team representatives during 1996 and 1997 are outlined in this report.

Since NMFS personnel designed or helped develop many of the present PIT-tag system components, NMFS actively interfaced with other agencies on PIT-tag related matters. During 1996 and 1997, NMFS personnel were consulted on 1) facility designs to accommodate PIT-tag systems, 2) system maintenance, 3) using prototype equipment, and 4) using the MULTIMON program. In addition, NMFS personnel conducted several public outreach activities that are detailed in this report.

INTRODUCTION

The National Marine Fisheries Service (NMFS), in cooperation with the Bonneville Power Administration (BPA), conducted research and development work on passive integrated transponder- (PIT-) tag technology for use in the Columbia River Basin (CRB) during 1996 and 1997. The work was divided into two general categories: 1) PIT-Tag System Development and Evaluation and 2) Technical Support Service and Technology Transfer. Each category consisted of multiple work elements that are discussed in this report.

The research and development effort of this project has produced and will continue to produce products that aid resource stakeholders in assessing the effectiveness of actions taken to enhance the survival of juvenile and adult salmonids. These products are used to 1) obtain survival and migration timing information on stocks for evaluating water management strategies and fish passage/collection facilities, 2) provide data needed for the management and restoration of salmonid and other fish stocks, 3) obtain information required for the management of multiple species in a variety of habitats, and 4) provide tools that will enable fishery researchers and managers to address previously unanswerable questions.

The research and development products have been and will continue to be used in genetic, physiology, behavior, and broodstock research on endangered species. The continued development of the PIT-tag technology will enable the PIT-tag systems to be used by researchers in addressing issues expressed in both the NMFS 1995 Biological Opinion for operation of the Federal Columbia River Power System and the proposed Snake River Recovery Plan (Tasks 2.1D, 2.3.b.4, 2.4.a, 2.6.c.2, and 2.9.d).

PIT-TAG SYSTEM DEVELOPMENT AND EVALUATION

Fish Diversion Systems

Introduction

Prior to the late 1980s, the primary method used to divert or reroute fish at CRB juvenile fish collection facilities were flip gates located within fish passage flumes. In the late 1980s, NMFS designed a slide-gate diversion system (Fig. 1, Prentice et al. 1993). The slide-gate system was "fish friendly" and could be operated rapidly enough to separate individual fish. These features enabled it to be combined with the PIT-tag interrogation systems installed at CRB dams to separate PIT-tagged fish from other fish. This permitted the PIT-tagged fish to be returned to the river for subsequent interrogation instead of being transported at the CRB facilities.

The slide-gate design was followed in the mid-1990s by two- and three-way rotational systems (Fig. 2). The three-way rotational diverter was the first diverter capable of separating fish groups into three directions. Fish separation was controlled by a computer running the MULTIMON program, which is discussed later in this report (see p. 10-16). The rotational gates of the three-way diverter could also be used in pipes as well as flumes. However, they could only operate with half-full pipes. To address this issue in 1996, NMFS designed two- and three-way side-to-side fish diversion systems that could be used in pipes that were full of water (Fig. 3). This design requires less dewatering of fish passageways prior to fish diversion, which potentially reduces stress on fish. These features enable the side-to-side diverters to operate under a greater range of flow and elevation conditions than the earlier designs. In addition, the side-to-side design requires no costly custom-made components and is easy to maintain because

of accessibility to its parts. Technical and isometric drawings of fish diversion systems designed by NMFS are available through NMFS or BPA.

Progress to date in the design and evaluation of the two- and three-way side-to-side fish diversion systems is presented below.

Discussion

Two-way side-to-side fish diversion systems--The first two-way unit measuring 15 cm in diameter was installed at Little Goose Dam on the Snake River in 1996. After 2 years of operation, the two-way side-to-side diverter has had no mechanical failures, the guides and other system components do not show significant wear, and the flexible hose shows no signs of fatigue. However, during the 2 years of operation at Little Goose Dam, some diverted fish were identified as having been damaged by the diverter.

To eliminate the fish damage problem, corrective measures were taken when another two-way diverter was designed for Bonneville Dam in 1997: the distance between the discharge nozzle and the pathway divider was increased and the pathway divider was sloped. The two-way diverter for Bonneville Dam was larger (25.4 cm in diameter). The side-to-side diverter was the only choice for Bonneville Dam because elevation and head loss restrictions precluded enough water from being removed to permit the use of a rotational diverter. The Bonneville Dam unit has also proved reliable and has shown no significant component wear. Furthermore, no fish damage has been attributed to the diverter at Bonneville Dam. Thus, similar corrective modifications will be made to the Little Goose Dam unit for the 1998 outmigration season.

Three-way side-to-side fish diversion system--A preliminary evaluation of a three-way

side-to-side diverter measuring 25.4 cm in diameter was conducted in 1997. Tests investigating mechanical durability and impact on fish were conducted at the NMFS Pasco (WA) Field Station. The designers were concerned about hose fatigue with the longer side-to-side travel distance of the three-way diverter compared to the short lateral movement of the two-way diverter. Thus, one objective of the mechanical test was to operate the system through 80,000 cycles which is estimated to equal 2 years of operation. A program logic controller (PLC) was used to control and record the number of operational cycles. During this test, parts wear and failure were also monitored. All cycle tests were conducted with the hose completely full of water and in air temperatures ranging from 0 to over 30°C.

