

**Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal**

New Fish-Tagging System

Bonneville project number, if an ongoing project 8331900

Business name of agency, institution or organization requesting funding
National Marine Fisheries Service

Business acronym (if appropriate) NMFS/NWFSC

Proposal contact person or principal investigator:

| | |
|-----------------|---|
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Subcontractors.

| Organization | Mailing Address | City, ST Zip | Contact Name |
|--|---------------------------------------|-----------------------|---------------|
| Summit Technology | 615 Second Ave Suite 580 | Seattle, WA 98104 | John Hutchins |
| Patten Engineering | 7337 North 63 rd Street | Longmont, CO 80503 | Whit Patten |
| Others unknown at this time because of bidding process | | | |

NPPC Program Measure Number(s) which this project addresses.
5.0F.9,10,11,12,13.

NMFS Biological Opinion Number(s) which this project addresses.
ITS 14

Other planning document references.

Recovery Plan (examples are 2.1D; 2.3.b.4; 2.4.a; 2.6.c.2; and 2.9.d).

Subbasin.

Snake and Columbia River Basins

Short description.

Determine the biological and technical feasibility of using PIT-tag technology to obtain information on juvenile and adult salmonids. Develop ancillary equipment to expand the PIT-tag system's capabilities to meet Bonneville Power Administration (BPA) and resource stakeholder needs.

Section 2. Key words

| Mark | Programmatic Categories | Mark | Activities | Mark | Project Types |
|------|-------------------------|------|------------------|------|-----------------------|
| x | Anadromous fish | + | Construction | | Watershed |
| + | Resident fish | | O & M | | Biodiversity/genetics |
| | Wildlife | | Production | x | Population dynamics |
| | Oceans/estuaries | x | Research | | Ecosystems |
| | Climate | | Monitoring/eval. | | Flow/survival |
| | Other | | Resource mgmt | | Fish disease |
| | | | Planning/admin. | + | Supplementation |
| | | | Enforcement | | Wildlife habitat en- |
| | | | Acquisitions | | hancement/restoration |

Other keywords.

Passive-integrated-transponder tag, PIT tag, tagging

Section 3. Relationships to other Bonneville projects

| Project # | Project title/description | Nature of relationship |
|-----------|--|---|
| 8712700 | Smolt monitoring by Non-Federal Entities | System development and evaluation |
| 9008000 | Columbia Basin PIT-Tag Information System | System development evaluation, and technical assistance |
| 9600600 | PATH | This study provides critical and empirical data used for modeling survival through the hydrosystem in PATH. |
| 9701000 | PIT-Tag System Transition | Technical assistance and evaluation of systems |
| | All projects that use PIT tags and information derived from the CRB PIT- | System development, evaluation, and support |

| | | |
|--|--|--|
| | tag system are dependent upon this project | |
|--|--|--|

Section 4. Objectives, tasks and schedules

Briefly describe measurable objectives and the tasks needed to complete each objective. Use Column 1 to assign numbers to objectives (for reference in the next table), and Column 3 to assign letters to tasks. Use Columns 2 and 4 for the descriptive text. Objectives do not need to be listed in any particular order, and need only be listed once, even if there are multiple tasks for a single objective. List only one task per row; if you need more rows, press Alt-Insert from within this table.

| Obj 1,2,3 | Objective | Task a,b,c | Task |
|----------------------|--|-----------------------|--|
| 1 | Develop an extended-range PIT-tag interrogation system for adult salmon and other fish | A | Develop 134.2-kHz ISO-based pass-by & pass-through PIT-tag interrogation systems for adult fish |
| | | B | Develop plans and obtain approval for installation of a pass-by adult PIT-tag interrogation system at a dam |
| | | C | Develop plans, model, & obtain approval to construct a test facility for evaluating extended-range PIT-tag interrogation systems |
| 2 | Assist BPA in the transition to a 134.2-kHz ISO-based PIT-tag system for the entire Columbia River Basin (CRB) | A | Conduct tests, evaluate equipment and tags, and participate in planning and coordination meetings. |
| 3 | Fish diversion system evaluation | A | Install and evaluate a 3-way side-to-side fish diverter at Lower Granite Dam |

Objective schedules and costs

| Objective # | Start Date mm/yyyy | End Date mm/yyyy | Cost % |
|--------------------|-------------------------------|-----------------------------|-----------------------------|
| 1 | 10/98 | 9/99 | \$1,025.2K 90% |
| 2 | 10/98 | 9/99 | \$146.5K 8% |
| 3 | 10/98 | 9/99 | \$30.7 2% |
| | | | Total \$1,202.4K 100% |

Schedule constraints.

1) Delay in the approval of the proposal; 2) delay in approving agencies accepting system designs; 3) delay in the installation of equipment due to weather or other factors; 4) inadequate funding; and 5) unforeseen technical difficulties.

Completion date.

