PTAGIS

PIT Tag Information Systems
Columbia Basin

Newsletter

November 2005
Volume 6
Issue 5

IN THIS ISSUE

The PTAGIS Newsletter is published periodically by Pacific States Marine Fisheries Commission.

We welcome input from the PTAGIS community, so email or write us with your story ideas.

If you have questions regarding the contents of this publication, or about the PTAGIS program, please contact Carter Stein, PTAGIS Program Manager.

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A Fisheries Data Project of the Pacific States Marine Fisheries Commission

TAG FORECAST DUE

Sponsors and Managers for the Northwest Power and Conservation Council's Fish and Wildlife Program project, funded by Bonneville Power Administration, that require PIT tags should submit their forecasted tag requirements to Renee Barrett as soon as possible.

TAG DISTRIBUTION PROCESS

There are five key steps to the process:

1 FORECAST

The Project Sponsor provided PSMFC with a Forecast Request Letter detailing tag requirements for BPA fiscal year (typically this occurs once per year, usually in August). This forecast is used to identify approved projects and to schedule deliveries from the manufacturer. The forecast can be found online at:

Forecast Spread Sheet

NOTE: *If you did not participate in the forecast process, you will still need to fill out a forecast form prior to requesting tags..*

2 CONTRACT NEGOTIATION

The Project Sponsor works with BPA COTR to negotiate project budget and work statement.

3 PRE-APPROVAL

Upon agreement the Project Sponsor's tag requirement is approved by the COTR. (This typically occurs once per year prior to the beginning project performance period.)

4 PDRF SUBMISSION

A Project Sponsor or Tag Coordinator verifies project approval (see step 1) then submits PIT Tag Distribution Request Form (PDRF) to PSMFC. This happens at least 30 days prior to the date tags are shipped.

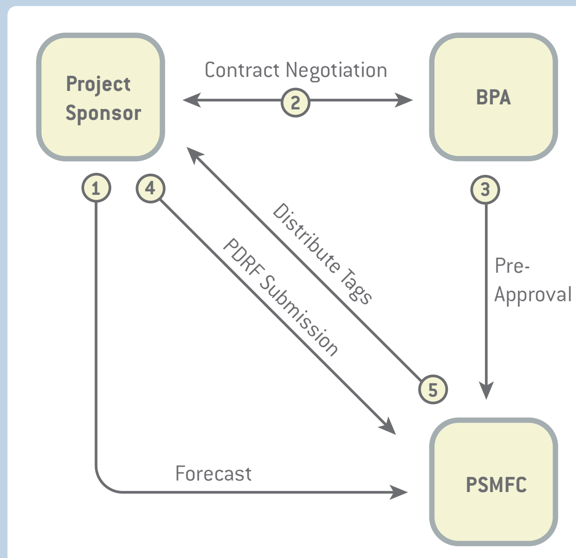
5 DISTRIBUTE TAGS

Pre-approved PIT tags are distributed to the Project Sponsor or Tag Coordinator.

To find out if a project has been pre-approved, check the link (Column K in the Forecast Spread Sheet). Call your COTR if your project is not listed or approved for the proper amount.

For distribution information, call Renee Barrett at PSMFC, 503-595-3100.

PIT Tag Distribution Process



The Forecast Request Letter is available at the link below. Sponsors are asked to include Tag Type this year. For details on Tag Type, please see the article, *"More Information Regarding the New Tag on the Block"* in this newsletter.

Download the Forecast Request Letter

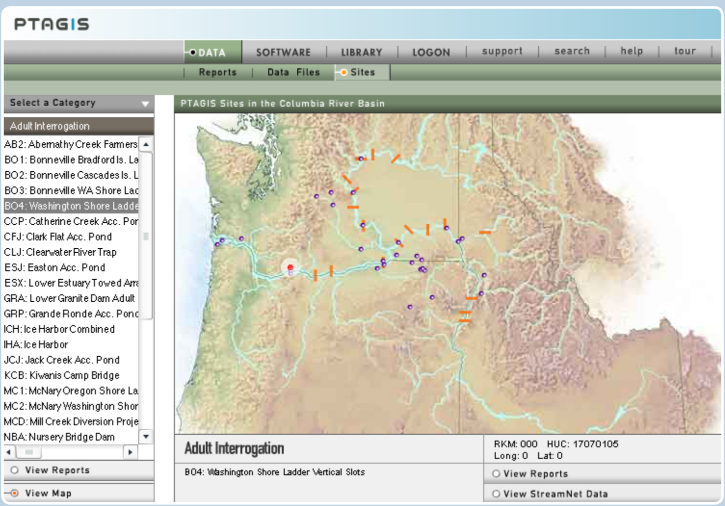
NEW PTAGIS WEB SITE

On September 7, 2005, the new PTAGIS web site went live at www.ptagis.org. The new site provides an interpretive as well as an interactive browser for site data, documentation library, and links to reports, data and software. Users may set up an account that will allow access to advanced services, query tools and other features.

The PTAGIS staff wishes to thank the members of the Columbia Basin PIT Tag Steering Committee who assisted in design review and testing of the new site. In addition, we would like to thank all of the PTAGIS users who assisted in beta-testing the site over the spring and summer months, and Fieldtrip for the design and development of the site. (You can view more of their work at www.fieldtripinc.com).

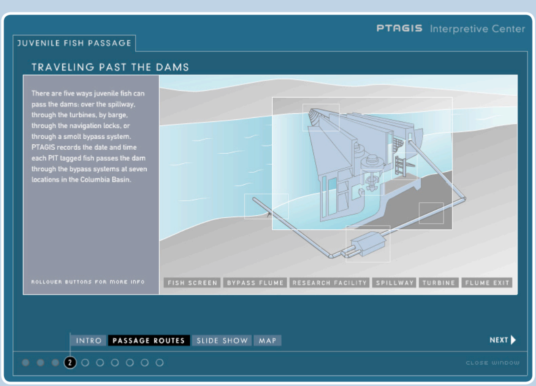
Information System programming was performed by Scientific Applications International Corporation (SAIC). www.saic.com

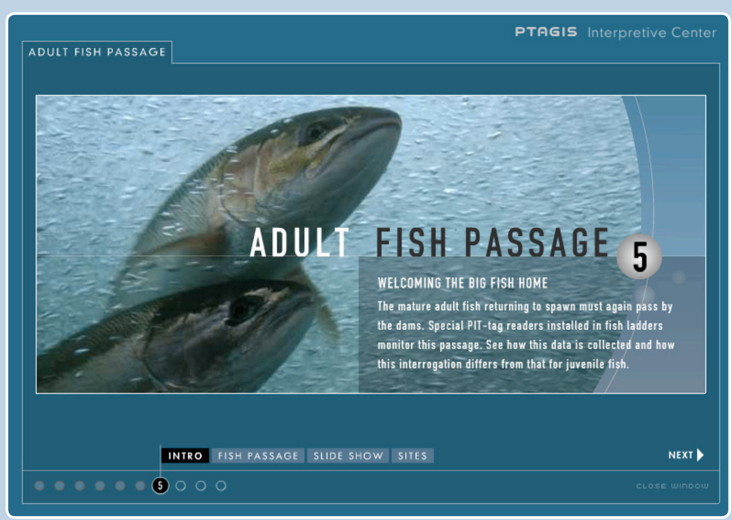
Please send comments and suggestions to: ptagis.support@ptagis.org



Software for PIT tag supported devices is available and easier to access.