As anticipated, the 25-cm-diameter flexible hose was problematic. Two material formulations for hoses were tested in 1997. The first hose lasted 10,000 cycles (cycle rate was 2 cycles/min) and the second hose lasted 19,000 cycles. Failure of the second hose occurred when small fractures (0.5-cm long) formed in the vicinity of the upstream flange. The diverter was cycled an additional 5,390 times until the hose started to leak at 24,390 cycles. At this time, a fracture had gradually increased to a length of 19 cm. To date, no significant wear has been measured on any of the mechanical parts (combined cycles for all types of testing equals ~60,000 cycles). To rectify the hose fatigue problem, the length of the flexible hose will be extended 10 cm, and a new polyurethane hose formulation will be evaluated in 1998.

We observed that extremely cold weather (0°C) noticeably reduced the cycle timing. This has also been observed at dams with pneumatically driven slide gates. We believe the problem originates in the air control valve system. Therefore, in 1998 we plan to install a thermostatically controlled heater into the air-controlled valve mechanism of the three-way side-to-side diverter

The PLC can then be used to determine cycle timing at different temperatures. If this modification helps stabilize timing, it will be installed into the slide-gate systems in 1999.

A test was also conducted to examine whether the three-way side-to-side diverter damaged fish during operation. Tag codes from 200 PIT-tagged steelhead (*Oncorhynchus mykiss*) were subdivided into three groups so that MULTIMON would be able to separate the fish into the diverter's three directions. Holding tanks were placed at the ends of the diverter's three directions. The passage of fish through the diverter system was video taped. Prior to release, the steelhead were examined and classified as to their physical condition by personnel from Washington Department of Fish and Wildlife using the descaling criteria established for the CRB. Of these fish, 14 were classified as having significant descaling. As a fish-handling control, a random subsample of 43 fish, of which 2 showed descaling prior to holding, were not passed through the three-way diverter, but were held for 24 hours in a fourth holding tank. After the rest of the fish had gone through the diverter, they were held for 24 hours (like the control group). All groups were examined at 24 hours to determine post-test survival and physical condition of the individual fish.

Results were inconclusive as to whether the three-way diverter caused any new scale loss to the test fish. Of the 14 steelhead recognized as having scale loss prior to testing, only 5 were recognized during the post-test examination as having scale loss. Otherwise, the post-test examination revealed that an additional 8 fish (not part of the original 14 fish) had scale loss and 3 others had damaged opercula. No correlation could be found between the direction fish were diverted and fish damage. Because of the inconsistencies in scale loss determination, no definitive answers could be derived from that portion of the test. One fish died during the test and another

during the 24-hour holding period. No fish-handling control fish died. General consensus was that severe water turbulence observed in the three holding containers (net-pens) during the testing caused the fish mortality and most, if not all, of the injuries. Every time a fish was diverted, a large volume of water would suddenly enter the restricted holding pen. Fish were observed being temporarily impinged against the sides of the holding pen and being tumbled within the pen.

The video record provided the best evidence of fish behavior while passing through the diverter. The opercular damage observed (3 fish) may have resulted from the diverter system because several fish were trapped in unnatural positions when they exited the hose nozzles and passed by a pathway divider. As a precautionary measure, modifications to the diverter's pathway dividers (slope and spacing) were suggested. These modifications were incorporated into the two-way side-to-side diverter installed at Bonneville Dam in 1997. The evaluation of the three-way diverter will continue in 1998 with emphasis on overcoming the hose fatigue problem. Once this technical problem is overcome, another fish test will be conducted. Once the prototype has passed these tests successfully, we propose to further evaluate the new diverter at Lower Granite Dam in 1999. This diverter will replace the present three-way rotational fish diverter at Lower Granite Dam.

Figure 1. Slide-gate fish diversion unit.

Figure 2. Three-way rotational fish diversion unit.

Figure 3. Three-way side-to-side fish diversion unit.

MULTIMON: A Multiple Function Computer Program

Introduction

During 1992-1994, NMFS developed and evaluated a separation-by-code system (computer program and fish diversion gates) at the Manchester (WA) Field Station. A computer program controls the separation of desired PIT-tagged fish from undesired tagged and untagged fish based on their individual tag codes. The development of this computer program is a joint project with Pacific Northwest National Laboratory (PNNL) whose personnel write the computer code. NMFS personnel oversee the development, test the program after modification, interface with Pacific States Marine Fisheries Commission (PSMFC) personnel, and assist researchers. PNNL and NMFS personnel have worked together on the program's online help file (accessible while the program is running) and user guide.

By fall 1995, the separation-by-code system had been successfully tested at Manchester and at Lower Granite Dam's experimental site (GRX); however, testing at the latter site indicated several features that had to be completed before the computer program could be fully implemented at the CRB dam sites as scheduled in 1997. Meanwhile, several researchers requested use of the computer program at two dams during 1996. Therefore, many of the identified changes had to be quickly implemented for the 1996 migration season. In addition, a few features were added to assist researchers in completing their studies.

The schedule was interrupted again when some of the planned work (e.g., developing help files) was delayed in favor of making modifications to the computer program to facilitate the evaluation of International Standards Organization (ISO)-based PIT-tag transceiver systems

being considered for the CRB. This actually required many changes, because we had to accommodate different data formats among three vendors.

The ISO-related changes were all unscheduled. However, these changes elucidated the dynamics of operating the system and pointed out the need for additional program changes that will probably be required to meet researcher needs or to accommodate new equipment each year. It is thus likely that the program will never be totally static. Nonetheless, since all of the currently identified changes will be finished by the start of the 1998 migration season, responsibility to further implement and use MULTIMON will be transferred to PSMFC after the conclusion of the 1998 field season. Major modifications made to the computer program during 1996 and 1997 are discussed below.