2007

Section 5. Budget

| Item | Note | FY99 |
|---|------------------|-------------------|
| Personnel | | \$404.3K |
| Fringe benefits | | 9.0 |
| Supplies, materials, non-expendable property | | 75.6 |
| Operations & maintenance | | 6.5 |
| Capital acquisitions or improvements (e.g. land, buildings, major equip.) | | 0.0 |
| PIT tags | # of tags: 1,000 | 2.9 |
| Travel | | 39.9 |
| Indirect costs | | 171.5 |
| Subcontracts | | 340.8 |
| Grants | | 150 |
| Other | Printing, etc. | 1.9 |
| TOTAL | | \$1,202.4K |

Outyear costs

| Outyear costs | FY2000 | FY01 | FY02 | FY03 |
|----------------------|---------------|-------------|-------------|-------------|
| Total budget | 1,450,000 | 1,450,000 | 1,200,000 | 930,000 |
| O&M as % of total | 0% | 0% | 0% | 0% |

Section 6. Abstract

The proposed work has three main objectives: 1) develop an extended-range PIT-tag interrogation system for adult salmon and other fish; 2) assist BPA in the transition to a 134.2-kHz ISO-based PIT-tag system for the entire Columbia River Basin; and 3) install and evaluate a 3-way side-to-side PIT-tag diversion system. The first objective is divided into three tasks: A) development of 134.2-kHz ISO-based pass-by and pass-through PIT-tag interrogation systems; B) develop plans and obtain approval for installation of a pass-by adult PIT-tag interrogation system at a dam; and C) develop plans, model, and obtain approval, to construct a test facility for evaluating extended-range PIT-tag interrogation systems.

For each of the project's work elements, realistic milestones have been established in conjunction with a decision tree. Because of the complexity of Objectives 1 and 2, they will not be completed during the performance period FY99. However, a 134.2-kHz ISO-base pass-by PIT-tag interrogation system will be ready for installation at a dam and approval for its installation should be obtained. In addition, progress toward developing large pass-by and pass-through PIT-tag interrogation systems will have been made and a test facility for field evaluation of extended-range PIT-tag interrogation systems will be designed, but not constructed. Objective 3 will be completed by 30 September 1999. The products from Objective 3 will be available to the fisheries community at the conclusion of the performance period given no unforeseen problems.

The continued development of the PIT tag and ancillary equipment will further expand the PIT-tag system's capabilities and thus enable managers to address issues expressed in both the Biological Opinion for operation of the Federal Columbia River Power System and the proposed Snake River Recovery Plan (examples are 2.ID, 2.3.b.4, 2.4.a, 2.6.c.2, and 2.9.d).

Section 7. Project description

a. Technical and/or scientific background.

Introduction

Bonneville Power Administration (BPA) initiated a contract with the National Marine Fisheries Service (NMFS) in 1983 to determine the technical and biological feasibility of applying Passive Integrated Transponder (PIT) tag and associated technology to fishery problems in the Columbia River Basin (CRB) migration corridor. NMFS designed, evaluated, and implemented such a system using a 400-kHz frequency PIT tag. The PIT-

tag system in conjunction with ancillary equipment enables data to be passively collected on individual juvenile and adult salmonids at select locations within the CRB in near real time without the fish being handled.

NMFS proposes the following PIT-tag system research and development work for the period of 1 October 1998 through 30 September 1999 (FY99). The proposed work consists of three main objectives: 1) develop an extended-range PIT-tag interrogation systems for adult salmon and other fish; 2) assist BPA in the transition to a 134.2-kHz ISO-based PIT-tag system for the entire CRB; and 3) install and evaluate a 3-way side-to-side PIT-tag diversion system. Objective 1 is divided into three tasks: A) development of 134.2-kHz ISO-based pass-by and pass-through PIT-tag interrogation systems; B) develop plans and obtain approval for installation of a pass-by adult PIT-tag interrogation system at a dam; and C) develop plans, model, and obtain approval, to construct a test facility for evaluating extended-range PIT-tag interrogation systems.

Objective 1: Develop an extended-range PIT-tag interrogation system for adult salmon and other fish

The need for detection of returning adult salmon has long been known. However, detection of PIT-tagged adult fish has only been possible on a small scale due to limitations of the present 400-kHz PIT-tag technology used in the CRB. Currently, adult salmon are only being interrogated at Lower Granite Dam in 31-cm pipes. A similar system will be installed at Bonneville Dam's Fisheries Engineering Research Laboratory (FERL) in 1998.

Conversion of the present juvenile PIT-tag interrogation system to a 134.2-kHz ISO-based technology is scheduled for the year 2000. Longer read range is possible with the 134.2-kHz tags than the 400-kHz tags, because they incorporate a different data recovery scheme, new silicon technology, and are governed by less stringent Federal Communication Commission (FCC) emission regulations. These advantages should enable the detection of returning adult salmon at several locations associated with fish ladders instead of being restricted to small-diameter pipes as with the 400-kHz technology.

