RECLAMATION

Managing Water in the West

Cle Elum Dam Juvenile PIT Tag Fish Bypass System Report

Storage Dam Fish Passage Study
Yakima Project, Washington

Technical Series No. PN-YDFP-004

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Boise, Idaho

October 2005

U.S. Department of the Interior

Mission Statement

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

U.S. Bureau of Reclamation

Mission Statement

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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CLE ELUM DAM JUVENILE PIT TAG FISH BYPASS SYSTEM REPORT

SEAN CASEY, ANTHONY CARSON, STEVE ANGLEA
10/10/2005

BACKGROUND:

This report was prepared for the Bureau of Reclamation under contract number 05CP1001587 to recount the installation and fish test of the PIT Tag detection system at the juvenile exit flume located at Cle Elum Dam. The components of this report are:

1.) Describe and review the installation of the PIT Tag detectors as well as provide suggestions for modifications to the system based on data collected this year.

2.) Review the fish test process, results, and conclusions.

INSTALLATION OF THE PIT TAG SYSTEM:

The PIT Tag detectors were installed May 9-12. Bureau of Reclamation personnel on site were: Wayland Huffines, John McCoy, Alan Heilberg, Phil Davis, and Shawn Rucker. The Biomark personnel on-site were Lance Batchelder and Sean Casey, with internal support provided by Brett Turley, Colby Blair, and Anthony Carson. Pictured below is the installation of a single antenna.

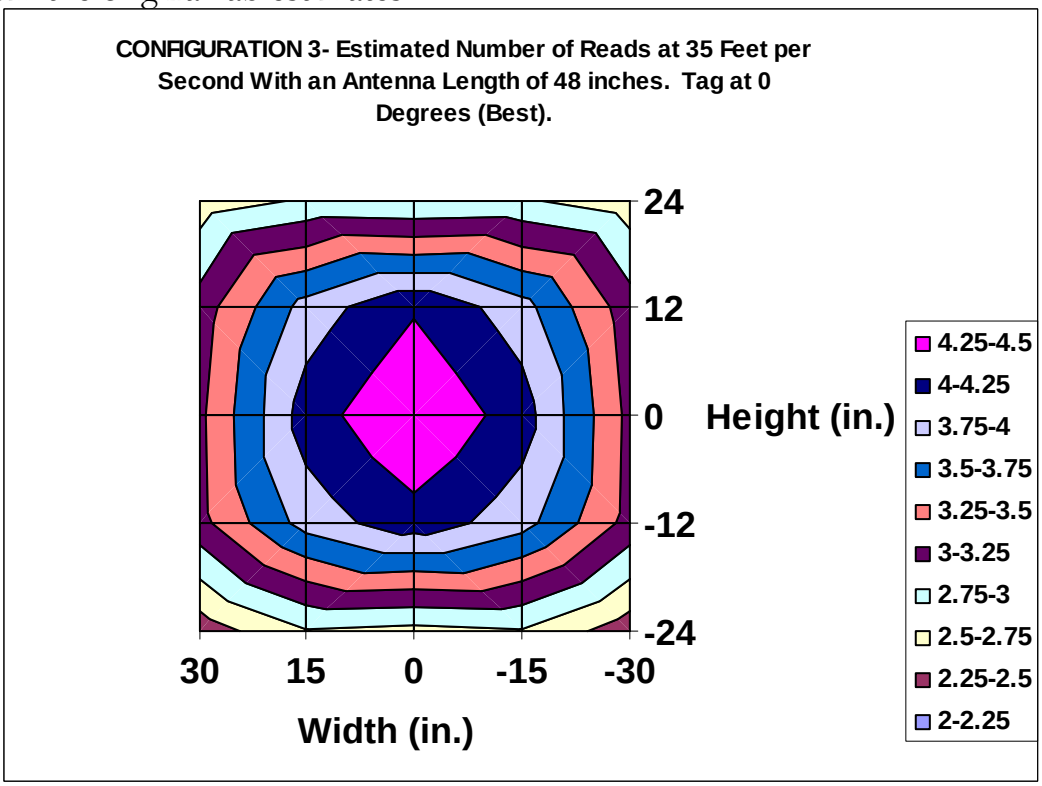
The installation went very smoothly and the crew from the Bureau did a great job. As with any installation of a new system there were issues (grounding, antenna alignment, reader selection), but they were addressed in a timely and professional manner.