1996 Computer Program Modifications

Changes for the migration season--In 1996, the name of the monitoring program was changed from BYCODE to MULTIMON to reflect its expanded ability to perform multiple tasks. Functions that the current version of the computer program can perform include the following:

1) Record tag code information (works simultaneously with 400-kHz and ISO PIT tags).

2) Control the separation of PIT-tagged fish by applying different sampling or separation protocols to a set of coils and fish diverters. This permits:

   a) separation of all PIT-tagged fish from untagged fish.
   b) separation of desired PIT-tagged fish from undesired tagged and untagged fish based on individual tag codes. The desired tags are stored in a user supplied database.
   c) separation of ratios of fish based on all PIT tags or specific PIT tags that are stored in the tag database.

3) Control or monitor a timed subsample during which all fish transiting particular coils are collected over a given amount of time.

4) Keep counts of all tagged fish on daily and seasonal bases.

5) Communicate diagnostic messages with the 134.2-kHz ISO-based stationary transceivers.

The following five research projects used MULTIMON in 1996 with the separation-by-code systems installed at Lower Granite and Little Goose Dams: 1) a National Biological Service study on ATPase levels in migrating fish, 2) a U.S. Fish and Wildlife study on fall chinook salmon, 3) the NMFS dam passage survival study, 4) the NMFS gas bubble disease study, and 5) a NMFS fish guidance study at Little Goose Dam. In addition, NMFS used MULTIMON to record tag codes with their flat-plate PIT-tag monitor at Bonneville Dam. To accommodate multiple researchers at one site and give them the most flexibility, we recognized in 1995 that we had to change the program so that each researcher could define whether he wanted every study fish diverted, only particular study fish diverted, or every n^{th} study fish diverted. Before the development of this program, only one choice was available for an entire site. In addition, researchers requested that a counter be added that made it possible to stop diverting study fish (regardless of how diverted) at any diversion gate after a given number of study fish had been diverted.

Another scheduled modification was to incorporate the ability to recognize remote commands that would enable PSMFC to manage its data files more effectively from its offices in Gladstone, Oregon. The success of this approach for collecting files from GRX made us realize that there were other tasks, such as updating tag databases, that would best be performed remotely in the future. Thus, we added more remote commands for the 1997 migration season.

ISO-related modifications--For the evaluation of the prototype ISO-based transceiver systems, the communication protocol was left undefined by BPA. This was beneficial in terms of deriving different approaches for evaluation, but added more work in terms of adapting MULTIMON to interface with each vendor's stationary transceiver. There were also general changes that had to be made to enable MULTIMON to monitor ISO tags and ASCII diagnostic messages. For one, ISO-tag codes include a manufacturer's code and thus are 14 characters long instead of the 10 characters for 400-kHz tags. After the initial round of transceiver evaluations, a communications protocol was established that addressed present and future requirements. This task was completed in September.

1997 Computer Program Modifications

Changes for the migration season--The evaluation of the ISO-based stationary transceivers introduced us to Comtrol's RocketPorts, which are computer products that control multiple high-speed serial ports. The evaluation team recognized that we could build a high-speed 400-kHz tag reader (the portion of the 400-kHz system that decodes tag signals) that utilized the RocketPorts. This permitted a simple reader design for controlling fish diversion gates. The newly designed 400X tag readers could be installed instead of the expensive GPIB (general purpose interface bus) readers previously used with separation-by-code systems. Two new high-speed 400X readers were installed at Lower Granite Dam to control the slide gates for the Idaho hatchery survival study. Some computer code had to be added to MULTIMON to accommodate this new reader.

To improve the user friendliness of MULTIMON, the display screens were made more consistent for the 1997 migration season. In addition, the following program features were

added: the ability to remove all of the tag codes from the tag database with one specific action code (a number assigned to tag codes to designate a subgroup of fish that is then used by MULTIMON to direct that group of fish to the predetermined destination); active daily and seasonal tag counters to help researchers track their study fish; ability to print the data file as it collects tag data; ability to define how many data files are opened during a day; and a subroutine to permit the backup computer to take over control of the fish diverters within 10 minutes if the primary computer were to fail.

Other changes made were transparent to the user. These included the need to rewrite the code for the section that contains the logic for diverting fish. This was necessary because in 1992 when this project started, the logic had only included one gate and the ability to divert specific tag codes. Since then, features such as the ability to control multiple fish diversion gates, different types of diversion gates, and to turn off a gate when a maximum count had been reached had all been added. These features had been inserted into the code as the need for them arose, which resulted in this portion of the code being unorganized. To ensure that the correct logic was followed, this section was rewritten. Another transparent change was to make the program setup easier by changing the default configuration file from one large binary file to three ASCII files. This allowed the use of an ASCII editor to easily make the few changes necessary to adapt the required files to each dam site. NMFS and PNNL also released drafts of the active user file and user guide for the 1997 migration season.

MULTIMON was installed at all of the major dams for the 1997 migration season. NMFS and PNNL personnel went to all of the sites to set up the program for PSMFC. After a few changes were made early in the season to accommodate a slow slide gate at Lower Granite Dam,

no more changes were necessary. In May, NMFS helped PSMFC install a separation-by-code system at Lower Granite Dam for adult salmon. This was the first time MULTIMON was used to control separation of adult salmon. Many of the same studies that used MULTIMON at Lower Granite, Little Goose, and Bonneville Dams during the 1997 season had also used it in 1996. One new use was for a study that tagged fish with both PIT tags and radio tags. Some of these fish were collected at Little Goose Dam to examine their physical condition.