The technology is not presently available to interrogate fish going through potential interrogation sites at a dam and thus these interrogation systems must be developed (Objective 1). The most prudent approach (Task A) is to determine the limitations of the ISO-based technology and then to work with the equipment manufacturers to adapt and improve upon that technology. Two general system design approaches will be taken: (1) pass-by and (2) pass-through. We also will plan for the installation of a pass-by adult PIT-tag interrogation system at some specific location (e.g., Priest Rapids or Ice Harbor Dam; Task B). The pass-by approach has advanced to the point that one version of the system could be considered for deployment in 1999. Task C will focus on the development of a test facility for evaluating various extended-range PIT-tag interrogation systems. Products resulting from Task A need to be evaluated under field conditions

prior to being implemented. Modification of adult fish ladders for the sake of evaluating potential interrogation systems prior to their evaluation under field conditions similar to those to be encountered at fish ladders is not practical. Therefore, we propose that a test facility for this purpose be constructed after resource stakeholders agree on the approach to be taken.

See Section 7.e for a list of the steps that will be taken in FY99 to achieve the above goals.

Objective 2: Assist BPA in the transition to a 134.2-kHz ISO-based PIT-tag system for the entire Columbia River Basin

The present 400-kHz PIT-tag system in the CRB will be replaced with a new 134.2-kHz International Standards Organization (ISO)-based system by 2000. As a result, fish will be tagged with new ISO FDX-B tags and detected using new FDX-B portable readers. Dams will be outfitted with ISO-based stationary readers, and the data will be collected using updated software and firmware. Most of these changes are scheduled to take place between the 1999 and 2000 migration seasons.

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 and during the deployment of the ISO-based equipment. In FY97, BPA established the "Transition Planning Team" to oversee the entire transition, the "Transceiver Technical Evaluation Team" to oversee the development of the stationary reader, 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. It also established an "Infrastructure Team" to oversee any construction necessary at the dams for the transition, the installation of the 134.2-kHz stationary systems, and the necessary changes to the tagging software and PTAGIS database for implementing the 134.2-kHz system. NMFS has been requested by BPA to provide representatives on each team. During FY98, the duties of the Portable Technical Evaluation Team were concluded.

See Section 7.e for a list of the steps that will be taken in FY99 to achieve the above goal.

Objective 3: Install and evaluate a 3-way side-to-side PIT-tag diversion system

In 1996, NMFS installed and evaluated a 15-cm diameter 2-way side-to-side fish diversion system at Little Goose Dam. In 1997, a 2-way diverter measuring 25-cm in diameter was installed at Bonneville Dam. Because of head loss restrictions, no other type of fish diversion system could have been easily installed at this site without adversely impacting fish passage. Both of these side-to-side diverters proved to be reliable and efficient.

Using the same general design principle, a 25-cm diameter, 3-way prototype unit was designed in 1997. In 1998, the 3-way side-to-side diverter will undergo mechanical and

biological evaluation at the NMFS Pasco Field Station. Mechanically, the system will be subjected to 80,000 cycles. At the completion of the cycle test, all parts will be examined for wear and fatigue. Fish tests will be conducted in 1998 to investigate whether the 3-way side-to-side diverter causes fish damage.

The 3-way side-to-side diverter could be used for the same applications as the present 3-way rotational diversion system with the added advantages of being less expensive to manufacture and being able to operate under a greater range of flow and elevation conditions. The tested unit will be installed and evaluated at Lower Granite Dam, but this type of diverter could also be installed at Bonneville Dam, The Dalles Dam, adult examination and sorting facilities, and hatcheries.

See Section 7.e for a list of the steps that will be taken in FY99 to achieve the above goal.

b. Proposal objectives.

See Section 7.a,c,e for a description of the objectives and tasks, rationale, and significance to programs.

Measurable Objectives by Task

Objective 1: Develop an extended-range PIT-tag interrogation system for adult salmon and other fish

Task A: Develop 134.2-kHz ISO-based pass-by and pass-through PIT-tag interrogation systems

- 1) Evaluate present 134.2-kHz technology for use in extended-range systems
- 2) Make modifications to digital controller for use with transceiver systems
- 3) Design and evaluate different antenna geometries
- 4) Design and evaluate antenna housings
- 5) Examine RF emissions from test antennas
- 6) Investigate FCC site license requirements for extended-range interrogation systems.

Task B: Develop plans for installation of a 134.2-kHz ISO-based PIT-tag system at a dam

- 1) Prepare concept drawings for presentation at meetings
- 2) Meet with resource stakeholders to determine site preference, needs, concerns and objections
- 3) Obtain preliminary approval for system installation at a specified site
- 4) Prepare technical drawings for final approval and cost estimation
- 5) Review and submit drawings for final approval
- 6) Prepare and submit documents to obtain Environmental Impact Statement, ESA, and other required permits
- 7) Determine funding source(s)
- 8) Prepare proposal for system installation and evaluation
- 9) Establish operating and maintenance responsibility once the system is considered operational

Task C: Develop plans, model, and obtain approval, to construct a test facility for evaluating extended-range PIT-tag interrogation systems

- 1) Prepare specifications document and concept drawings to be used at meetings
- 2) Hold planning meetings with resource stakeholders to discuss various approaches and to establish a working plan for the development of a test facility
- 3) Obtain approval of a plan from U.S. Army Corps of Engineers (COE) and other resource stakeholders
- 4) Prepare and submit Environmental Impact Statement and other permitting requests
- 5) Depending upon the approach taken for the test facility, modeling may be required to satisfy hydraulic and structural concerns
- 6) Obtain technical drawings and modeling reports

- 7) Submit technical information to COE and other resource stake holders for review and approval
- 8) Prepare request for funding the test facilities construction and operation.