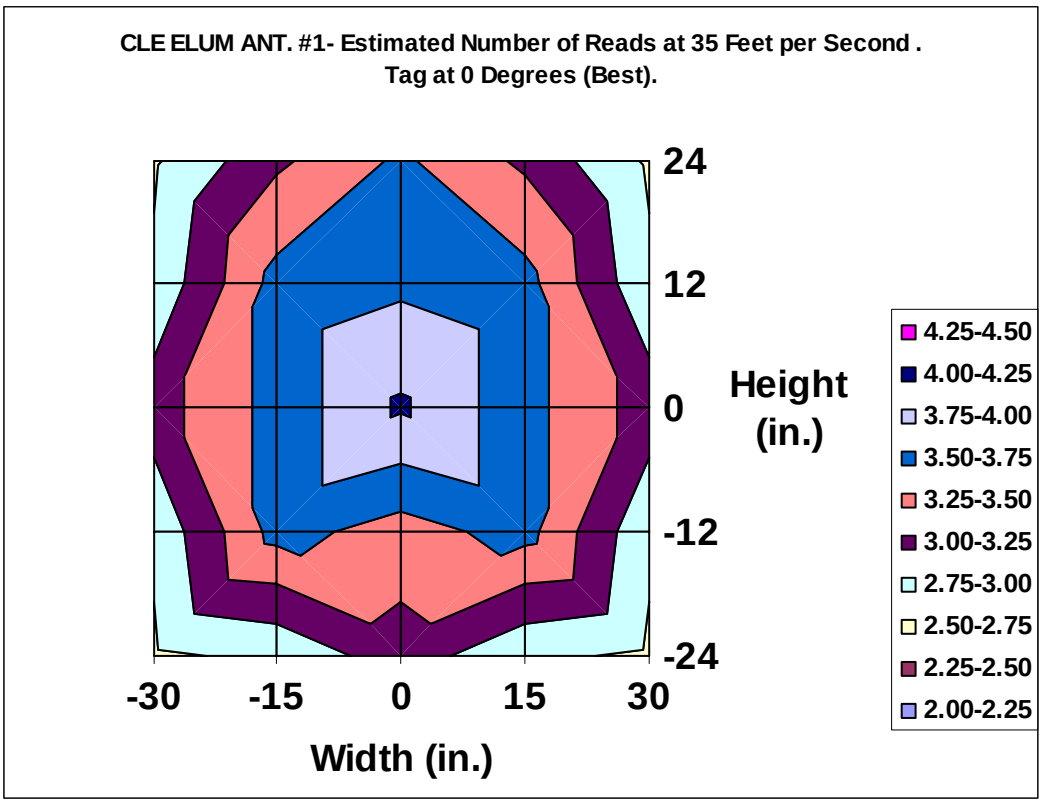
The Bureau of Reclamation decided to use the configuration 3 electronics package based on the performance lab testing at Biomark Inc. (reference the performance data at the top of page 4). In comparing the performance of the systems on-site, it was clear that the Multiplexer with auto-tuning did not offer the speed of detection as the FS1001A with the new analog board designed for large antenna applications. Therefore we installed the FS1001A system at both sites. Biomark did include DC power supplies that will be available for retro-fitting any new reader systems that may come on-line in the future or if it will be necessary to use a DC powered system at future sites were AC is not available. The electronics enclosure is pictured below.