ISO-related modifications--The evaluation of the ISO-based transceiver system at McNary Dam revealed a few modifications that were needed to improve the diagnostic capabilities of the stationary transceivers. For instance, a stationary transceiver would send a message when a component failed; however, which stationary transceiver was failing was not identified. Therefore, we had to change MULTIMON so that the particular stationary transceiver was identified in all ASCII messages.

Future Computer Program Modifications

Since MULTIMON performed admirably in 1997, we believe that MULTIMON is capable of handling the current needs of the fisheries community. Therefore, most of the scheduled modifications for the 1998 migration season involve increasing the flexibility of the program for future use (e.g., increasing the number of action codes from 100 to 256). Other changes include adapting the subsample section of MULTIMON to interface with the program logic controller (PLC) that will control the U.S. Army Corps of Engineers (COE) subsamples. To accommodate the sites at Bonneville Dam where SUN computers will not be used, we are currently investigating how to adapt MULTIMON so it can run from within the multi-tasking

Windows 95 platform. This will enable the PSMFC server at Gladstone, Oregon to call and collect closed data files while MULTIMON continues to operate.

Other schedule changes include adapting the counting ability so that the maximum number can be defined by summing the fish numbers from multiple gates. For example, there are two gates at the Little Goose Dam separation-by-code site, and because there is poor species separation at this dam, researchers want to define the maximum number of study fish that can be diverted based on both gates. There will also be a few changes for the ISO-based transceiver system as the diagnostic capabilities are further defined. The schedule also calls for the online help file and user guide to be finalized for the 1998 season.

Operation and Evaluation of a 400-kHz Flat-Plate (Pass-By) PIT-Tag Interrogation System at Bonneville Dam

Introduction

Plans for construction of new juvenile fish collection and sampling facilities for the first and second powerhouses at Bonneville Dam are being prepared by the COE. These new facilities include provisions for improved fish passage and the interrogation for PIT tags of all fish passing through the facilities. The facilities are currently scheduled for completion in 2000-2001. However, an immediate need exists for information on fish passing through the present facilities. The information is, in part, required to meet the objectives of the Endangered Species Act Salmon Recovery Plan. This informational need was partially addressed in the spring of 1996 by installation of a prototype 400-kHz flat-plate (pass-by) PIT-tag interrogation system at the terminus of the downstream migrant (DSM) channel within the first powerhouse

(Figs. 4 and 5).

The flat-plate system consists of prototype signal receivers, a controller, and two excitation/receiving antennas that are installed in a movable carriage on top of an existing fish trap. Fish exiting the DSM channel are directed over the antennas, where they are interrogated for PIT tags before returning to the Columbia River. Each antenna is housed in a watertight enclosure (2.2-m wide by 0.51-m long by 0.1-m deep), with water flows at right angles to the longest dimension. The upstream antenna is installed 25 cm above the downstream antenna. The fish trap can be operated using previously established procedures by lifting the antenna carriage with a pneumatic ram. The system electronics are located in an instrument rack 18 m away from the antenna housings. Cabling between the electronics and the antennas are passed through pulley

blocks to allow vertical positioning (4.7-m range) of the fish trap and the antenna array within the downwell. The major advantage of this system is that fish can be interrogated for PIT tags without restricting their movements or forcing them to pass through a tunnel. Nunnallee et al. (in press) present a detailed description of the system.

Below is a discussion of flat-plate system performance during 1996 and 1997.

Discussion

The flat-plate PIT-tag interrogation system at Bonneville Dam was operated during the 1996 and 1997 field seasons. The system was evaluated for PIT-tag reading efficiency during both years using PIT-tagged juvenile chinook salmon (*Oncorhynchus tshawytscha*). The same testing procedure was also used during both years: prescanned PIT-tagged fish were introduced into the DSM channel about 20 m upstream from the flat-plate antennas, and the detected tag codes were compared to those of released fish. The proportion of detected tag codes to released tag codes was used as direct measurement of reading efficiency. Reading efficiencies of the upstream and downstream antennas during normal water flow conditions were 89.4 and 86.7% during 1996, and 89.9 and 93.2% during 1997, respectively (Table 1). The combined reading efficiencies for the antenna array (both antennas) were 97.3% for both years. In 1996, the reading efficiencies of the upstream and downstream antennas measured under maximum water flow conditions were 68.5 and 81.5%, respectively, with a combined array reading efficiency of 92.0%. Reading efficiency under maximum water flow conditions was not measured in 1997.

Indirect estimates of reading efficiencies for the individual and combined antennas were calculated during 1996 and 1997 using a statistical procedure based on the total number of migrating PIT-tagged fish detected during the season on the two antennas (Prentice et al. 1993).

During 1996, the reading efficiencies of upstream and downstream antennas were estimated at 86.8 and 84.8%, respectively. The reading efficiency of the combined array was estimated at 98.0%, with calculations based on the interrogation of 4,371 individual PIT-tag codes. Similar calculations during 1997 produced reading efficiency estimates of 91.2 and 90.7% for the upstream and downstream antenna, respectively. The reading efficiency of the combined array was estimated at 99.2%. Calculations were based on the interrogation of 12,298 individual PIT-tag codes.

The functionality of the flat-plate system was monitored daily using PIT-tagged wooden test sticks (2 x 2 x 14 cm), which were passed over the flat-plate antenna array. Two types of test sticks were used: one with PIT tags inserted lengthwise (0 degree), and the other at 45-degree orientation. The 0-degree test sticks were used to represent fish at near-ideal tag reading orientation as they crossed the flat-plate, while the 45-degree test sticks represented fish at poor orientation and provided a test of system tag-reading sensitivity. All stick tests were performed under the normal water flow condition. Each test consisted of 100 trials of a single test stick passing over the antenna array. Stick tests were conducted daily at the beginning of each work shift throughout the 1996 and 1997 field seasons. The presence or absence of tag detections indicated system operational status.