Deliverables by Task

Task A: Develop 134.2-kHz ISO-based pass-by and pass-through PIT-tag interrogation systems

- 1) Summary report covering activities associated with the Task (December 1999).

Task B: Develop plans for installation of a 134.2-kHz ISO-based PIT-tag system at a dam

- 1) Concept drawings for presentation at meetings (November 1998)
- 2) Prepare technical drawings for final approval and cost estimation (March 1999)
- 3) Permits for installation and evaluation of the system (September 1999)
- 4) Summary report covering activities associated with the Task (December 1999).

Task C: Develop plans, model, and obtain approval, to construct a test facility for evaluating extended-range PIT-tag interrogation systems.

- 1) Facility specifications and concept drawings (November 1998)
- 2) Technical drawings for construction (May 1999)
- 3) Modeling report discussing the impact of the structure on ladder hydraulics and structural integrity (May 1999)
- 4) Permits for installation and operation of the test facility (September 1999)
- 5) Approval to proceed with construction of facility (August 1999)
- 6) Proposal requesting funds to construct, install, and operate the test facility (September 1999)
- 7) Summary report covering activities associated with the Task (December 1999).

Objective 2: Assist BPA in the transition to a Columbia River Basin-wide 134.2-kHz ISO-based PIT-tag system

Measurable Sub-Objectives

- 1) Participation in team meetings
- 2) Participation in evaluation/oversight activities.

Deliverables

- 1) Report on tag development issues (December 1998)
- 2) Summary report of FY99 activities (November 1999).

Objective 3: Install and evaluate a 3-way side-to-side PIT-tag diversion system

Measurable Sub-Objectives

- 1) Fishery agencies and Tribal Nations approval
- 2) COE approval
- 3) Install fish diverter
- 4) Evaluate fish diverter.

Deliverables

- 1) Installation of the Prototype 3-way diverter at Lower Granite test site (March 1998)
- 2) Summary report of FY99 activities (December 1999)

c. Rationale and significance to Regional Programs.

As shown by our research and development to date (see Section 7.d), this project has and will continue to result in products that aid stakeholders in assessing the effectiveness of various actions taken to enhance the survival of juvenile and adult salmonids. Specifically, the research and development effort will provide: 1) approaches that will

enable fishery researchers and managers to address previously unanswered questions; 2) accurate and reliable data in near real time that enable effective decisions to be made regarding multiple species in a variety of habitats; 3) products that can be used in genetic, physiology, behavior, and broodstock research efforts on endangered species; and 4) products that can be used in obtaining survival and migration timing information on stocks for evaluating water management strategies and fish passage/collection facilities.

The continued development of the PIT-tag and ancillary equipment will further expand the system's capabilities by enabling issues to be addressed that are expressed in both the 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).

All ongoing and proposed research in the CRB using PIT-tag technology is the result of NMFS's continuing PIT-tag research and development. Many of these projects are dependent upon the development of extended-range PIT-tag interrogation systems (i.e., adult interrogation) in the near future. NMFS will focus much of its effort on this requirement. However, we will continue to propose new and innovative approaches to interrogate juvenile and adult fish.

d. Project history

The biological studies associated with the PIT-tag project have been conducted in the laboratory, in the field under controlled conditions, and in the field under natural conditions. The results of these studies are available in reports and journals (see publications list). In the laboratory we have been able to determine: 1) a suitable anatomical area and insertion techniques for PIT-tag placement within salmonids that is acceptable from a biological and human standpoint; 2) the minimum-sized juvenile salmonid that can be effectively tagged with the PIT tag; 3) host tissue response to the tag; 4) the effect of the tag on growth and survival for various age groups of fish; 5) tag wound healing rate and disease occurrence from tagging; 6) tag effect on swimming performance of parr, transitional, and smolted salmon; 7) effect of electromagnetic fields produced by the PIT-tag interrogation system on the biology of salmon and a surrogate fish species, medaka; 8) predator avoidance of tagged fish; and 9) PIT-tag retention in various sizes and species of salmonids in relation to traditional tags and marks.

Under controlled field conditions we have determined: 1) susceptibility of PIT-tagged and traditionally marked and tagged fish to predators in both clear and turbid water; 2) the growth, survival, and tag retention of several species of salmonids held for extended periods in both fresh water and sea water; and 3) the behavior of PIT-tagged juvenile salmonids to various geometries and colors of PIT-tag interrogation passageways.

Under natural conditions in the field we have determined: 1) return rate, tag retention, size at return, and timing of PIT-tagged coho salmon released to the wild; 2) overwinter survival (recapture rate) of coho salmon released to the wild compared to coded-wire tagged and other traditional tagged and marked fish; 3) the reaction of naturally migrating

coho salmon to electromagnetic fields produced by an underwater PIT-tag interrogation system; and 4) using video equipment, the behavior of fish ascending a fish ladder.