Lance Batchelder (Biomark)

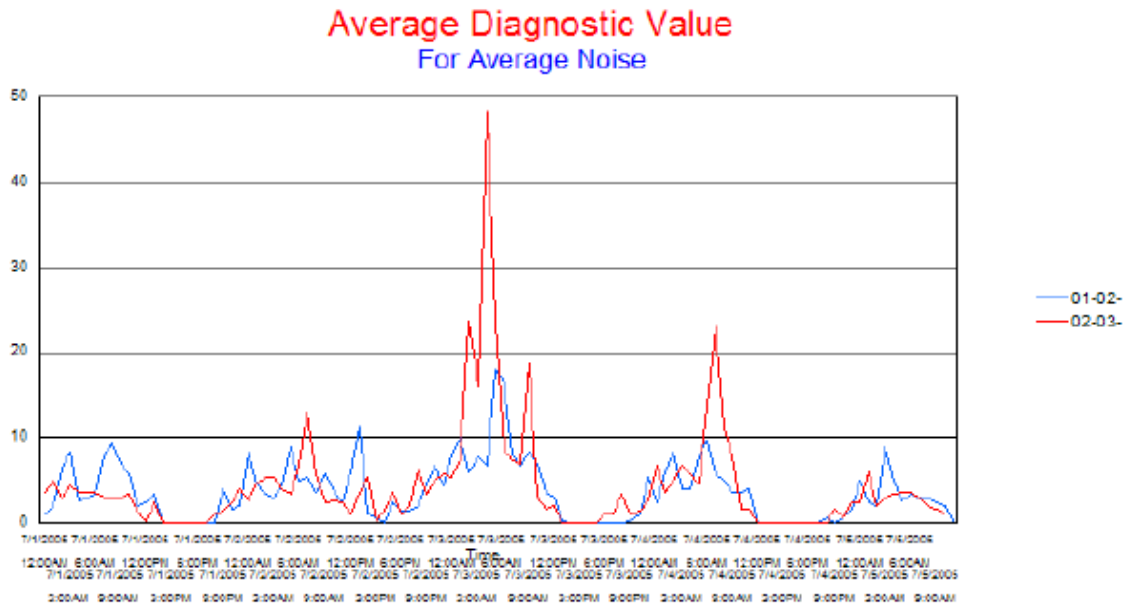
After the installation, the PIT tag systems were checked to determine if the performance in the field was similar to the estimates found in the lab at the Biomark facility in Boise. The field test was not comprised of as many data points as the lab test due to the amount of time that is necessary to take the matrix of data points and therefore does not appear as detailed as the lab data. The field results indicate a trend that the lower edge was slightly better and the center was slightly worse than in the lab. The actual difference is approximately one fourth of a read. Antenna #2 was slightly better with a maximum overall read range of 68 inches, compared to 64 inches for antenna

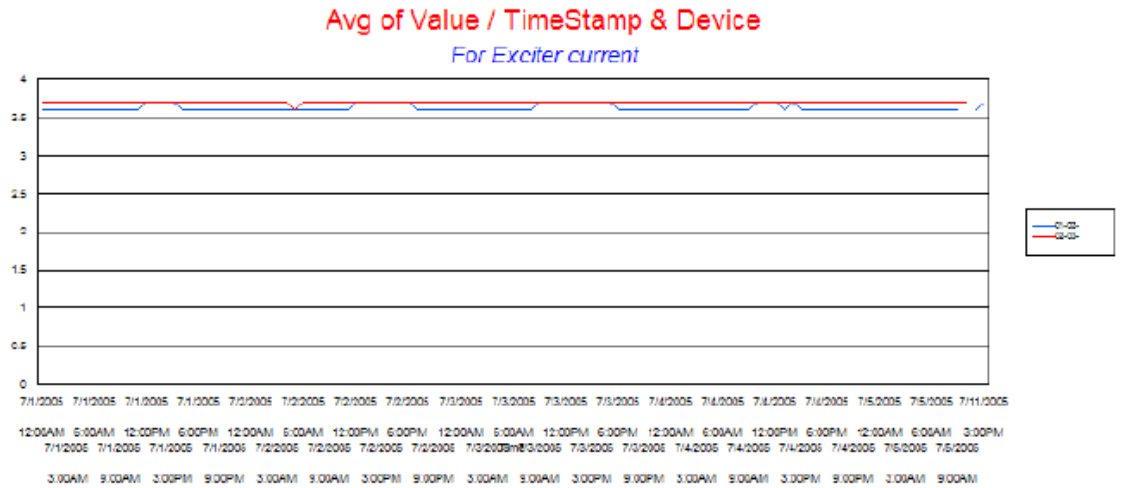
#1. On the following are plots of antenna #1 after the installation, and the plot from the original lab estimates.