System operation diagnostic capability was added in 1997 with the installation of fixed reference tags to each antenna. These tags consisted of standard PIT tags that could be activated and deactivated by computer control at predetermined times (e.g., once an hour). The tags were enclosed in a coil of wire the ends of which could be either connected or opened by a relay. When the coil ends were connected by the relay, the tag was shielded and could not be

interrogated. When the coil was opened, the shielding was disabled and the tags operated normally. When the tags were activated their codes and time of detection were recorded by the computer program MULTIMON.

Other modifications made to the system in 1997 included replacing hand-wired (prototype) circuit boards with electronically printed circuit boards; installing quick disconnect connectors to all component boxes to allow rapid and reliable component connection or replacement; and installing waterproof electronic connectors to the antenna housings to facilitate component connection and reduce the possibility of water damage to the electrical cabling or leakage into the antenna housings.

Data from daily stick tests and the presence/absence of reference tag codes in the data files proved invaluable for rapid identification of reduced system performance or equipment failure. The flat-plate system required maintenance and repair on six occasions during the 1996 field season; however, at no time was the system totally inoperable because each time only one antenna ceased to operate. Furthermore, repairs only took a few hours each time. The only failure that occurred in 1997 was during the first week of the field season when the cable bundle between the electronics rack and the antenna array was overstressed and damaged due to improper operation. As a precaution, all system power and communication cables were changed. After replacement of these cables, no further system failures were noted.

Figure 4. Diagram of the juvenile fish sampling facility and flat-plate antenna array, as installed within the downstream migrant (DSM) channel of Bonneville Dam First Powerhouse (side view). The main diagram shows the flat-plate antenna array lowered for PIT-tag detection. The insert shows the antenna array raised for juvenile fish sampling.

Figure 5. Diagram of the juvenile fish sampling facility and flat-plate antenna array, as installed within the downstream migrant (DSM) channel of Bonneville Dam First Powerhouse (side view). The juvenile fish sampling box is shown in the raised (sample retrieval) position, and the small bridging screen is in the retracted position. Fish passing through the DSM channel will pass from the crest of the inclined screen directly into the downwell.

Table 1. PIT-tag reading efficiencies (RE%) for the flat-plate interrogation system using juvenile salmon at Bonneville Dam, under normal and maximum water flow conditions during 1996, and under normal water flow conditions during 1997.

	1996				1997	
	Normal Water Flow		Maximum Water Flow		Normal Water Flow	
	Counts	RE%	Counts	RE%	Counts	RE%
Total test fish	226		162		148	
Antenna A detections (upstream)	202	89.4	111	68.5	133	89.9
Antenna B detections (downstream)	196	86.7	132	81.5	138	93.2
Total missed tags (both antennas)	6		13		4	
Combined array efficiency	--	97.3	--	92.0	--	97.3

Development of 134.2-kHz Flat-Plate (Pass-By) PIT-Tag Interrogation System

Introduction

When the transition to the 134.2-kHz ISO-based PIT-tag system takes place in 2000, the present 400-kHz flat-plate (pass-by) PIT-tag interrogation system in the first powerhouse at Bonneville Dam will no longer be able to read the tagged fish. The loss of information from this location would effectively terminate several ongoing studies (e.g., The Dalles Dam spill study and a portion of the hatchery survival study). In addition, the data loss would have a negative impact on mid-Columbia and other passage survival studies and on the Smolt Monitoring Program. Therefore, we plan to replace the 400-kHz flat-plate interrogation system with a 134.2-kHz flat-plate monitor.

The length of time that the 134.2-kHz flat-plate system would remain operational at Bonneville Dam after installation is unknown. The COE presently plans to replace the existing facility in the year 2000 or 2001. Since these dates are likely to be modified, a flat-plate 134-kHz system must be ready for installation for 2000. Furthermore, even though the flat-plate system may be installed only temporarily at Bonneville Dam, its design could potentially be applied to other sites within the CRB. For example, a flat-plate system could be used at Priest Rapids Dam to interrogate returning adult salmon tagged with 134.2 kHz ISO-based tags used in the mid-Columbia survival study. This could be accomplished by modifying the existing adult fish counting boards located within the fish ladders at the dam. Similarly, a system could be deployed at Ice Harbor Dam for adult salmon PIT-tag interrogation.

In anticipation of replacing the existing 400-kHz flat-plate interrogation system at Bonneville Dam in 2000, development work commenced in 1997 on a 134-kHz ISO-based flat-plate system. The status of the development work at the end of 1997 is described below.

Discussion

There are three general steps in developing a 134.2-kHz flat-plate system: 1) development of the analog excitation and detection circuitry, including the antenna design, 2) development of the digital detection/control circuit and its firmware, and 3) building and testing the engineering design model or prototype. NMFS has contracted a private engineering firm, Patten Engineering, to develop a prototype unit for testing. The firm developed two excitation amplifiers, a Class E and half-bridge power design, to power the antenna and excite the PIT tags. The analog detection circuitry employs crystal filters and a precision rectifier. The firm is initially using a modified version of a simple detection/control circuit for the prototype. NMFS is currently overseeing the development of a more versatile detection/control circuit that will have enough flexibility to interface with almost any analog circuit from any vendor and thus be usable for many different types of interrogation systems (e.g., large detectors that might monitor adult salmon, single and multiple flat-plate arrays, and underwater towed-array detectors). To minimize development costs, this detection/control circuitry is being designed around a commercially available single-board computer. NMFS is utilizing another contractor to program the firmware. Although the work has begun, the firmware will not be completed until late 1998.