Site information and reports are detailed in graphic displays.





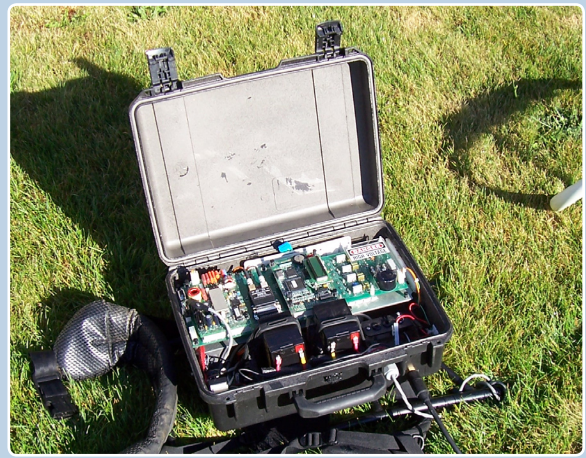
The Interpretive Center provides an interactive tour for learning about the PTAGIS program.

Mobile Monitor **WIRELESS COMMUNICATION** added to PITpack Equipment

The Abernathy Fish Technology Center, USFW, has integrated wireless Bluetooth technology and MobileMonitor software with portable PITpack systems making data collection easier and more accurate.

When a fish is detected by one of the portable antennas the MobileMonitor software records the tag id, the time stamp of the detection, and the GPS coordinate of the detection location. Prior to incorporation of wireless communication with the Mobile Monitor software all of this information had to be recorded manually. At the end of the interrogation period the Pocket PC is connected to a desktop computer and MobileSync Manager software is used to export the fish detection information to an Excel file.

PITpack System



A PITpack system is comprised of a ruggedized Pocket PC with built in GPS receiver and two modified FS1001A transceivers with portable antennas.

Transceivers

The electronics for the transceivers are enclosed in Pelican cases and mounted on frames allowing them to be carried like backpacks.

Each of the transceivers now has a Cordless Serial Adapter that allows wireless communication with the PocketPC.

Fall 2005

PTAGIS CLIENT SOFTWARE RELEASE

As mentioned in a previous newsletter article, PTAGIS will release all client software on a biannual schedule with the exception of critical issues.

The table at the right provides a brief overview of the scheduled release for fall of 2005.

All software can be downloaded and installed from the PTAGIS web site by clicking on the *Software* links. Please review the accompanying readme.txt file before installing any new version onto your system.

Scheduled Release • Fall 2005

Software	Version	Date	Description
P3	1.4.2	9/1/05	Resolves a compatibility issue with a common library also used PTAGIS.
MiniMon	1.4.10	9/7/05	Supports the latest firmware for the FS1001M multiplexer reader version 1.7. Also provides a fix related to encrypting passwords for uploading data to PTAGIS.
Mobile Monitor	1.0.18	8/16/05	Also checks system resources on startup, and outputs battery charge every 10 minutes regardless of the alarm threshold value.

Click on software name to download.

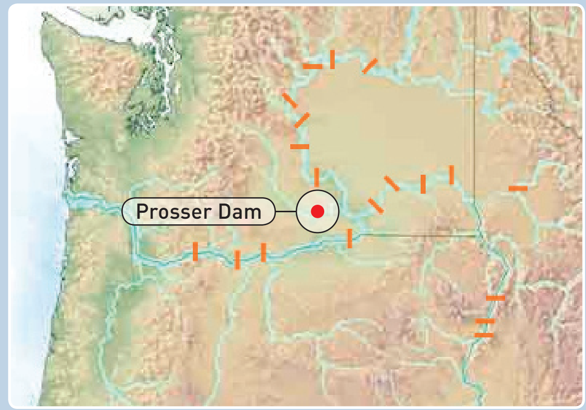
Additional **ADULT LADDER DETECTORS** at Prosser Dam

In September 2005 the PTAGIS project completed Phase 2 coordination efforts and electronics modifications for incorporation of two new counting window detectors at Prosser Dam on the Yakima River.

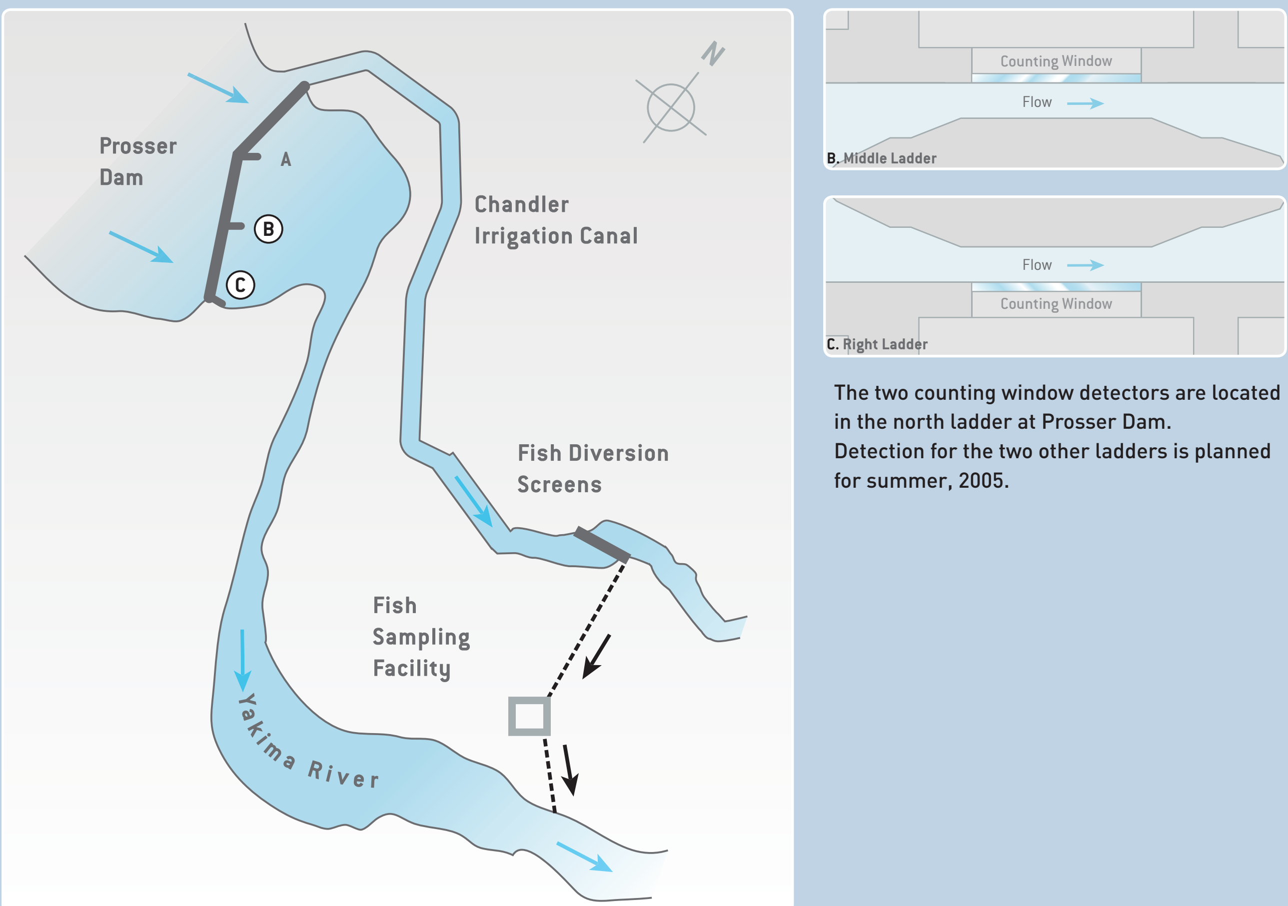
Completion of the first counting window was described in the December 2004 PTAGIS newsletter. The Phase 2 installation was also a collaborative effort of the Yakama Nation, Bureau of Reclamation, Washington Department of Fish and Wildlife, Biomark, Pacific States Marine Fisheries Commission, Knight Construction, and Inca Engineers, Inc.