Activities that support the CRB PIT-tag system and consequently indirectly enhance the salmon recovery effort include the following ancillary systems development: 1) PIT-tag injectors, both hand-held and semi-automatic; 2) a computer-based PIT-tag data entry station; 3) rectangular slide-gate fish diverter; 4) 2- and 3-way fish diversion systems; 5) the first computer program for recording PIT-tagged fish passing through interrogation units at dams; 6) the first rectangular pass-through, round pass-through, and pass-by PIT-tag interrogation systems for juvenile salmonids; 7) the first adult salmon PIT-tag interrogation units; 8) the first underwater towed PIT-tag interrogation system; 9) the first CRB PIT-tag data base; 10) the first computer controlled juvenile fish diversion system; and 11) first multi-tasking computer program for controlling fish separation, subsampling, and data collection.

The above accomplishments are discussed in reports and journals (see publications list Section 7.g).

e. Methods.

Objective 1: Develop an extended-range PIT-tag interrogation system for adult salmon and other fish

Proposed Work

Task A: Develop 134.2-kHz ISO-based pass-by and pass-through PIT-tag interrogation systems

Although the read range is extended with the ISO-based PIT-tag system, detection is still only possible at locations where fish are confined to narrow passageways, i.e., choke points. Examples of choke points present at dams include underwater orifices, overflow weirs, and vertical slots. In addition, one could build artificial choke points in a ladder or by constructing a side channel to the ladder in which choke points are installed. To take advantage of these potential interrogation locations, PIT-tag interrogation systems of various geometries need to be designed and evaluated.

In FY98, NMFS will determine the electronic limitations of the current ISO-based technology. Three promising commercial 134.2-kHz ISO-based transceiver systems, the Destron Fearing system used for detection of juvenile salmon in pass-through systems, the Patten Engineering (PE) system being developed for the flat-plate or pass-by system, and the Datamars transceiver system, are being evaluated.

In FY99, NMFS proposes to continue to examine the analog electronics of these systems to determine which will yield the maximum reading range with antennas of various geometries (i.e., several pass-by and pass-through configurations). The goal is to choose a suite of equipment that is functional as well as versatile, and can be used as a basis for

the extended-range PIT-tag system. NMFS plans to work closely with equipment manufacturers during the project. If no system is found to meet the community's needs, then NMFS will design the entire system. However, at this time we do not believe that approach will be necessary. Depending upon the system chosen, a digital controller may need to be designed to interface with the NMFS system to provide interfacing between multiple antennas.

Another problem to be addressed is meeting the FCC requirements for radiated electromagnetic energy. While shielding the detectors in a fish ladder with an electrostatic shield may be impractical, there are potentially other ways to satisfy FCC requirements. These include: a) energizing the antennas at a periodic duty cycle to reduce average emissions levels, b) energizing pairs of antennas out of phase with each other, and thus canceling the far-field emissions, or c) obtaining a site license from the FCC to exceed the emissions limits. All of these approaches will be examined.

Using in-house and outside contractors, NMFS will design antennas of various geometries and evaluate them in the laboratory. For the pass-by systems, single and multiple antenna arrays in vertical and horizontal positions will be examined while large opening antennas will be examined for the pass-through systems. Evaluation factors will include: tag read distance, effect of tag orientation on reading efficiency, tag read speed, effect of "cross talk" when multiple antennas are operated in close proximity to one another, the effects of vibration and electrical noise on reading efficiency, and radio frequency emissions. Antenna housings will also be designed, constructed, and evaluated. Evaluation factors will include: ease of access to electronic components, water tightness, pressure effects on the housing, and resistance to damage. Test antenna arrays and housings will be sized to a specific location at a dam of interest (e.g., Bonneville Dam). We will rely upon the Adult System Planning and Oversight Team created in 1998 to provide direction as to what location(s) within a specific fish ladder that the test systems should be designed for.

Task B: Develop plans for installation of a 134.2-kHz ISO-based PIT-tag system at a dam

NMFS proposes that plans be made and approval obtained to install present 134.2-kHz ISO-based PIT-tag technologies into locations where they could be used immediately for detecting adult salmon. One system that will be ready for deployment is the 134.2-kHz ISO-based flat-plate system that is being developed for the First Powerhouse at Bonneville Dam. A similar system could be used for adult interrogation at select locations with minor modifications. We suggest that the Adult System Planning and Oversight Team be tasked with selecting suitable locations. Two potential site locations for the system installation have been identified. The first is Priest Rapids Dam where fish counting boards are now located in the dam's fish ladders. The interrogation antennas would be placed in housings that have the same width and length as that of the present counting boards. The new housings would act as the existing counting boards, and thus no change in operation at the facility would be required. The Mid-Columbia Survival Study group may tag fish with FDX-B ISO tags in early 1999 and therefore, would be

expecting some adults (jacks) to return as early as 2000. Since these fish will be present, interrogating fish at Priest Rapids would yield valuable biological information for the Mid-Columbia Survival study and would also provide valuable system design and operational information (technical and biological).

The second site suggested for pass-by deployment is Ice Harbor Dam. This site would require more extensive modification to accommodate the proposed pass-by interrogation system since no counting board systems exist at the site. However, the anticipated installation costs are thought to be relatively low in comparison to other alternatives. Interrogation at this site, in addition to Priest Rapids Dam, would provide complete coverage of this area of the river and thus would provide a means to determine fish straying, timing, and survival as related to a number of ongoing and proposed projects.