Patten Engineering has conducted some preliminary testing on their prototype unit which is powered by the amplifier using the half-bridge design, and the results have been favorable. The prototype generally delivered an adequate reading range for its intended application; however, t

techanical vibrations sometimes caused interference that masked the return signal of the tag. Efforts to remedy this problem, such as using instrument vibration dampening pads and antenna encapsulation materials, are being investigated. A full laboratory evaluation is scheduled for early 1998 at Manchester.

TECHNICAL SUPPORT SERVICE AND TECHNOLOGY TRANSFER

Participation in the Transition to the 134.2-kHz ISO-Based PIT-Tag System for Juvenile Pacific Salmon

Introduction

The present 400-kHz PIT-tag system in the CRB is scheduled to be replaced with a new 134.2-kHz ISO-based system. With the new system, fish will be tagged using new ISO FDX-B tags, and tags will be verified using ISO-based portable readers. Dams will be outfitted with new 134.2-kHz ISO-based stationary readers, and the data collected using new ISO-based compatible software and firmware. Installation of equipment at the dams is scheduled to take place between the 1999 and 2000 migration seasons; thus, final testing of the ISO system must be completed before that time.

To provide a smooth transition and to ensure that CRB salmon research is not adversely affected, the entire system must be thoroughly tested and evaluated prior to the deployment of the new equipment. BPA has established the "Transition Planning Team" to oversee the entire transition, the "Transceiver Technical Evaluation Team" to oversee the development of the stationary readers that will be installed at the dams, the "Portable Technical Evaluation Team" to oversee the development of the portable reader, and the “Tag Development Team" to oversee the development of suitable PIT tags. An “Infrastructure Team” was also established to oversee the construction necessary at the dams for the transition, the installation of the stationary transceivers, and the necessary changes to the tagging software and PTAGIS database for implementing the ISO-based system. NMFS has representatives on each team. Below is an outline of the general activities completed by NMFS team representatives during 1996 and 1997:

Transition Planning Team

Participated in meetings and conference calls with the multiagency team to discuss the progress of the various technical teams and to make decisions on schedules.

Transceiver Technical Evaluation Team

Reviewed the technical proposals submitted by manufacturers and aided BPA in choosing acceptable vendors.

Assisted in writing test procedures for evaluation of the prototype stationary ISO-based transceivers.

Evaluated the prototype stationary ISO-based transceivers during the summer of 1996.

Wrote reports covering the prototype evaluation and provided recommendations of necessary system changes.

Developed communications protocol to be used with the ISO-based transceiver system to be deployed in the CRB.

Evaluated the prototype stationary ISO-based transceivers during winter, 1996-1997.

Wrote reports covering the prototype evaluation and provided additional recommendations of necessary system changes.

Determined ISO-based transceiver software changes that are required to meet the diagnostic needs of the fisheries community.

Helped oversee the installation of stationary ISO-based transceivers at McNary Dam. Assisted in the electromagnetic field (EMF) measurements of ISO-based transceivers at McNary Dam.

Helped evaluate the stationary ISO-based transceivers with PIT-tagged sticks over the 1997 juvenile salmon migration season. This included analyzing the results of the weekly stick tests and reporting the results to BPA and team members.

Headed the team that used fish to evaluate the stationary ISO-based transceivers in May and July 1997.

Wrote reports summarizing the fish tests conducted at McNary Dam.

Helped determine what electronic parameters should be measured on the stationary ISO-based transceivers to determine system longevity and electronic stability (e.g., component drift, failure rates).

Performed some measurements on electronic components of the stationary ISO-based transceiver systems at McNary Dam.

Helped in determining and correcting tag-reading problems encountered with the stationary ISO-based transceivers at McNary Dam.

Participated in multiple meetings and conference calls to accomplish the above tasks.

Portable Technical Evaluation Team

Assisted in writing the "Request for Proposals" for a new ISO-based portable PIT-tag reader.

Reviewed proposals submitted by equipment manufacturers and aided in choosing an acceptable vendor.

Assisted in writing test procedures for evaluating the portable readers.

Participated in conference calls with the selected system manufacturer to clarify items wanted in the final product.

Tag Development Team

Evaluated two versions of firmware from Destron-Fearing, Inc. for their ability to decode different manufacturer's PIT tags.

Helped identify deficiencies in the design of the FDX-B ISO tag as related to CRB requirements.

Suggested changes (e.g., reduction to a 64-byte message) to the tag code design for improving its performance in relation to CRB requirements.

Worked on the development of non-fish test(s) that will provide results that correlate with reading efficiency results found in the fish tests.

Infrastructure Team

Helped identify which aluminum shields need to be replaced at the juvenile collection facilities in the CRB.

Helped identify locations for the installation of ISO-based transceivers, electrical junction boxes, and fiber-optic patch-panels at the juvenile collection facilities in the CRB.

Technology Transfer Activities

NMFS actively interfaces with other agencies on PIT-tag related matters (e.g., facility designs to accommodate PIT-tag systems, PIT-tag system maintenance, assistance in using prototype equipment and the MULTIMON computer program, and information transfer). Because NMFS personnel designed or helped develop many of the present PIT-tag system components within the CRB, they are an important resource for providing technical support and training to ensure the reliable operation of PIT-tag systems throughout the CRB. Activities that NMFS has been involved in during this reporting period are outlined below.