The facility will be online in November, 2005 after work is completed.

Site Overview



Counting Window Detectors



The two counting window detectors are located in the north ladder at Prosser Dam. Detection for the two other ladders is planned for summer, 2005.

More Information Regarding

NEW TAG ON THE BLOCK

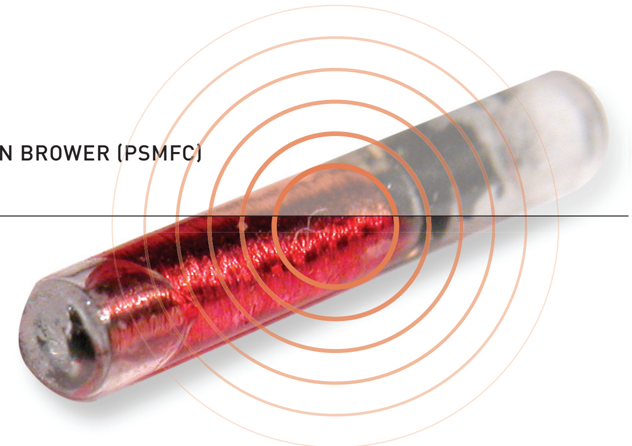
PROVIDED BY SANDRA L. DOWNING (NMFS), DARREN CHASE AND ALAN BROWER (PSMFC)

Digital Angel (DA) developed a new 12-mm PIT tag (SGL model) as part of developing a new PIT tag detection system for the corner collector at Bonneville Dam.

The antenna that will be installed in the exit flume will be a 17' by 17' antenna, which is two orders of magnitude larger than the largest PIT tag antennas that are currently installed at sites for juvenile salmonids along the Snake and Columbia Rivers. During system testing in 2004, the ST tag left a large hole in the center of the antenna where it could not be detected. Therefore, in order for PIT tags to be detected in these large antennas, DA developed a new tag model that when turned on would return a stronger signal, which would allow their transceiver to be able to pick up the return signal more easily against background noise levels.

In the November 2004 issue of the PTAGIS newsletter, DA introduced the new SGL tag to the fisheries community and indicated that it had a 20% longer read range than the current ST tag in a 6' by 7' test antenna located in a shielded room. Three other articles in other PTAGIS newsletters have informed the fisheries community about the physical parameters of the SGL tag model, its cost, the need to use thin-walled needles, and to update the firmware on the transceivers.

To avoid problems that have occurred in the past when new tags were introduced into the Columbia River Basin without testing them in the laboratory first, the PIT Tag Steering Committee (PTSC) requested that NMFS design a series of tests to evaluate how well a new tag model would perform in the current network of interrogation systems.
In December and January, PSMFC and NMFS conducted a number of performance tests on the SGL tag with antenna sizes that are currently in service for interrogating juvenile and adult salmonids (i.e., these were much smaller than the 6' by 7' test antenna).



The results for the SGL tags were compared to results for ST tags, which is the current tag mostly being used.

In these tests, we examined:

- Physical and electrical parameters (e.g., weight, resonant frequency, turn-on voltage)
- Read ranges under different noise levels
- Maximum read speed under different noise levels
- Impact of tag grouping on reading efficiencies

Most of the interrogation systems within the network installed throughout the Columbia River Basin have not changed in years. However, as the technology advances, there is potential for new interrogation systems to be developed that would allow detection of tags in new locations. Consequently, NMFS and PSMFC added a set of tests that would evaluate how well an applicant tag model would perform in a 4' by 4' antenna (largest size that would work well in PSMFC's shielded room) to help researchers who are trying to push the technology to its limits. As part of this set of tests, we also analyzed whether there were any correlations with read-range values and the three electrical parameters that were measured individually on approximately 400 ST and SGL tags.

More tests were conducted than are presented on the following pages, but these results should give the fisheries community a solid indication of the performance of the SGL tag relative to the ST tag.

Readers who wish for a copy of the report covering all of the tests should contact Sandy Downing sandy.downing@noaa.gov.

CONTINUED →

THE NEW TAG ON THE BLOCK

TABLE 1

Parameter	ST tags	SGL tags	Increase from ST tag
Length (mm)	12.45±0.11	12.70±0.18	2.0%
Diameter (mm)	2.03±0.02	2.22±0.02	9.9%
Weight (g)	0.1067±0.0010	0.1254±0.0010	17.5%

The averages and standard deviations are given for three physical parameters for the ST and SGL tag models. The values were based on 30 tags.

PHYSICAL PARAMETERS

Thirty tags of each model were individually measured and weighed. The average length and width for the SGL tags was 2% longer and 10% wider than the averages for the ST tags (*Table 1*). Of more significance for tagging small salmonids, the average weight for the applicant SGL tags was 17.5% heavier than the average for the ST tags.

ELECTRICAL PARAMETERS

PSMFC measured resonant frequency, turn-on voltage, and 3-dB bandwidth on SGL and ST tags (*Fig. 1*). The electrical parameters for 400 individual tags of each model showed specific differences in how the two tag models operate. As indicated by DA, the ST tags will generally turn on first because the stronger modulation index of the SGL tag needs additional voltage to turn on; the stronger modulation is what enables the tag to be detected in the large corner collector antenna. The median value was 0.37V for the ST tags and 0.39V for the applicant SGL tags (*Table 2*). The bandwidth values for the SGL tags were generally much lower than the values for the ST tags, which should mean that the SGL tags will handle interfering noise close to 134.2 kHz better than the ST tags. Both tag models had a few tags with higher bandwidths.

There were 3 ST and 11 SGL tags that were outside the acceptable resonant frequency range of 134.2 ± 2 kHz or in reality, 132.325 ‹X ‹136.387 kHz. These tags should not have been delivered to PSMFC. DA had problems with their testing apparatus occasionally getting jammed with the larger diameter SGL tags and determined subsequently that when this happened tags were indiscriminately getting put into the acceptable bin. They have corrected this problem and will be retesting all of the SGL tags delivered to PSMFC. Therefore, we have eliminated these 14 tags from our results.

TABLE 2

	Median turn-on voltage	Median resonant freq (kHz)	Median 3-dB down bandwidth
SGL tags	0.39V	134.512 kHz	6.234 kHz
ST tags	0.37V	134.512 kHz	7.793 kHz

The median values are given for three electrical parameters for the ST and SGL tag models. The values were based on 388 SGL tags and 397 ST tags.