Task C: Develop plans, model, and obtain approval, to construct a test facility for evaluating extended-range PIT-tag interrogation systems

Extended-range PIT-tag interrogation systems can only be tested to a limited extent in a laboratory setting. Field tests are required to verify laboratory findings, to determine effects of antenna housings on hydraulics, to determine fish behavioral responses to antenna systems, to determine reading efficiency with fish, and to verify suitability for installation and long-term operation. There is no identified site where full-scale extended-range PIT-tag interrogation systems can be evaluated in the field. We believe it prudent to evaluate any system prior to installation, especially in a fish ladder or location that could cause hydraulic, mechanical, structural, or biological difficulties. Therefore, the community needs to establish a testing site. A basic test facility would need to include the ability to install and remove antenna housings and associated electronics at will and in a timely and efficient manner. This would enable tests to be conducted with flowing water that is of a depth and velocity similar to that where a system would be deployed. The facility should also emulate the size and geometry of antenna housings that would be deployed in a fish ladder, operate nearly any time of year, and have limited or no impact on other research projects, facilities, or the migrating fish.

General activities for Task C include: designing the system using in-house and outside resources (e.g., marine and hydraulic engineers and modelers); obtaining approval from the fishery agencies; obtaining technical drawings; have COE and other resource stakeholders review the technical drawings and obtain their approval for the installation of the test facility at a location (e.g., Bonneville Dam). Construction and installation of the test facility would take place in early FY2000 and be operational that same year.

Objective 2: Assist BPA in the transition to a Basin-wide 134.2-kHz ISO-based PIT-tag system

Proposed Work

Transition Planning Team

This multi-agency team meets every 2-3 months to discuss the progress of the various technical teams and to make decisions on schedules. Our representative will continue to participate in these meetings during FY99.

Transceiver Technical Evaluation Team

NMFS personnel will continue to participate on the Transceiver Technical Evaluation Team. Stationary transceivers were installed at McNary Dam during 1997 with additional units to be installed at other dams in 1998. The performance of these units been and will continue to be monitored. Performance has been monitored with weekly tests using sticks containing PIT tags (stick tests) to check for consistent reading efficiency over time and to reveal any component failures. Monthly electrical parameter tests have been conducted to examine the longevity of the electronic equipment (i.e., component drift, failure rates), and two live fish tests have been run to determine how fish behavior affects the reading efficiency of the system.

Many of these performance monitoring activities will continue during FY98 and will extend into FY99. Changes to the system will be recommended based on the monitoring results. Because some changes will probably be required, it will be necessary to continue the stick and electrical parameter tests in FY99. In addition, the software will be finalized during FY98 and further evaluated in FY99. We expect that by spring 1999, all necessary system modifications will have been made (e.g., improved 12-mm tags, software changes); thus, the Transceiver Technical Evaluation Team plans to run another fish test in FY99. NMFS personnel will participate in this test.

Tag Development Team

NMFS personnel will continue to participate on the Tag Development Team (TDT). The 1997 fish tests at McNary Dam indicated that the 12-mm tags did not perform as well as the 13.5-mm tags. A non-fish read-range test appeared to work at distinguishing high quality 13.5-mm tags from lower quality 13.5-mm tags. In other words, during the fish test the previously identified high quality tags were read on more coils and fewer were missed entirely than the lower quality tags. However, the test did not appear to work with the Destron Fearing (DF) 12-mm tags. The goal of the TDT in FY99 is to develop and verify a non-fish test or series of standardized tests that will accurately predict the performance of 12-mm tags or all ISO-based tags in fish. The TDT is also responsible for coordinating the development of performance criteria for 134.2 kHz, 12-mm tags to be used with the new ISO-based interrogation system. This effort will continue during FY99.

In FY99, the TDT will evaluate various manufacturers tags and provide information to the fisheries community as to the performance of the tags. Since a tag can perform

differently in different transceiver systems, the TDT is planning on using the DF transceiver system as their reference transceiver system. With this setup, a number of non-fish tests (e.g., measuring read volume) will be conducted in hopes of finding those that help to determine differences in tag quality. In addition, the team will measure how much energy it takes to turn on individual tags to see if this is a distinctive test. Other testing apparatus may be needed as new information surfaces during the testing. To examine how well these non-fish evaluation tests correlate with tag performance in tagged fish, 134.2-kHz ISO-based tags will be tested first on the belt system at NMFS' Manchester test facility and then in tagged fish at one of the ISO-based stationary reader installation sites. In addition, as mentioned above, during the season the detection equipment will be evaluated weekly with tagged sticks at one of the dams where ISO-based stationary readers are installed.

The TDT also proposes to evaluate a 134.2-kHz tag that contains a shorter message (64 bits) compared to the ISO-defined 128-bit message during FY99. To properly evaluate this shorter message, it will be necessary for DF to adapt their firmware to recognize these tags. This shorter message tag will only be evaluated at Manchester unless test results indicate tests should be performed at a dam. Any decision regarding Basin-wide use of a non-ISO tag with the new ISO-based system will require regional consensus, including that of regional fisheries managers.

