RECLAMATION

Managing Water in the West

Construction and Deployment of Pontoon Barge Mounted Vertical PIT Antennas in the Yakima River

Research and Development Office
Science and Technology Program
(Final Report) ST-2017-6448-01

U.S. Department of the Interior
Bureau of Reclamation
Research and Development Office

December 2017

Mission Statements

Protecting America's Great Outdoors and Powering Our Future

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

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14. ABSTRACT *(Maximum 200 words)* West Fork Environmental was awarded an assistance agreement to continue development and operational deployment of a vertical PIT tag antenna system capable of detecting juvenile salmonids travelling in the upper water column. A pontoon barge and associated antennas operated via a Biomark MTS system was deployed in the Yakima River upstream of the Roza Pool in April of 2017. During the sampling period April 5 to June 1, 2017 749 unique individuals were detected at the barge with the majority being hatchery released Spring Chinook. These results indicate the usefulness of this type of antenna system in deeper waters that have previously limited other antenna designs. Future studies would be used to optimize antenna design and placement.

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PERFORMANCE PROGRESS REPORT
SF-PPR

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See attached report narrative and sf-425

11. Other Attachments *(attach other documents as needed or as instructed by the awarding Federal Agency)*

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12a. Typed or Printed Name and Title of Authorized Certifying Official N. Phil Peterson	12c. Telephone *(area code, number and extension)* (360) 753-0485 12d. Email Address phil@westforkenv.com
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Final Report: Assistance Agreement No. R17AC00031

Construction and Deployment of Pontoon Barge Mounted Vertical PIT Antennas in the Yakima River Basin

WEST FORK ENVIRONMENTAL

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October 13, 2017

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Introduction

West Fork Environmental was awarded an Assistance Agreement (No. R17AC00031) from the Bureau of Reclamation (BOR) to continue development and operational deployment of a vertical PIT tag antenna system capable of detecting juvenile salmonids traveling in the upper water column. Tasks in the Agreement included; 1) construction of a pontoon barge and fabrication of the vertical antennas, 2) integration and testing of the equipment on the barge, and 3) deployment of the barge to the Yakima River. The following performance report is submitted consistent with requirements of Section 9.0 of the Agreement with special reference to Section 9.3 Monitoring and reporting program performance (2 CFR §200.328). This report contains reference to all activities conducted under the Assistance Agreement including the results of the detections of tagged fish.

Accomplishments and Award Objectives

West Fork has met all the Milestones of the Assistance Agreement and completed all the major tasks. We were able to meet the planned completion dates and were on schedule for deployment of the completed PIT detection barge to the Yakima River on April 5, 2017.

Goals and Milestone Reconciliation

All goals and milestones have been reconciled to demonstrated accomplishments and West Fork considers their contractual obligations under the Assistance Agreement complete.

Other Pertinent Information

In this final report we reiterate the following under this heading:

- the vertical antenna system appears to be capable of addressing some longstanding needs in field research of juvenile salmonid populations and their response to habitat restoration and adjustments in water management through better tag detection,
- from our communications there is a high likelihood that several Indian Tribes, the Washington Department of Fish and Wildlife and the Bonneville Power Administration may be interested in funding deployment of vertical PIT antenna arrays.

Milestone 1: Construct Pontoon Barge and Fabricate Vertical Antennas

Milestone 1 required fabrication and assembly of the barge base and fabrication of the vertical antennas. The barge was constructed of HDPE plastic pipe and welded with services of Pacific Netting Products (Figure 1). Decks were built over the pontoon base and winch and mounting bracketry were mounted along with solar panel fixtures (Figure 2). Fiberglass fabrication of the vertical antennas and tuning to specific frequency was accomplished in West Forks shop (Figure 3).

Figure 1. Pontoon barge bases of HDPE 30” diameter pipe prior to assembly and dry fitting.

Figure 2. Assembly of barge decks and antenna, winch and solar panel bracketry fore and aft respectively.

Figure 3. Fabrication and tuning vertical antennas in West Fork shop.

Milestone 2: Assemble, Integrate, and Test Equipment on the Barge

Milestone 2 required assembly of the vertical antenna system for deployment to the Yakima River. Antenna, winch and solar brackets were fastened to the other barge components and the antennas were mounted from their brackets (Figure 4). Power for the Biomark MTS system was supplied through a 1 kW solar array connected to a bank of 8D 250ah AGM 12 volt batteries which were housed in one of the two enclosures on board the barge. Two FINs operate as a single antenna with the detection field coupling between. Coupling between them is enhanced by reversing the phase in opposing FINs. Controller status reports recorded amperage at each node of between 7-8 amps with noise values ranging from 5-10%.

Figure 4. Integration and onshore testing of partially assembled PIT detection barge prior to launch in the Yakima River, April 5, 2017.

Milestone 3: Deployment of Pontoon Barge in the Yakima River

Milestone 3 required deployment of the PIT detection barge to the Yakima River for live field trials of fish detection during the smolt outmigration. We coordinated with Yakima fisheries staff to determine how many fish were being released from upstream acclimation facilities and how many wild fish were tagged in previous efforts in the current calendar year. The barge was deployed on April 5 and recovered on June 1, 2017.