FIGURE 1

Setup used by PSMFC to measure the electrical parameters.

FIGURE 2

Read-range distances were measured with tags placed along the Z-axis out from the center of an antenna.

CONTINUED

THE NEW TAG ON THE BLOCK

TABLE 3

	Average percent increase in read ranges of SGL tags compared to ST tags	
Antenna size	**Low (150 mV) noise test**	**Mid-range (500 mV) noise test**
Center of 6" pipe	7.8	6.6
Center of 12" pipe	8.5	8.5
26" x 26" orifice antenna	9.3	11.0

The average read-range distances for 0°-oriented PIT tags in different sized antennas under low (150 mV or 3% on the display) and mid-range (500 mV or 10% on the display) noise conditions. The read-range distances were measured along the Z-axis out from the center of the antennas when the transceiver was steadily detecting 10 tag codes out of 100 attempts.

READ RANGES UNDER DIFFERENT NOISE LEVELS

All read-range distances for the evaluation were measured along the Z-axis out from the center of the antennas (*Fig. 2*). In this article, the read ranges presented were measured when the transceiver was steadily detecting 10 tag codes out of 100 attempts in the continuous read mode. Although the measurements were made with static tags, the 10% detection distance usually corresponds well to the distance a tag would start being detected for a moving tagged fish.

Results for the three smaller antennas showed that with optimally 0°-oriented PIT tags we observed a 7–11% increase in read-range distances for the SGL tag compared to the ST tag under two noise conditions (*Table 3*). The averages were determined using five tags of each model.

MAXIMUM READ SPEED UNDER DIFFERENT NOISE LEVELS

Both tag models were detected at levels >95% at the maximum belt speed of 27 ft/sec for most of the individual tests (*Table 4*). Only at the highest noise level test for the orifice antenna did we have to reduce the belt speed down to 10 ft/sec to obtain the 95% standard. We repeated the test at a slightly lower noise level to determine the impact. There was a large increase, as the read speed result effectively doubled for both tag types.

It was interesting that there appeared to be a threshold noise level as there was a large drop in the ability of the transceivers to detect tags when the noise levels were at 1250 mV or above (~25% on the transceiver display). We had originally planned to test at 1500 mV (30%), but we could not even detect the 0°-oriented tags of either tag model at that noise level. This was quite different from the results obtained by Brad Peterson (2003) in his evaluation for PSMFC of the ST tag model in 2001, where he was able to go up to 40%. We tried several transceivers with the same results.

IMPACT OF TAG GROUPING ON READING EFFICIENCIES

This series of tests was only conducted with the antennas for the juvenile system because grouping (multiple tags in the tag-energizing field simultaneously) is not a significant problem with the interrogation systems for adult salmonids. In these tests, we determined how close different groups of tags could be to each other without interfering with the transceiver's ability to detect the individual tags. The tests were conducted at a fixed belt speed (13 ft/sec)

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TABLE 4

		ST-maximum read speed (feet per second)			SGL-maximum read speed (feet per second)		
	Tag angle	**6" pipe**	**12" pipe**	**Orifice**	**6" pipe**	**12" pipe**	**Orifice**
150 mV noise	0°	27	27	27	27	27	27
	45°	27	27	27	27	27	27
500 mV noise	0°	27	27	27	27	27	27
	45°	27	27	27	27	27	27
1250 mV noise	0°	27	27	27	27	27	27
	45°	27	27	10	27	27	10
1000 mV	45°			19			21

The maximum belt speeds for detecting 0° and 45°-oriented PIT tags at 95% or better reading efficiencies under different noise conditions. The belt was located in the center of each of the antennas. Additional tests under slightly lower noise conditions were run with the 45°-oriented PIT tags in the orifice antenna; the results are in the highlighted boxes.

THE NEW TAG ON THE BLOCK

with only tags in the 0° orientation. Reading efficiencies were determined for replicate sets of tags that were separated by fixed distances (e.g., tags were separated by 24", 12", 6", and by 3").

In the first set of tests, we examined groups of two tags. Regardless of whether two adjacent tags were of the same or different tag types, there was no interference in the 6" or 12" pipes until the tag separation was reduced to 3" (*Tables 5 & 6*). The SGL tags did a little better at 3" when they were paired with the weaker ST tag than they had when they were paired with another SGL tag. Similarly, the ST tag did a little worse when paired with the stronger SGL tag than when it was paired with another ST tag.

In the second set of tests, we examined groups of three tags. Significant interference with sets of three tags occurred at slightly longer separation distances than with the two-tag groups: interference occurred at 6" tag separation for the 6" pipe and at 8" for the 12" pipe antenna. At these separation distances, detection of the middle tag became negligible

TABLE 5

	Reading efficiencies (%)			
	ST tag model		SGL tag model	
Separation	**6" pipe**	**12" pipe**	**6" pipe**	**12" pipe**
24"	100	100	100	100
12"	100	100	100	100
6"	100	100	100	99.5
3"	96.3	60.0	84.0	48.9

The combined (two coil) reading efficiencies are presented for a set of two tags separated by different distances. The two tags were of the same tag model for these tests.

TABLE 6

	Reading efficiencies (%)			
	ST tag first		SGL tag first	
Separation	**6" pipe**	**12" pipe**	**6" pipe**	**12" pipe**
24"	100	100	99.9	100
12"	100	100	100	100
6"	100	100	100	99.1
3"	94.1	55.5	89.7	55.3

The combined (two coil) reading efficiencies are presented for a set of two tags separated by different distances. Each group contained one tag from each tag model for these tests.

TABLE 7

	Reading efficiencies (%)					
	All ST tags		All SGL tags		SGL-ST-SGL	
6" Separation	**6" pipe**	**12" pipe**	**6" pipe**	**12" pipe**	**6" pipe**	**12" pipe**
Outside tags	100		100		100	
Middle tag	8.0		1.9		10.0	
8" Separation	**6" pipe**	**12" pipe**	**6" pipe**	**12" pipe**	**6" pipe**	**12" pipe**
Outside tags		100		100		97.3
Middle tag		5.7		0.1		2.7

The reading efficiencies are presented for the outside tags and middle tag from a set of three tags separated by different distances. The tags were all from the same tag model for these tests.

while the outside tags were still being detected at levels above 95% (*Table 7*). The results followed the same pattern even when the outside tags were SGL tags and the middle tag was a ST tag, which because the SGL is the stronger tag, would be the worst-case scenario.

None of these results was surprising and fish tagged with the SGL tag would be detected fine in the network of interrogation systems for juvenile fish that are currently installed. These results show that if there were a mixture of tags in the system, detection efficiencies would be no worse than if fish tagged with either tag model transited independently through the current set of interrogation systems at the juvenile fish facilities.