Infrastructure Team

The Infrastructure Team visited the Snake River and Mid-Columbia River Dams having PIT-tag interrogation equipment in 1997. Items were identified that need to be replaced (e.g., electromagnetic-field (EMF) shields) and installed (e.g., catwalks, conduit and junction boxes for electrical power, and fiber optic cables). Many of these tasks will be completed during FY99. The Infrastructure Team will oversee these modifications. During FY99, the Infrastructure Team will need to coordinate with DF on an overall plan for installation at the present 400-kHz sites. They will also need to oversee the installation of new PIT-tag systems at CRB dams using the protocol established in FY98 for accepting/approving the systems. The NMFS representatives will participate in these activities.

Objective 3: Install and evaluate a 3-way side-to-side PIT-tag diversion system

Proposed Work

In FY99, we propose to install the 3-way side-to-side diverter at Lower Granite Dam's experimental site (GRX). This is where the 3-way rotational fish diverter was installed for evaluation in 1995. Based on that evaluation, rotational fish diversion systems are now being used at a number of dams in the CRB. The existing rotational fish diversion unit at GRX will be replaced with the side-to-side unit before the spring field season. Some modification to the current configuration will be necessary to install the new

diverter. Our plans will be presented to the fisheries agencies for approval and technical drawings submitted to COE for approval before the actual installation.

PIT-tagged hatchery fish (500) will be used to evaluate the diversion efficiency and to establish cycle timing of the diverter. Fish used in each test will be collected in three separate raceways after passing through the diversion system. All fish will be reexamined for injury and held for observation. A video camera will be used to document the behavior of the fish in the area of the hose nozzle and the pathway divider. All test fish will be released to the river after testing.

f. Facilities and equipment.

Most of the electronics for the described systems will be developed and evaluated at NMFS facilities at Sand Point, Manchester, and Pasco, Washington. NMFS Electronics Shop at Sand Point is equipped with state-of-the-art electronics diagnostic and test equipment. The shop also has the capability of producing its own printed circuit boards for prototype systems. The shop has ample room for system development and bench-test evaluation work. Being located in Seattle, most required electronics supplies are easily obtainable. This shop has been the prime site for the development of not only the electronic systems associated with the PIT-tag project, but also for radio-tag equipment and other electronics used by NMFS in the CRB.

The NMFS Design and Fabrication Shop is located at the Pasco Field Station. This shop has milling machines, sheet metal benders, welders, etc. and is capable of producing a variety of prototype equipment that may be required for this or any other NMFS project. The shop provides primary design and mechanical support to biologists working in the CRB. For example, the shop has in the past designed and constructed traveling screens used at the turbine intakes, boats, wet separators, fish collection equipment, most of the PIT-tag interrogation antenna housings and RF shields, and fish diversion systems. Shop personnel have also been instrumental in the installation of all equipment.

After development, PIT-tag equipment is often evaluated at the NMFS Manchester test facility before it is evaluated at river sites. Both indoor and outdoor testing can take place at Manchester. The indoor laboratory room measures 7.5-m wide by 15-m long. Within the laboratory, which is equipped with electronic test equipment, is a large belt-drive PIT-tag interrogation system controlled by a Program Logic Controller. This equipment is used to evaluate transceiver systems and antenna designs. The outdoor test area is configured to emulate a portion of a juvenile fish collection facility. Water velocity and volume can be controlled and directed to flow in pipes and flumes to which PIT-tag interrogation and ancillary equipment can be attached for evaluation. Among other uses, the test facility has been used to evaluate the various 134.2-kHz ISO-based transceiver systems being considered for the CRB.

Existing support equipment for both laboratory and field work are adequate to carry out the tasks outlined.

g. References.

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1993. A study to determine the biological feasibility of a new fish tagging system. Annual Report 1983. U.S. Dep. of Commer., Natl. Oceanic and Atmos. Admin., Natl. Marine Fish. Serv., Northwest Fish. Sci. Cent., Seattle, WA. 131 p. plus Appendixes (Report to Bonneville Power Administration, Contract DE-179-83BP11982, Project 83-19).

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1985. A study to determine the biological feasibility of a new fish tagging system. U.S. Dep. of Commer., Nat. Oceanic and Atmos. Admin., Nat. Marine Fish. Serv., Northwest and Alaska Fish. Cent., Seattle, WA. 34 p. plus Appendixes (Report to Bonneville Power Administration, Contract DE-179-83BP11982, Project 83-19).

Section 8. Relationships to other projects

Virtually all projects that rely on PIT-tag information are dependent upon the continued support of this project. Research and development efforts of this project have and will continue to result in products that aid stakeholders in assessing the effectiveness of various actions taken to enhance the survival of juvenile and adult salmonids. The products provide approaches that enable fishery researchers and managers to address previously unanswered questions. In addition, they provide accurate and reliable data in near real time that enable effective management of multiple species in a variety of habitats. The products are used in genetic, physiology, behavior, and broodstock research on endangered species. This research is also used in obtaining survival and migration timing information on stocks for evaluating water management strategies and fish passage/collection facilities. This research aids all stakeholders by providing data needed for the management and restoration of salmonids and other fish.