Figure 5. PIT detection barge deployed to the Yakima River fishing approximately 4,500 cfs in this photo.

Figure 6. Recovery of PIT detection barge on June 1.

Results of Deployment

Detection Data

Between April 5 and June 1 we recorded 2,400 detections at the barge, 749 of these being unique tag codes. Of the unique codes 657 were hatchery Chinook from volitional release locations in the upper watershed with other species and stock origins given in Table 1 below.

Species (stock)	Number
Coho (unknown r/t)	1
Coho (hatchery)	40
Spring Chinook (hatchery)	657
Rainbow Trout (wild)	27
Spring Chinook (wild)	18
Summer Steelhead (wild)	4
Unknown	2
Grand Total	749

Table 1. Detections on the vertical antenna array at the head of Roza Pool by species and stock of origin between April 5 and June 1 2017.

The number of unique detections varied significantly by day over the time period (Figure 7). During each day we observed normal patterns of timing consistent with typical smolt activity periods (i.e., many fish passing during the hours of darkness) (Figure 8). This finding suggests that the detection barge is unbiased in its temporal assessment of fish abundance moving past its mooring location.

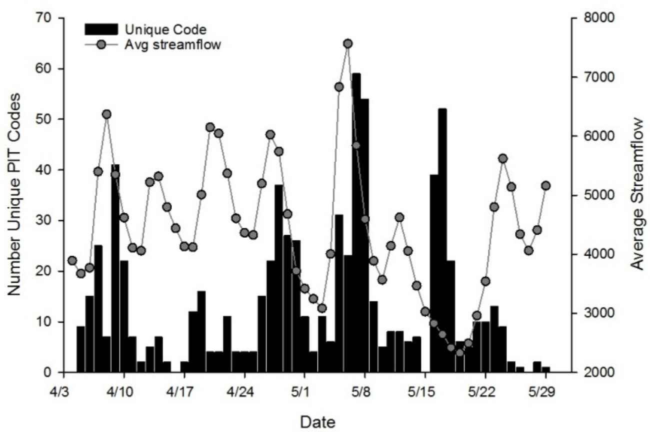


Figure 7. Unique tag detections by day and average daily flow of the Yakima River at Umtanum (USGS gage # 12484500).

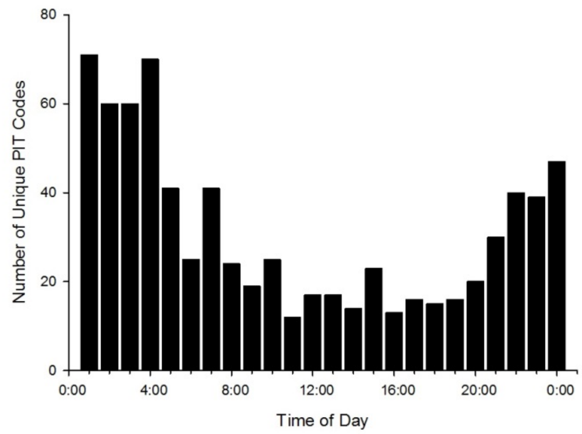


Figure 8. Number of unique tag codes detected at the barge by hour of the day.

We detected fish on both ascending and descending limbs of the hydrograph and on all flows (Figure 9). This finding is consistent with the vertical antenna concept as designed to detect fish moving in the upper water column and demonstrates the benefits of full water column detection in deep water. While there was no traditional antenna array fixed to the channel bed in the vicinity to compare to, a system anchored to the channel bed would be expected to get many fewer detections during the flow peaks as fish travel in water out of the limited vertical detection field over the antennas.

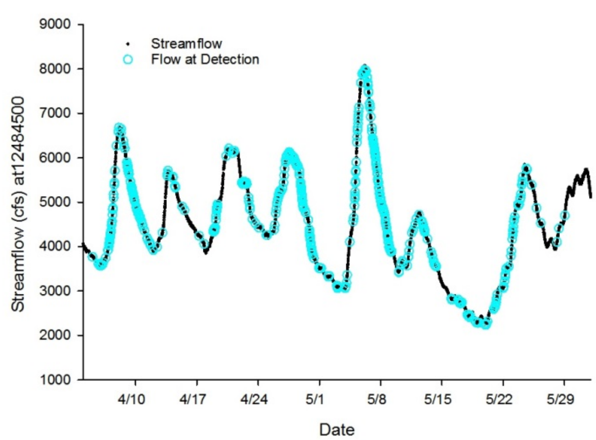


Figure 9. Stream flow at time of detection for all unique tag codes.

Most fish that were detected had 1-3 detections as they passed the vertical array (Figure 10). This finding suggests that fish did not use the vertical antennas for velocity cover or refuge and kept moving past the barge. If fish did find the antennas as a locally attractive cover object it could increase the rate of tag collision or perhaps work positively to increase detection rates due to movement around and between the vertical antennas. Fish did not spend much time within the field of the array. The longest time any fish spend within the array's field was 88 seconds and this fish accounted for 77 detections. Thirty fish had 5 detections or more with the greatest having 77.