LARGE 4' BY 4' TEST ANTENNA

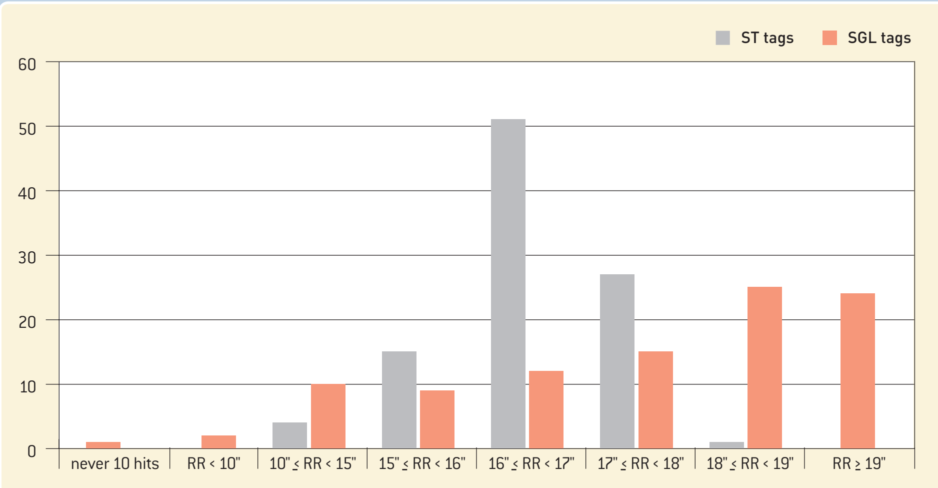
We ran tests in a 4' by 4' test antenna for two reasons:

1. To investigate whether the improvement in read range with the SGL tag would increase significantly with a larger antenna.
2. To determine if a correlation existed between read range and any of the three electrical parameters measured (resonant frequency, turn-on voltage, and 3-dB bandwidth). We measured the read ranges of 400 ST and 400 SGL tags in 0° orientation under low (3–5%) noise conditions.
   However, the results for the 3 ST and 11 SGL tags that were outside the acceptable resonant frequency range were not included in the results because DA has since fixed their quality-control problem.

CONTINUED

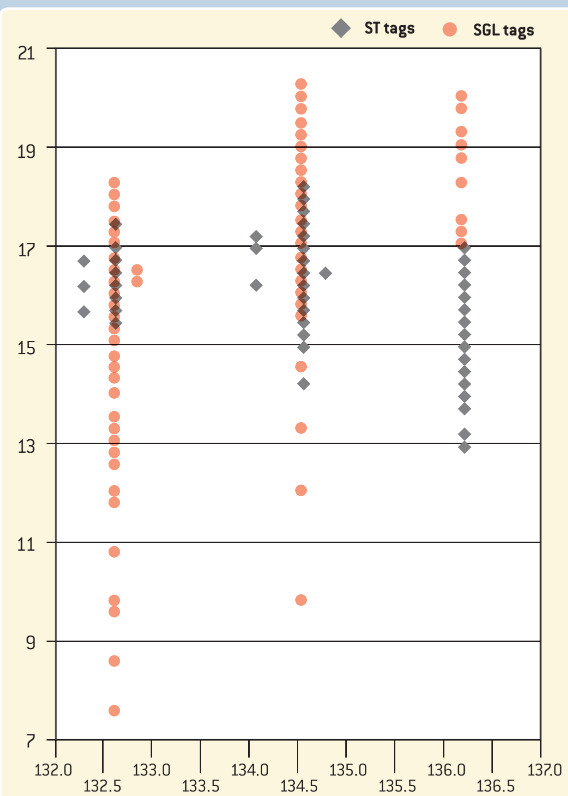
THE NEW TAG ON THE BLOCK

FIGURE 3 • Tag Distribution on Read Range (inches)



Tag distribution for both the ST and SGL tag models based on read-range measurements (inches). The distributions were based on 388 SGL tags and 397 ST tags.

FIGURE 4 • ST and SGL Tags



The relationship between read range (inches) and resonant frequency (kHz) for the ST and SGL tags.

The median read-range values were 16.50" for the ST tag model and 18.00" for the SGL tag model. This represents a 9.1% gain, which is less than the 20% that DA stated. Overall, the ST tags had a tighter distribution of read ranges than did the SGL tags (*Figs. 3 & 4*). Over 50% of the ST tags read in the 16–17" read-range category while 25% was the highest value for any of the SGL read-range categories. In general, around 50% of the SGL-tag population had read ranges longer than the ST-tag population (read ranges ›18").

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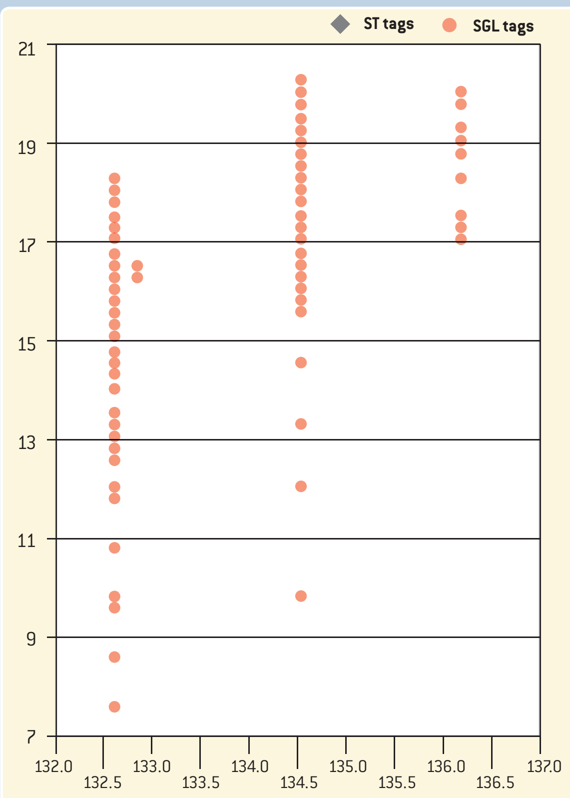
THE NEW TAG ON THE BLOCK

We did find a correlation between resonant frequencies and read range: SGL tags with resonant frequencies at 134.5 kHz and 136.4 kHz were the better performing tags (*Table 8 & Fig. 5*).

Since there definitely is a large portion of the SGL tag population that read significantly better than the ST tag, it would be beneficial for the fisheries community if they could purchase tags from that subgroup for applications that require PIT tags with longer read range. One possibility would be for DA to filter the SGL tags into two grades using resonant frequencies and set a higher price for the better performing tags.

FIGURE 5 • SGL Tags



The relationship between read range (inches) and resonant frequency (kHz) for the SGL tags.

TABLE 8

Resonant frequency	Median read range		Percent change from ST tag
	ST tags	SGL tags	
132.637	16.50	15.50	-6.1
134.512	16.50	18.50	12.1
136.387	15.75	18.75	19.0

The median read range values (inches) for the ST and SGL tags are given for the three main resonant frequencies (kHz). The percent changes from the ST tag are also given.

GENERAL COMMENTS

The results from the evaluation showed that fish tagged with the SGL tag should be detected in the network of interrogation systems for juvenile and adult salmonids that are currently installed. Furthermore, the results substantiated that if there were a mixture of SGL and ST tags in the system, detection efficiencies would be no worse than if fish tagged with either tag model transited independently through the current set of interrogation systems at the fish facilities.