One issue that Biomark Inc. will be addressing is the fact that the system we installed is sensitive to temperature variations. In order minimize this effect it is recommended that the system have a sun shield placed over the antenna assembly, implement increased ventilation, or retrofit the readers with new analog boards that are currently being evaluated at Bonneville Dam. Below is the diagnostic data taken from the reader after this year's fish test. A special thanks to John Tenney of Pacific States Marine Fisheries Commission for the software to reduce this data.





The above average noise graph demonstrates the fluctuation of noise as a function of time. In most cases the noise remains below 10% and is usually in the 5% range. With the implementation of one of the previously mentioned

corrective actions the system will be optimized for detection efficiency throughout the operating season.

The tuning of the systems are characterized in the second graph depicting the exciter current variations over time. The changes are .1 Amperes of peak to peak current which is the resolution of the ability of the reader to sense the current. It appears that the tuning is stable over this period of time.

The installation team from the Bureau made recommendations on any future installations regarding the lead-in and lead-out transitions. The consensus was that the rubber flap design would work well for both transitions, but that it should be installed in the field to allow for easier adjustment to the existing structures. This may be something that could be done next year should the team determine it would be a benefit and provide for an easier installation.

The systems were removed from the flume this fall and will be returned to Biomark to evaluate the structures and coatings to determine if there are any improvements or modifications that could be made to the antenna structure to ensure the system's integrity. As these systems are the first of their kind, this evaluation is important even though the performance of the system during the fish testing was good and there are no indications of any near term problems.

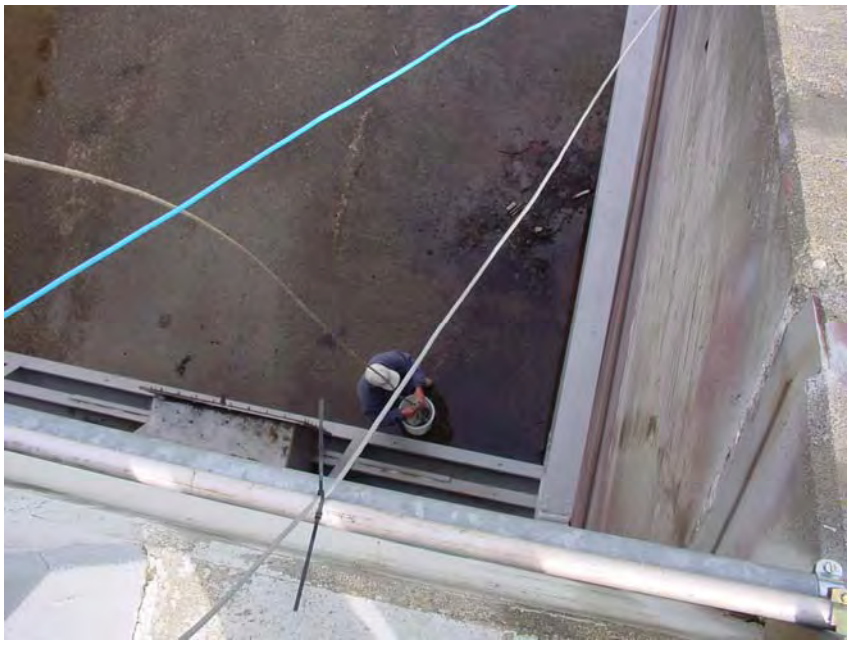
FISH TEST OF THE PIT TAG SYSTEM:

A fish test was conducted at Cle Elum Dam on June 2nd and 3rd to determine the detection efficiency of the PIT tag systems. Members of the Yakama Nation provided the PIT tagged fish and performed the test under the direction of Mark Johnston. Single fish and groups of 5 were released into a funnel that was connected to a 4 inch tube that ran from the deck to the flume. The following are pictures courtesy of Dave Fast of the Yakama Nation of the release site and release apparatus provided by the Bureau of Reclamation.

Mark Johnston placing PIT tagged fish into the release apparatus.

The release apparatus provided by the Bureau of Reclamation for the fish testing

Larger groups of 10, 15, 20, 25, and 61 were released by lowering buckets of pre-scanned fish to the spillway floor and dumping them into the flume.



Fish were scanned to verify the presence of a tag and on day 1 some fish were checked for read range. The tags from the rejected fish were taken by Dean Park (Biomark Inc.) to the PIT tag vendor and used to calibrate their quality control fixture.

Tagged hot dogs were used to test the system prior to the fish tests each day as they provided a means of checking the system performance without using the small number of live tagged fish. Special software was provided by John Tenney of Pacific States marine Fisheries Commission to determine fish travel rates to the millisecond. Steve Anglea from Biomark reduced the travel time and number of reads per fish. Overall system efficiency, reads per fish, and travel time data is included in the following pages.

Biomark personnel tuned the systems early in the morning prior to the fish test on Day 1 and did not modify the system throughout the fish test.

Day 1 consisted of the releases of single, groups of 5, 10, and 15 fish. The water depth was 7 to 7.5 inches at the two detector sites. Day 2 included additional releases of groups of 20, 25, and 61 fish. The water depth was 5 inches on Day 2. The purpose of increasing the size of the release groups was to determine the point at which the system began to significantly decrease in efficiency. With the exception of the group of 25, the efficiencies reduced as the group size increased on the overall system.

Portions of this data were formatted by Dave Fast of the Yakama Nation from a presentation he gave on the project.

Table of Fish Test PIT Tag Efficiencies for Cle Elum Dam

Cle Elum Fish Test- Day 1

Note: Total # of fish may not be a multiple of the number of fish per group as the last bucket of each group was dumped with the fish remaining.

Group	Total # of Fish	Misses Upstream Antenna	Read % Upstream Antenna	Misses Downstream Antenna	Read % on Downstream Antenna	Misses Both Antennas	Combined Read %
Single	437	27	**93.82**	37	**91.53**	5	**98.86**
Groups of 5	167	20	**88.02**	25	**85.03**	6	**96.41**
Groups of 10	179	60	**66.48**	53	**70.39**	19	**89.39**
Groups of 15	129	51	**60.47**	38	**70.54**	14	**89.15**
Overall	**912**	**158**	**82.68**	**153**	**83.22**	**44**	**95.18**