To continue providing systems that can meet the needs of the fisheries community, ample lead time for the development and evaluation of systems is required. In many instances specific applications for a device cannot be cited at the time of its development but a general need can be described. An example is the development of the multi-function computer program MULTIMON and its ability to control fish separation based on tag code. Another example is the suite of fish diversion systems now available for a variety of applications. At the time this development effort was initiated, no PIT-tag system user in the Basin was calling for such systems. Now that the systems have been developed many PIT-tag system users are totally dependent upon this new capability in order to carry out their research. Examples of several projects include "Survival Estimation for Dam/Reservoir Passage," COE-sponsored Transportation studies, and COE-sponsored The Dalles Dam Spill study.

Section 9. Key personnel

Name: Earl F. Prentice

Education

1962 - A.A., Skagit Valley Junior College - Major: Biology

1965 - B.A., Western Washington University- Major: Biology

1971 - M.S., Western Washington University- Major: Biology

Work Experience

Job title: Task Manager, Fisheries Research Biologist, Supervisor

From 1972 to Present

Employer's name and address: National Marine Fisheries Service, P.O. Box 130,
Manchester, WA 98353

Supervisor's name and phone number: Douglas Dey (206) 860-3237

Expertise:

Since 1972 Mr. Prentice has been assigned to the U.S. National Marine Fisheries Service (NMFS), Manchester Fisheries Marine Research Laboratory near Manchester, Washington. He has been a task manager for the Fish Ecology Division (formally the Coastal Zone and Estuarine Studies Division) of the NMFS for 20 years.

From 1983 to the present, he has been managing a project developing PIT-tag technology and ancillary equipment for fisheries research. The project requires the management of personnel from a variety of disciplines within the general fields of biology, mechanical engineering, and electrical engineering. As project leader, he is responsible for: developing the research and system work plans; developing and managing budgets; coordinating a number of individual research, development, and system installation tasks annually; developing the research plans for all the various tasks within the overall project; overseeing systems development, evaluation, and installation; coordinating the teams efforts with federal, state, tribal, and private resource stakeholders; and preparing reports and scientific research papers. In addition to his management responsibilities, he actively participates in the biological research projects and in the design and installation of the PIT-tag systems.

Job Completions:

- Determined host response to the PIT tag.
- Installed the first PIT-tag systems in the CRB.
- Initiated the development of a regional automated database to make PIT-tag information available to users in near real time.
- Directed the development of mechanical systems and a new computer program for the automatic separation of PIT-tagged fish from non-tagged fish based on the tag identification tag code.
- Directed the development of systems for PIT-tagging fish and automatically entering PIT-tag and related information into computer files.

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Name: Bradley W. Peterson
Education: 1984 -- B.S. in Electrical Engineering. University of Kentucky
Work Experience:

Title: Group Leader, Electronic Engineering
Current Employer: National Marine Fisheries Service (NMFS)
Current Responsibilities: Oversee and participate in all PIT tag and radio tracking related electronic development, integration, and installations for NMFS.

Employment History:

1984 - 1989 U.S. Department of Defense
Naval Electronic Systems Engineering Center
4297 Pacific Hwy.
San Diego, CA 92110
1989- Present U.S. Department of Commerce
National Marine Fisheries Service
Sand Point Way N.E., Bldg. #4
Seattle, WA 98115

Expertise:

Thirteen years of experience developing, modifying, purchasing, and installing microprocessor based signal acquisition systems for U.S. government. Seven years of experience designing, developing, modifying, and installing PIT-tag and radio telemetry systems and equipment for fisheries research in the Columbia River Basin. Specific areas of expertise include microprocessor based systems design utilizing Zilog, Motorola, and Intel microprocessors that interface with existing or customized analog signal detection circuits. Assumed supervisory responsibility of the Electronic Engineering Group in 1993 after the retirement of the previous supervisor.

Job Completions:

- Development of lab test procedures and test equipment for BPA procurement of ISO-based 134.2-kHz PIT-tag stationary reader systems.
- Design and development of a high-speed controller for 400-kHz PIT-tag diversion systems.
- Modification a 400-kHz juvenile PIT-tag detector for use in a towed array detection system.
- Design and development of a multichannel 30-MHZ radio-telemetry monitor for fisheries research.

Publications:

Hockersmith, E. E., and B. W. Peterson
1997. Use of Global Positioning System for Locating Radio-Tagged Fish from Aircraft. N. Am. J. Fish. Manage. 17:457-460.

Section 10. Information/technology transfer

We propose that NMFS continue its activities of interfacing with other agencies (e.g., PSMFC, COE, BPA, and Tribal Nations) regarding PIT-tag related matters (e.g., facility design to accommodate PIT-tag systems, system maintenance, system design specifications, assistance in using prototype equipment and MULTIMON program, information transfer). Since NMFS personnel designed or helped develop many of the present PIT-tag system's 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 Basin.

Technical reports, scientific papers, meetings, and workshops are important means of transferring information and technology. During the performance period, NMFS proposes to complete a report describing the results of PIT-tag development and evaluation work and to participate in meetings and workshops.