The tests confirmed DA's assertion that although the new tag model takes slightly more voltage to turn on, the stronger modulation index in its return signal would enable it to have a longer read range. They claim that the stronger modulation is critical to being able to successful detect tags in the large antenna needed for the corner collector at Bonneville Dam. We will have to wait until this fall or maybe next spring when we can test the two tag models in the large corner collector antenna. However, even in the smaller antennas we tested the new SGL tag model had a longer read range than the current ST model; the increase was in the 5-10% range for the different sized antennas. In general, the read range increased as the antenna size increased.

CONTINUED →

THE NEW TAG ON THE BLOCK

TABLE 9 • PIT Tag Models Manufactured by Digital Angel Corporation

	Original ISO tag (for comparison only)	Currently available		Available June 2006	Currently available Specialty tags	
	TX1400BE	TX1400ST	TX1400SGL	TX1400ST2	TX1415BE	8 mm tag
PARAMETERS						
Length (mm)	11.78	12.45	12.70	12.45	23.75	8.1
Diameter (mm)	1.97	2.02	2.22	2.02	3.86	2.02
Weight in air (g)	0.0843	0.1067	0.1254	0.1067	0.57	—
Requires Thin Wall Needle?	No	No	Yes	No	No	No
Cost ($)	—	2.05	2.25			
APPLICATIONS						
FCRPS juvenile fish facilities flumes	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
FCRPS full-flow sites	Very good	Excellent	Excellent	Excellent	Excellent	Good
Adult ladders: orifice antennas	Excellent	Excellent	Excellent	Excellent	Excellent	Good
Estuary pair trawl	Good	Excellent	Excellent	Excellent	Excellent	Good
In-stream sites	OK	Good	Very good	Excellent	Excellent	OK
Adult ladders: vertical-slot antennas	OK	Very good	Excellent	Excellent	Excellent	OK
Corner collector at Bonneville	Poor	Good	Very Good	Very Good	Excellent	Poor

This table presents the relative performances for different fisheries applications of the different tag models manufactured by DA based on laboratory and real fish data. The cells in red are conjecture —we will know more when we can test during the fall of 2005.

The fisheries community should be aware that the SGL tags were more variable than the ST tags. DA explained that these tags use an extruded ferrite that yields the higher performance, but also is less consistent than the molded ferrite used in the ST tags. DA is working on developing a new tag model that will use a molded ferrite and also yield the longer read range of the SGL tag. They have given this future tag the model number TX1400ST2.

We hope that DA considers selling a subgroup of the SGL tags that would consistently yield tags with longer read ranges that the ST tag. This would give researchers the option of purchasing tags based on what was needed for their particular project (*Table 9*).

REFERENCE

Peterson Engineering Services. 2003.
Super Tag and Standard Tag Comparison Test.
Report to Pacific States Marine Fisheries Commission. 53 p.

Evaluation of the **FULL-FLOW PIT TAG INTERROGATION SYSTEM** at Ice Harbor Dam (2005)

BY SANDRA L. DOWNING AND GORDON A. AXEL (NOAA'S NATIONAL MARINE FISHERIES SERVICE)

Bonneville Power Administration (BPA) contracted National Marine Fisheries Service (NMFS) to evaluate the newly installed full-flow PIT tag interrogation system at Ice Harbor Dam. The full-flow system at Ice Harbor Dam is very similar to the system at McNary Dam.

Both full-flow systems consist of four individual antennas (*Fig 1*). The most significant difference between the two full-flow systems is that the spacing between the Radio Frequency (RF) clamps for the individual antennas is 3–8" wider at Ice Harbor Dam. A larger tag-energizing field was employed at Ice Harbor Dam because the density of the inriver fish population is substantially lower than at McNary Dam and therefore, there is less likely to be problems with tag collisions (neither tag reads if both tags are in the field simultaneously). Therefore, the larger field will assist in detecting more PIT tagged fish.

NMFS was tasked with determining whether the new system detected PIT tagged fish at an acceptable level (typically this is defined as having an overall reading efficiency of 95% or better). NMFS proposed to evaluate the performance using both direct evaluation (releasing a known number of fish under different test conditions and determining how many of them were detected) and indirect evaluation (using statistical models to evaluate inriver fish) methods. We also proposed to use the fish tests to compare the new PIT tag model (TX1400SGL) with the current tag model (TX1400ST) at both Ice Harbor and McNary Dams. This article only presents the results from the direct evaluation at Ice Harbor Dam.

CONTINUED

FIGURE 1

The four RF shields for the full-flow PIT tag system at Ice Harbor Dam. The individual antennas are wrapped inside the shields.

DESCRIPTION OF TEST CONDITIONS

Because of delays in the construction contract issued by the U.S. Army Corps of Engineers, PSMFC was not able to start installing the electronic equipment until 1 April 2005. They finished on 19 April. Unfortunately, because of the delays and low-flow river conditions, the yearling steelhead fish we had reserved for the evaluation had already been released from the hatchery. Therefore, the system was evaluated with subyearling fall Chinook salmon. The fish tests were conducted on 20 April 2005.

Since the full-flow system at McNary Dam, which was installed in 2002, has had overall reading efficiencies in the upper 90s (determined with the indirect statistical method) during the past 3 years, we based the fish tests for the Ice Harbor system on the test conditions used to evaluate it in 2002 (Axel et al. 2003 and 2005). Consequently, three out of the four tests run were identical in terms of the numbers of fish released over time (e.g., 5 fish released every 15 seconds) (*Table 1*).

To compare the two tag models, duplicate sets of fish tests were run with fish tagged with both ST and SGL tags (*Table 2*). The original tests at McNary Dam were done with the previous tag model (TX1400BE or the BE tag).

Prior to release, each previously PIT tagged fish was scanned and its tag code was automatically recorded in a tagging file. The scanned fish was then placed into either a beaker for single fish releases or into a bucket for group releases.

Fish were released into a hopper that had a continuous source of flush water added to its bottom to ensure that fish did not get trapped in the flexible hose (7.6 cm diameter) connecting the hopper to the transport pipe (*Fig. 2*).

TABLE 1

Test conditions	McNary Dam	Ice Harbor Dam
1 fish released every 15 sec	Yes	—
1 fish released every 5 sec	Yes	Yes
5 fish released every 15 sec	Yes	Yes
10 fish released every 15 sec	Yes	Yes
10 fish released every 10 sec	—	Yes

A comparison of the fish test conditions used to evaluate the full-flow PIT tag interrogation systems at McNary and Ice Harbor Dams.

TABLE 2

Test conditions	ST tag	SGL tag
1 fish released every 5 sec	150	150
5 fish released every 15 sec	200	200
10 fish released every 15 sec	200	200
10 fish released every 10 sec	200	196

The number of tagged fish used for the four fish tests for the ST and SGL tag models.

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FIGURE 2

The hopper and flexible hose used for releasing fish at Ice Harbor Dam.

Flexible hose.

THE FULL-FLOW PIT TAG INTERROGATION SYSTEM

RESULTS AND DISCUSSION

The fish at Ice Harbor moved through the system quickly; within a minute or less of when the last fish or group of fish were released, the fish had finished passing through the set of four antennas. To compare the fish tests, we determined the fish distributions over time recorded by the four coils. When one examines the tags-per-minute median values, one sees that there were three general patterns.
Based on the median number of fish/min, Group 1 tests (not highlighted) had around 10 fish/min, Group 2 tests (highlighted in red) had around 20 fish/min, and Group 3 tests (highlighted in blue) had around 30 fish/min (*Table 3*). Since all of these values were less than their theoretical values, they show that the fish were actively responding to the fish-release and flow conditions in the transport pipe.