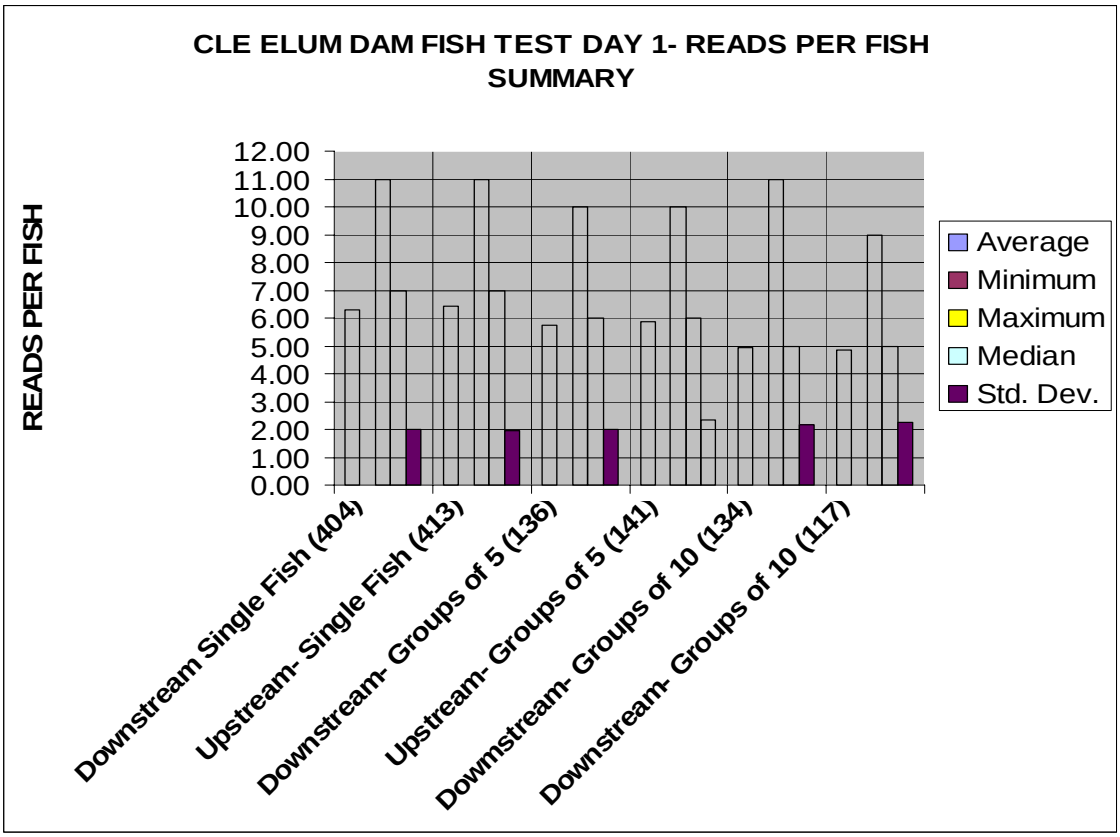
Cle Elum Fish Test- Day 2

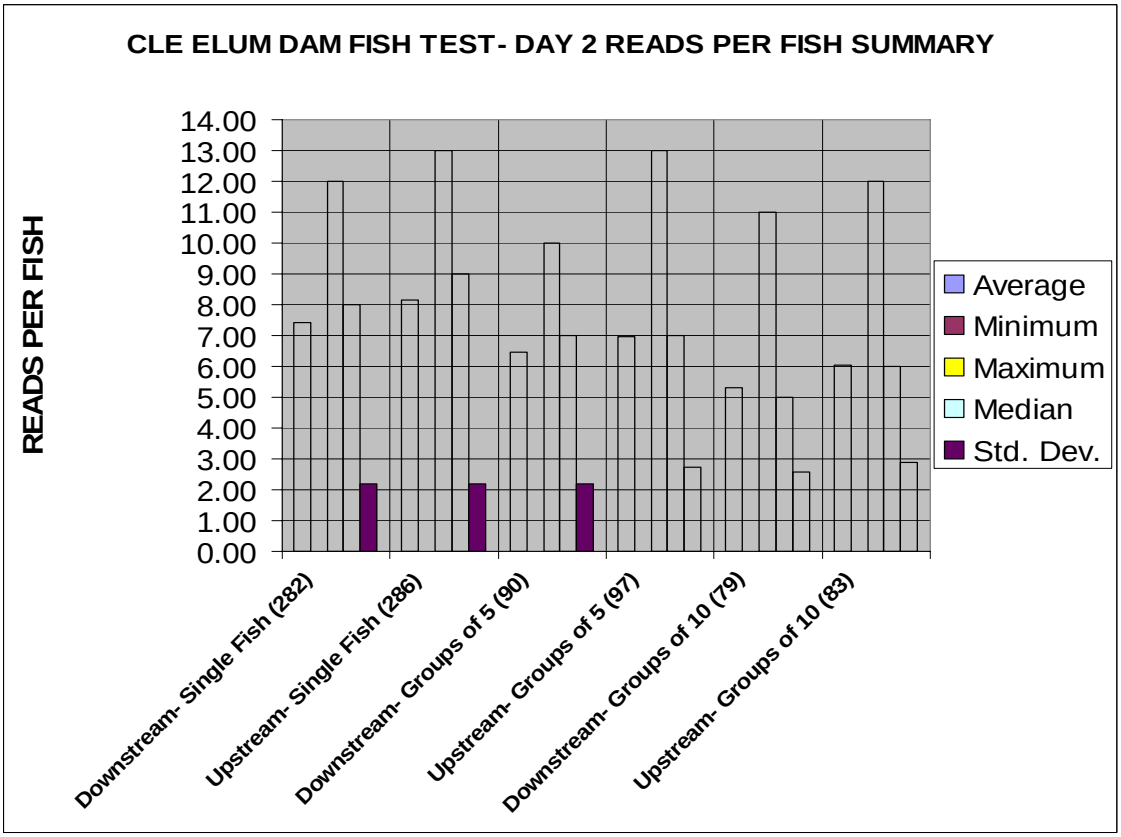
Group	Total # of Fish	Misses Upstream Antenna	Read % Upstream Antenna	Misses Downstream Antenna	Read % Downstream Antenna	Misses on Both Antennas	Combined Read %
Single	299	13	**95.65**	16	**94.65**	6	**97.99**
Groups of 5	105	8	**92.38**	15	**85.71**	1	**99.05**
Groups of 10	101	16	**84.16**	21	**79.21**	4	**96.04**