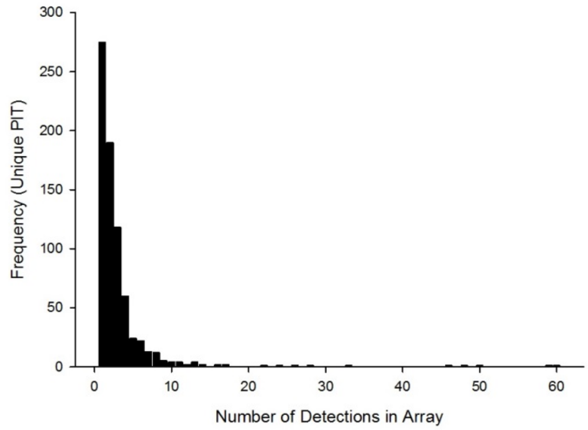


Figure 10. Detection frequency for all unique codes.

Detections by node showed a consistent pattern that at this point remains inexplicable. The center node, node 3 from day 1 had the most detections and the most unique detects (Figure 11). This pattern of detections was obvious throughout the period of deployment. We parsed the data by daylight and night time detections to determine if light or shade differences under different sections of the barge was having an effect on detection pattern (Figure 12). From this analysis it does not appear that fish were seeking cover or darkness that might have been greater at the center of the barge.

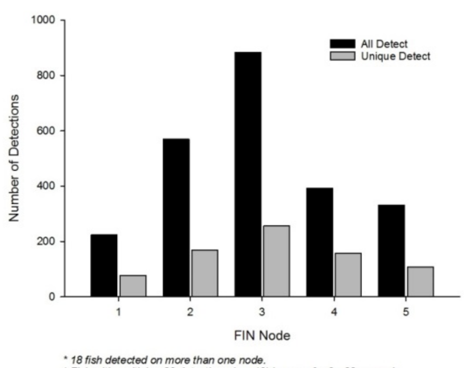


Figure 11. Detections and unique detects by node, node 3 is the center of the barge and consistently had better detects.

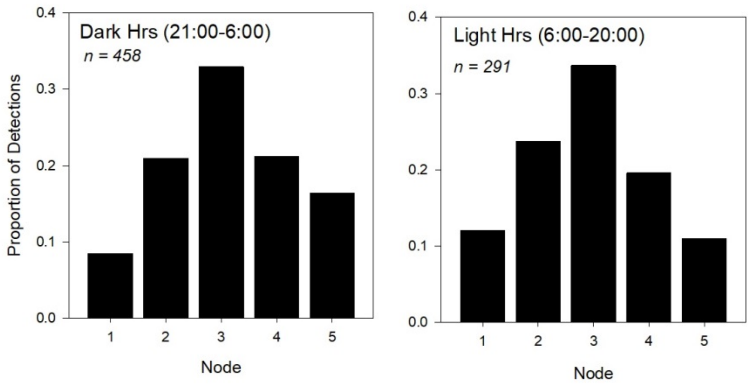
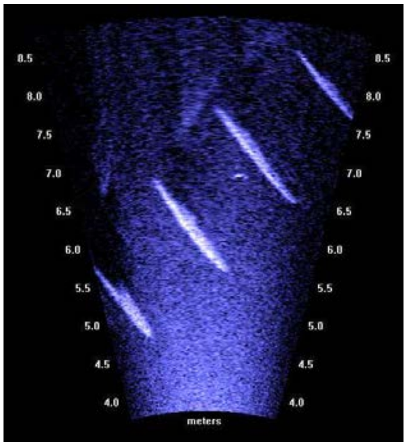


Figure 12. Patterns of unique detections by dark and light hours.

We further analyzed data for differences in detections by flow. This also proved fruitless to explain higher detections at the center node of the array as the pattern persisted throughout all flows. One possible explanation for this difference is that fish may have shied away from the barge as they approached it, some moving to river right some moving to river left. If the fish were evenly distributed across the detection field and some went one way while an equal number went the opposite, and if there was insufficient time for them to clear the array before passing through it, detections could have "piled up" on the center node.

Didson Images



Some corroborating evidence for the above supposition may be found in a few of the Didson images that were collected. The image to the right captures a smolt sized fish turning around and moving laterally in front of the array. If most of the fish approached the array in this manner, some moving right, some moving left, it could result in a pattern of increased detections in the center of the array, especially if fish made this "correction" relatively near the array, passing through it or to the side of it depending on their directional decision. However we do not know the reason for the pattern of detections in Figure 11. If we are correct in our supposition that the higher detections in the center of the barge are due to some avoidance behavior of the smolts as they approach the array, it may be possible to increase overall detections with wing guide nets, reconfigure the nodes on the barge into a V arrangement with the opening to the upstream direction, or increase the width of the detection field by mooring two barges side by side. This is a fruitful are of future research with regard to the vertical antenna system.

Acknowledgements

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