TABLE 3

Test conditions	ST tag	SGL tag
1 fish released every 5 sec	9.0	10.5
5 fish released every 15 sec	17.0	18.5
10 fish released every 15 sec	29.0	31.0
10 fish released every 10 sec	37.5	29.0

The median number of fish per minute for the 8 fish tests. The highlighting is added to help distinguish the three groups based on their median tags-per-minute values.

OVERALL READING EFFICIENCIES

For each fish test, overall reading efficiencies were determined by dividing the number of test fish that were detected by at least one of the four antennas by the original number of test fish released. If we examine the overall reading efficiencies for the eight fish tests, we observe that all of the results for the fish tests at Ice Harbor Dam are >98.0% (*Table 4*). Therefore even at the highest fish density tested, the full-flow interrogation system was able to detect the tagged test fish at levels well above the 95% standard. Furthermore, not until the higher fish densities represented by Group 3 were tested did any of the reading efficiencies go below 99.0%.

Looking at the data for the inriver fish population, the largest number of tagged juvenile salmonids passed Ice Harbor Dam on 16 May (n=1094). Even on that day, the median number of fish/min was 1.0 (the highest number recorded was 8 fish/min); therefore, the full-flow system is most likely detecting the inriver fish population in the 99–100% range.

TAG COMPARISON

Both tests with overall reading efficiencies below 99.0% were with fish tagged with SGL tags (Table 4). Since the SGL tags have the longest read range of the three tag models, this may be because there were more tag collisions among fish spaced similarly for the comparable tests or it may just be due to fish behavior that was unique to a test. It may be impossible to distinguish between these two possibilities considering that the small 1–2% differences among the overall reading efficiencies could be based on whether two or three fish were more closely or distantly spaced apart.

TABLE 4

Test conditions	ST tag	SGL tag
1 fish released every 5 sec	100	99.3
5 fish released every 15 sec	99.0	100
10 fish released every 15 sec	99.0	98.5
10 fish released every 10 sec	99.5	98.0

The overall reading efficiencies for the 8 fish tests. The highlighting is added to help distinguish the three groups based on their median tags-per-minute values.

There certainly is evidence that the fall Chinook salmon were able to swim in the water flowing at 12 ft/s and actively delay their downward passage. It was not uncommon to see some fish released in one group that would go through the full-flow system with the next group while tagged sticks or drones would have all gone downstream immediately. And it all depends on how close two or more fish are to each other as to whether their tags affect the detection of one another. The shortest time dimension recorded by the computer program *Minimon* is whole seconds. Therefore, fish recorded within the same second could be separated by up to 11 feet. Yet for the tags to affect each other, the fish need to be separated by less than 1 foot.

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THE FULL-FLOW PIT TAG INTERROGATION SYSTEM

If we analyze the average reading efficiencies for the individual coils, we do observe the impact of the higher tagged fish densities as the values decreased as the fish densities increased (*Table 5*). Group 1 typically had individual coil reading efficiencies around 90%, Group 2 around 85%, and Group 3 around 80%. Although we observed a decrease in average reading efficiencies as the fish densities increased, we did not observe a significant difference between the tag types. It is interesting that the fish test (10 fish tagged with ST tags released every 10 sec) with highest median number of fish per minute (37.5 fish/min) also had the highest average reading efficiency for its individual coils (83.3%) among the three higher density fish tests for the ST tag. This supports more the likelihood that the differences among the overall reading efficiencies are due to fish behavior rather than to a real difference in tag performance given that all of the fish were tagged with the same ST tag model in these three tests.

We will continue our evaluation using inriver fish, but at this time, it appears that the full-flow interrogation system at Ice Harbor Dam will detect PIT tagged fish at levels above the 95% standard (and most likely in the 99–100% range). The Corps and PSMFC should be applauded on jobs well done.

TABLE 5

Test conditions	ST tag	SGL tag
1 fish released every 5 sec	87.8	90.3
5 fish released every 15 sec	82.8	85.8
10 fish released every 15 sec	76.3	77.4
10 fish released every 10 sec	83.3	77.2

The average reading efficiencies for individual coils for all of the 12 fish tests. The highlighting is added to help distinguish the three groups based on the median tags-per-minute values.

REFERENCES

G. A. Axel, E. F. Prentice, and B. P. Sandford. 2003. *Evaluation of a full-flow PIT tag Interrogation System at McNary Dam, 2002*. Report by the National Marine Fisheries Service to the U.S. Army Corps of Engineers in Walla Walla, Washington. 36 p.

G. A. Axel, E. F. Prentice, and B. P. Sandford. 2005. *PIT tag Detection System for Large-Diameter Juvenile Fish Bypass Pipes at Columbia River Basin Hydroelectric Dams.* North American Journal of Fisheries Management: Vol. 25, No. 2, pp. 646–651.

Development of a **PIT TAG CORNER COLLECTOR** for the Corner Collector at Bonneville Dam (summer 2005 update)

BY SANDRA L. DOWNING (NOAA's National Marine Fisheries Service)

As reported in earlier PTAGIS newsletters, BPA, the Corps, Digital Angel Corporation (DA), NMFS, and PSMFC are working on developing a PIT tag system for the corner collector at Bonneville Dam. The project is currently on schedule for having the system installed in time for the 2006 smolt migration. For this corner collector PIT tag system to be successful, DA has had to develop a new transceiver, new tag, and now a new antenna system.

The group is moving forward on a slot antenna design. This design will make this installation similar to the PIT tag systems installed into the fish ladders, where BPA will be responsible for providing the antenna and the Corps will be responsible for designing how to modify the location for installing the provided antenna. The Corps has designed the concrete flume structure that will hold the slot antenna. Through a contract with BPA, DA has designed the slot antenna, which consists of three separate coils that together form a single antenna for detecting tagged fish transiting the exit flume of the corner collector.