Groups of 15	151	52	**65.56**	42	**72.19**	17	**88.74**
Groups of 20	99	49	**50.51**	49	**50.51**	28	**71.72**
Groups of 25	103	46	**55.34**	45	**56.31**	20	**80.58**
Groups of 61	61	40	**34.43**	41	**32.79**	30	**50.82**
Overall	**919**	**224**	**75.63**	**229**	**75.08**	**106**	**88.47**

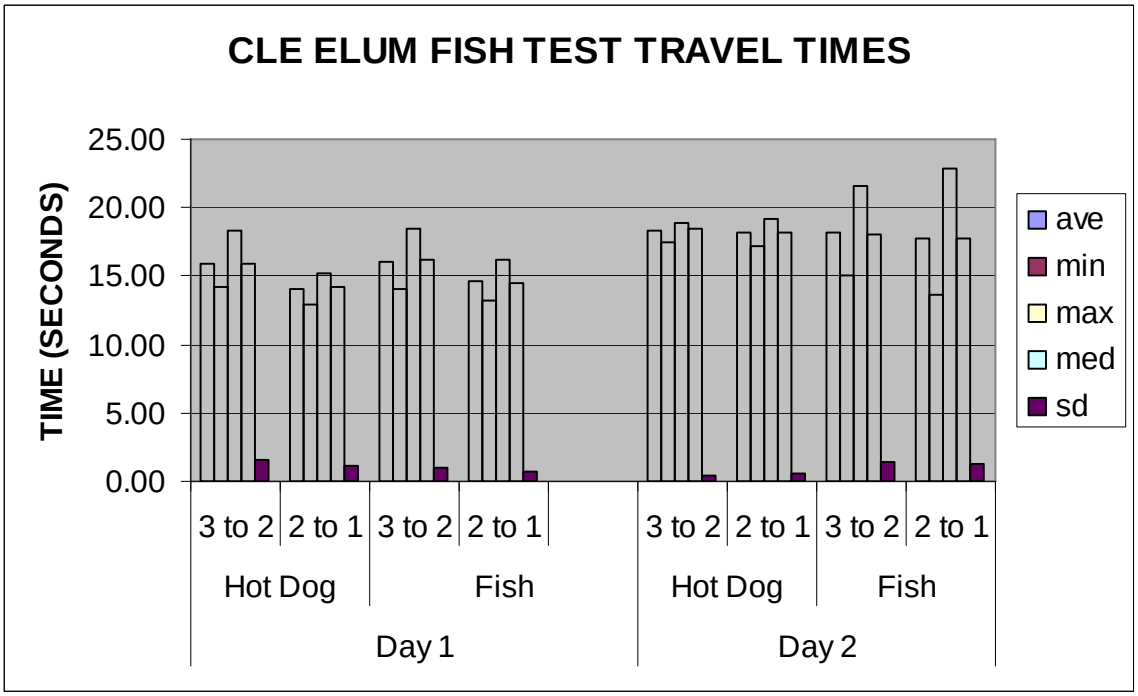
Cle Elum Fish Test- Day 1 and Day 2 Combined