Provided assistance to PSMFC regarding the repair of PIT-tag interrogation systems, ancillary equipment such as fish diversion systems, and the MULTIMON computer program setup at CRB dams.

Reviewed COE juvenile salmonid collection facility drawings for Bonneville, John Day, and The Dalles Dams.

Participated in the 1997 BPA Program Review with a presentation highlighting the accomplishments of the PIT-tag research and development program.

Submitted a paper to the Journal of Aquaculture Engineering that describes the 400-kHz flat-plate PIT-tag interrogation system installed at Bonneville Dam First Powerhouse.

Provided classes to fisheries agency investigators on the use and operation of CRB PIT-tag fish diversion and separation-by-code systems (including MULTIMON).

Assisted investigators from several fishery agencies in setting up the MULTIMON computer program to accommodate their separation-by-code requirements.

Participated in the 1996 “Water Days” festival held in Kitsap County by providing demonstrations of PIT-tag equipment used in CRB. The festival is a community outreach program highlighting activities associated with natural resources.

Participated in the Northwest Fisheries Science Center open house celebrating NMFS's 125th anniversary by providing demonstrations of PIT-tag equipment used in CRB. The open house was a regional outreach program highlighting NMFS activities.

Provided information on the CRB PIT-tag system to numerous national and international investigators.

Provided consultation to Sweden and Iceland on their use of PIT-tag systems as related to fisheries problems.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This report covers work performed by NMFS during 1996 and 1997 in cooperation with BPA, focusing on expanding and improving PIT-tag technology throughout the CRB. The timely and accurate information derived from PIT-tag technology is critical in helping regional decision-makers address questions raised by the Northwest Power Planning Council Fish and Wildlife Program, the NMFS 1995 Biological Opinion on operation of the Federal Columbia River Power System, and the NMFS Proposed Recovery Plan for Snake River Salmon.

Fish Diversion Systems

Both the 15- and 25.4-cm-diameter, two-way diversion systems have proved to be reliable and have not exhibited any mechanical failures or shown component wear. The 15-cm unit installed at Little Goose Dam in 1996 has injured a few fish, but none are known to have been damaged by the 25.4-cm unit installed at Bonneville Dam in 1997. The unit at Bonneville Dam was modified to correct the cause of injury observed at Little Goose Dam. Since the modifications were successful, the same changes will be made to the Little Goose unit in 1998.

A prototype three-way side-to-side diverter was designed in 1997 and is undergoing mechanical and biological evaluation at the NMFS Pasco Field Station. The mechanical evaluation revealed that the flexible hose started to fatigue after 19,000 cycles, far below the goal of 80,000 cycles. The 80,000 cycles represent 2 years of operation. Modifications to hose length and formulation of the hose will be evaluated in 1998. A biological evaluation was inconclusive as to whether the diverter injured fish because injuries that were observed could not be directly

attributed to the diverter. In fact, observations during testing suggested that the majority of the recorded injuries probably occurred while the fish were in the holding pens. However, videotape of fish being diverted suggested the observed opercular damage may have been caused by the pathway dividers. The pathway dividers were modified in this unit and in the two-way diverter installed at Bonneville Dam to avoid such injury. Further biological testing will be conducted in 1998 once the hose fatigue problem is solved.

These new side-to-side fish diversion systems offer a number of advantages over slide gates and rotational diverters: 1) the units can be installed in pipes that are completely full of water, 2) the design requires less dewatering of fish passageways prior to fish diversion, 3) the design eliminates many costly custom-made components, and 4) the units are more easily maintained because of accessibility to parts. These features enable the new system to operate under a greater range of flow and elevation conditions than the earlier designs.

MULTIMON

During 1992-1994, NMFS developed and evaluated the separation-by-code system (computer program and fish diversion gates) at its Manchester Field Station. The computer program, MULTIMON, controls the separation of desired PIT-tagged fish from undesired tagged and untagged fish based on their individual tag codes. The name MULTIMON refers to a monitoring program that performs multiple functions, and these functions are listed as follows:

Record tag code information (400-kHz and ISO PIT tags).

Control the separation of PIT-tagged fish by applying different sampling or separation protocols to a set of coils and fish diverters.

Control or monitor a timed subsample during which all fish transiting particular coils are collected over a given time.

Keep counts on all tagged fish on daily and seasonal basis.

Communicate diagnostic messages with the 134.2-kHz ISO FDX-B stationary transceivers.

The development of this computer program is a joint project with PNNL. In 1996, five research projects used MULTIMON with the separation-by-code systems at Lower Granite and Little Goose Dams. Some program modifications were made to accommodate these projects. Other general changes were made to facilitate the evaluation of the ISO-based PIT-tag transceiver systems being considered for the CRB. MULTIMON had to be adapted so it could monitor ISO tags and ASCII diagnostic messages.

In 1997, MULTIMON was installed at all PIT-tag interrogation facilities in the CRB where it was used to record 400-kHz tag codes and to control separation of specific PIT tags for multiple research programs. To perform this separation successfully with the slide gates at Lower Granite Dam, a new high-speed reader was designed and named the 400X reader. In May, NMFS helped PSMFC install a separation-by-code system at Lower Granite Dam for adult salmon. This was the first time MULTIMON was used to control separation of adult salmon. MULTIMON was also used for the evaluation of the ISO-based transceiver system at McNary Dam. NMFS and PNNL also released drafts of the active user file and user guide for the 1997 migration season.