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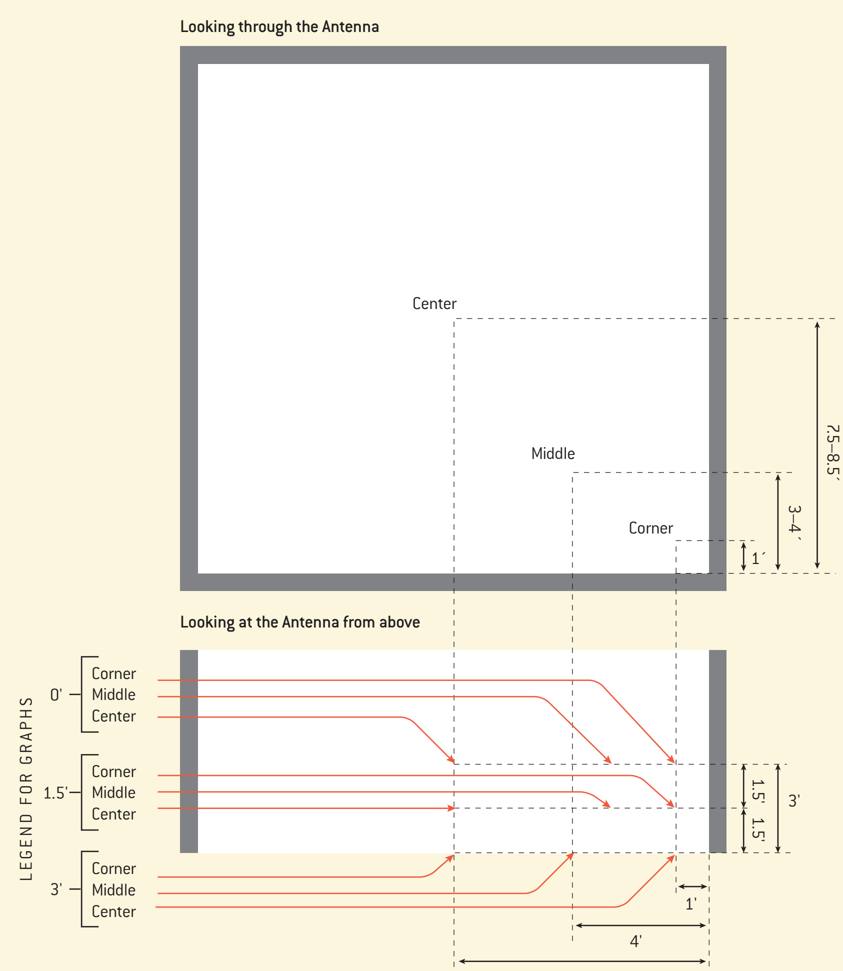
FIGURE 1 • Antenna Tests



The drawing shows the nine tag positions that were used during the testing of the testing of the three antenna sizes.

- The Corner dimensions were the same for all three Antenna sizes.
- All dimensions are referenced to the antenna orifice.
- Vertical dimensions for the antenna size:

15' x 15' antenna
Center = 7.5'
Quadrant = 3'

15' x 16' antenna
Center = 8'
Quadrant = 3.5'

15' x 15' antenna
Center = 8.5'
Quadrant = 4'

PIT TAG DETECTION SYSTEM

FIGURE 2

0° Oriented

17' X 17'

Corner	100	100	100	100	100	100
Middle	93	99	100	100	99	93
Center	16	62	57	57	62	16
Middle	99	99	100	100	99	93
Corner	100	100	100	100	100	100

17' X 18'

Corner	100	100	100	100	100	100
Middle	91	91	100	100	91	91
Center	2	23	51	51	23	2
Middle	91	91	100	100	91	91
Corner	100	100	100	100	100	100

17' X 19'

Corner	100	100	100	100	100	100
Middle	13	72	85	85	72	13
Center	0	0	0	0	0	0
Middle	13	72	85	85	72	13
Corner	100	100	100	100	100	100

30° Oriented

17' X 19'

Corner	100	100	100	100	100	100
Middle	13	72	85	85	72	13
Center	0	0	0	0	0	0
Middle	13	72	85	85	72	13
Corner	100	100	100	100	100	100

17' X 19'

Corner	100	100	100	100	100	100
Middle	13	72	85	85	72	13
Center	0	0	0	0	0	0
Middle	13	72	85	85	72	13
Corner	100	100	100	100	100	100

17' X 19'

Corner	100	100	100	100	100	100
Middle	13	72	85	85	72	13
Center	0	0	0	0	0	0
Middle	13	72	85	85	72	13
Corner	100	100	100	100	100	100

Reading efficiencies for different locations within the three antenna sizes for 0º-oriented (left) and 30º-oriented (right) tags.

The blue shading shows the approximate location for the water in the flume.

ANTENNA SIZE

During May, DA finished the antenna-size tests. They tested three antenna sizes (17' x 17', 17' x 18', and 17' x 19'—all of the antennas were 6' deep). The corresponding openings of the finished antenna housings would be 15' x 15', 15' x 16', and 15' x 17'. The three antennas were tested with tags at the optimal 0° orientation and tags at 30° orientation. They measured reading efficiencies at three planar locations within one quadrant of the antenna (center of antenna, 1' from corner, and middle of quadrant) and at three depths for each planar location (*Fig 1*). For each tag position in the test matrix, five reading efficiencies were taken and averaged to obtain the reported result. Each reading efficiency measurement was obtained by counting the number of decoded tags messages out of 100 tag message transmissions.

The results can be graphed to show how well stationary tags are detected at the various locations in the three antenna sizes (*Fig 2*). The blue shading shows the approximate water depth (11') for each antenna. Given that the center of each antenna is where large numbers of PIT tagged fish could potentially be passing the antenna, the results strongly support installing the smallest sized antenna.

Furthermore, DA noted that ambient noise caused more interference as the antenna size increased. Therefore, the decision was made to go with the 17' x 17' antenna.

ANTENNA FABRICATION

As indicated in the last update, DA intends to fabricate a full-scale housing for testing before it is installed. The original schedule called for this fabrication to happen in August, but it has been delayed until some time in the fall. The plan is to fabricate the sections (made from a copolymer polypropylene thermoplastic material) at the manufacturer's plant and then assemble the antenna housing onsite at Bonneville Dam near the existing test pit. DA will wrap the antenna at Bonneville Dam. Since the Corps is unable to issue a contract for retrofitting the existing test pit this summer, the earliest it could be available for testing would be November. This would be too late to allow for a new antenna to be fabricated if testing revealed problems. Therefore, the full-scale housing will not be evaluated under wet conditions in the pit as had been planned; however, some water testing is necessary to determine the effects of river water on the electrical parameters of the antenna. DA, NMFS, and PSMFC will test it under wet conditions as best they can. Other tests that will be

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PIT TAG DETECTION SYSTEM

conducted on the complete interrogation system include repeating the above reading efficiency tests, determining how stable the transceiver system is over time, and tests that compare the newly fabricated antenna with the test antenna in St. Paul. Based on the results from these tests, DA will make any adjustments they need to make before the antenna is delivered to the Corps for installation.

INSTALLATION AND TESTING

Based on reviews by the group on the 60% Plans and Specifications, the Corps finished its 90% Plans and Specifications for the corner collector PIT tag system in June. They then completed the 100% Plans and Specifications in early July. The project also passed the BCOE review process and its contract was put out for bid in August. In September, the Corps reviewed the proposals from the different contractors and selected the contractor, Triad Mechanical.

The Corps will issue the contract during the first week of October 2005 and the demolition work will begin around 1 November. Most of the work during the fall will be removing the flume section that is currently in place. Then, the Corps contractors will build the concrete support structure for the antenna housing using material that will not interfere with the PIT tag interrogation system.

As indicated in the last update, the antenna housing will be installed in February and then tested first under dry flume conditions and then under wet flume conditions. DA will make adjustments during this period and because this is a new system, further adjustments may need to be made during the 2006 season itself. This may require that the flume be dewatered for short periods of time so that people can safely access the antenna. Fish tests to evaluate the performance of the corner collector PIT tag system will be conducted throughout 2006. If substantial modifications are executed during 2006, it may become necessary to repeat some of the fish tests in 2007. Depending on system performance (i.e., will the corner collector interrogation system achieve the overall detection rate of 60% needed to provide adequate PIT tag detection coverage at Bonneville Dam), a decision will be made on whether to move forward with a second antenna site.