Group	Total # of Fish	Misses Upstream Antenna	Read % Upstream Antenna	Misses on Downstream Antenna	Read % Downstream Antenna	Misses on Both Antennas	Combined Read %
Single	736	40	**94.57**	53	**92.80**	11	**98.51**
Groups of 5	272	28	**89.71**	40	**85.29**	7	**97.43**
Groups of 10	280	76	**72.86**	74	**73.57**	23	**91.79**
Groups of 15	280	103	**63.21**	80	**71.43**	31	**88.93**
Groups of 20	99	49	**50.51**	49	**50.51**	28	**71.72**
Groups of 25	103	46	**55.34**	45	**56.31**	20	**80.58**
Groups of 61	61	40	**34.43**	41	**32.79**	30	**50.82**
Overall	**1831**	**382**	**79.14**	**382**	**79.14**	**150**	**91.81**

Graphs of the Day 1 and Day 2 PIT Tag Reads per Fish







3 is the exit of the release tube
2 is the upstream antenna
1 is the downstream antenna

CONCLUSION

The number of reads per fish that were estimated in the lab testing for water levels in the lower 25% of the antenna ranged from a small zone of 2.25 to 2.5 in the corners to the largest area of 3.25 to 3.5 in the upper area in the middle. These estimates were based on a velocity of 35 feet per second. In analyzing the above results is important to note that the average fish velocities ranged from 18.75 to 21.4 feet per second on Day 1 and were approximately 17 feet per second on Day 2. These numbers were derived by dividing the distance between sites (300 feet) by the average time for a fish to travel between them. These numbers are averages and the instantaneous velocities at each site on Day 1 would be slightly higher than the average.

Since the average fish velocities are slightly higher and lower than 50% of the estimated 35 feet per second the results of the number of reads per fish are approximately two times the lab evaluation. On Day 1 the average was 6.25 to 6.5 reads per fish in the single fish tests. On Day 2 the averages increased to

the 7.5 to 8.25 range due to the decrease in velocities. The times for the hot dog testing tracked very closely to the fish in the velocity graph.

Although the goal of any system is to achieve 100% detection, the performance of the Cle Elum PIT system was very good considering the conditions and may perform better with higher flows. The combined detection was over 97% on single and groups of up to 5 fish released at once. The system selected by the Bureau of Reclamation performed very well and the decision to integrate the reader and antenna into one modular system improves the possibility for consistent performance as well a mobile detection system that will meet the needs for future bypass evaluations.

ACKNOWLEGEMENTS

Biomark Inc. would again like to thank the Bureau of Reclamation, Yakama Nation, and PSMFC for their cooperation in this project. It was a fast track program that required everyone to perform at a high level to achieve the resulting PIT tag system.