Since MULTIMON performed admirably in 1997, NMFS believes that MULTIMON is capable of handling the current needs of the fisheries community. Therefore, most of the

scheduled modifications for the 1998 migration season involve increasing the flexibility of the program for future use. During 1998, MULTIMON will be used to monitor the COE timed subsamples at all PIT-tag interrogation facilities. The schedule also calls for the active help file and user guide to be finalized for the 1998 season. Since the program will be complete except for unknown future modifications, we recommend that it be turned over to PSMFC after the 1998 season.

400-kHz Flat-Plate Interrogation System

A 400-kHz flat-plate (pass-by) PIT-tag interrogation system was installed at the terminus of the DSM channel in the first powerhouse at Bonneville Dam in 1996. The system was installed to satisfy the immediate need for information on fish passing the facility. The information was, in part, required to meet objectives of the Endangered Species Act Salmon Recovery Plan.

The flat-plate system consists of prototype electronics and two excitation/receiving antennas that are installed in a movable carriage on the top of an existing fish trap. This permits the fish trap to be operated using established procedures. Each antenna is housed in a watertight enclosure (2.2-m wide by 0.51-m long by 0.1-m deep). Water flows at right angles to the longest dimension.

The system was operated and evaluated during the 1996 and 1997 field seasons. The reading efficiency was determined using PIT-tagged juvenile salmon. Under normal water operating conditions, fish tests yielded reading efficiencies for the antenna array (both antennas) of 97.3% for both years.

Indirect estimates of reading efficiencies for the individual and combined antennas were calculated during 1996 and 1997 using a statistical procedure based on the total number of migrating PIT-tagged fish detected during the season by the two antennas. For 1996, reading efficiency of the antenna array was estimated at 98.0% based on the interrogation of 4,371 PIT-tagged fish. For 1997, reading efficiency of the antenna array was estimated at 99.2% based on the interrogation of 12,298 PIT-tagged fish.

The functionality of the flat-plate system was monitored daily using PIT-tagged wooden test sticks passed over its antenna array. The presence or absence of a tag reading indicated the system's operational status. The flat-plate system had few electronic problems during the two field seasons with little data lost due to down time for repairs.

The flat-plate interrogation system has proved to be a valuable tool that has several advantages over pass-through PIT-tag interrogation systems. The system can be used with fish of various sizes and in areas with high debris loads because fish and debris pass over rather than through the interrogation system. Furthermore, unlike the pass-through system, the flat-plate system can be used in areas requiring interrogation over a wide area, assuming the water depth does not exceed the vertical read distance of the system. Also, this system could be operated with the flat plate oriented vertically, which would make additional applications possible.

134.2-kHz Flat-Plate Interrogation System

Once the transition is made to the 134.2-kHz ISO-based PIT-tag system in 2000, the present 400-kHz flat-plate at Bonneville Dam will no longer be able to read tagged fish. Unless this system is replaced, the loss of information would negatively impact a number of ongoing

studies and fisheries programs in the CRB. Furthermore, flat-plate systems could be used to interrogate adult salmon migrating back to the mid-Columbia River if the systems were installed at Priest Rapids and Ice Harbor Dams. Therefore, development work was initiated in 1997 on an ISO-based flat-plate interrogation system.

There are three general steps in developing a 134.2-kHz flat-plate system: 1) development of the analog excitation and detection circuitry, including the antenna design, 2) development of the digital detection/control circuit and its firmware, and 3) building and testing the engineering design model or prototype. NMFS has contracted an engineering firm to develop a prototype unit for testing. By fall 1997, the firm had produced a prototype unit. Preliminary testing indicated that the prototype generally delivered an adequate reading range for the Bonneville Dam application; however, mechanical vibrations sometimes caused interference that masked the return signal of the tag. Efforts to remedy this problem are being investigated and a full laboratory evaluation is scheduled for early 1998 at Manchester and at Bonneville Dam.

Since flat-plate technology has many potential applications, NMFS recommends that different electronic approaches be investigated. Therefore, NMFS is overseeing the development of a more versatile detection/control circuit than that used in the above prototype. The goal is that it will have enough flexibility to interface with many types of analog circuitry and thus be usable for a wide range of interrogation systems (e.g., large detectors that might monitor adult salmon, single and multiple flat-plate arrays, and underwater towed-array detectors). Further effort will be devoted to this project in 1998.

Participation in the Transition to the 134.2-kHz PIT-Tag System

To provide for a smooth transition and to ensure that CRB salmon research is not adversely affected, the entire ISO-based system must be thoroughly tested and evaluated prior to the deployment of the new equipment. Toward this goal, BPA has established technical and advisory teams. The teams include the "Transition Planning Team" to oversee the entire transition; "Transceiver Technical Evaluation Team" to oversee the development of the stationary readers that will be installed at the dams; "Portable Technical Evaluation Team" to oversee the development of the portable reader; and the “Tag Development Team" to oversee the development of suitable PIT tags. An “Infrastructure Team” was also established to oversee the necessary construction for the transition at the dams, the installation of the stationary transceivers, and the necessary changes to the tagging software and PTAGIS database for implementing the ISO-based system. NMFS has representatives on each team. The general activities completed by the NMFS team representatives during 1996 and 1997 are outlined above.

Technology Transfer Activities

Because NMFS personnel designed or helped develop many of the present PIT-tag system components, we have actively interfaced with other agencies on PIT-tag related matters. During 1996 and 1997, we were consulted on the following technical issues: 1) facility designs to accommodate PIT-tag systems, 2) system maintenance, 3) using prototype equipment, and 4) using the MULTIMON program. In addition, we participated in several public outreach activities. Details are provided in previous sections of this report.

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