



PIT Tag Information System
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PTAGIS O&M Concerns Using FDX Tags In Adult and Juvenile Lamprey Studies

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Executive Summary

Lamprey marked with full duplex (FDX) PIT tags attached themselves to both antennas at the south ladder of Prosser dam in May of 2017 preventing the reading of any other tags for a substantial period. The marked lamprey were discovered and removed after the ladder was dewatered. The PIT Tag Steering Committee (PTSC) banned the use of FDX tagging of lamprey in 2003 to prevent this type of event from occurring and lamprey researchers used an alternative half duplex (HDX) PIT tag technology to avoid interference. Upon formal request from the BPA, the PIT Tag Steering Committee (PTSC) [lifted the ban on using full duplex \(FDX\) PIT tags for lamprey research in 2015](#) to consolidate infrastructure, lower costs and to make use of smaller FDX tags for marking juvenile lamprey.

Significant impact on critical long-term research could occur with the increasing number of studies releasing PIT tagged lamprey near other vulnerable antennas similar to those at the Prosser ladders if FDX tags are used instead of HDX. As a cost savings, antennas installed in adult fishways have lower redundancy than at juvenile interrogation sites. FDX tagged lampreys attaching to or residing near two antennas at a counting window could effectively shut down all detections for an entire interrogation site. Detection efficiency used for modeling and O&M could not be computed if a single antenna out of a pair is compromised.

This issue was discussed at the [2018 Annual PIT Tag Steering Committee Meeting](#) resulting in multiple actions, one of which is this document to identify vulnerable antennas. Another action was to [enable dual mode detection](#) features at adult interrogation sites that support the reading of both FDX and HDX tags with the hope of encouraging the continued use of HDX tags for lamprey research.

The vulnerable antennas identified here are those in adult fishways and operated by PTAGIS; instream antennas and interrogation sites operated by other agencies are outside the scope of this document. Detailed schematics for antenna installations are also outside the scope of this document and as-built drawings can be requested from the U.S. Army Corps of Engineers (USACE).

Background

In 2002, PTAGIS operated the first interrogation site installed in the McNary dam ladders to detect returning adult fish marked with a PIT tag. Since then, additional interrogation sites were installed throughout the region in key adult passage routes at mainstem locations. To date, PTAGIS provides O&M efforts and technology to ensure all of the 29 large scale interrogation sites (targeting both adult and juveniles) operate consistently at greater than 99 percent detection efficiency. This effort involves daily monitoring and regular onsite visits to maintain the detection equipment that provides the majority of 200 million observation events available in the database system. Most of these observation events represent salmonids marked with full duplex (FDX or ISO FDX-B) PIT tag technology.

Also in 2002, the scope of the Columbia Basin PTAGIS program expanded to include entries for resident and semi-anadromous stocks of rainbow and cutthroat trout, bull trout, and lamprey, sturgeon and other species. In 2003, the [PIT Tag Steering Committee](#) (PTSC) requested that lamprey researchers use an alternative half duplex (HDX) PIT tag technology because they were concerned about the long time it takes lampreys to pass through orifices. If lampreys remained in the field a long time, they could prevent FDX-tagged salmonids from being detected in the orifices due to tag collisions.

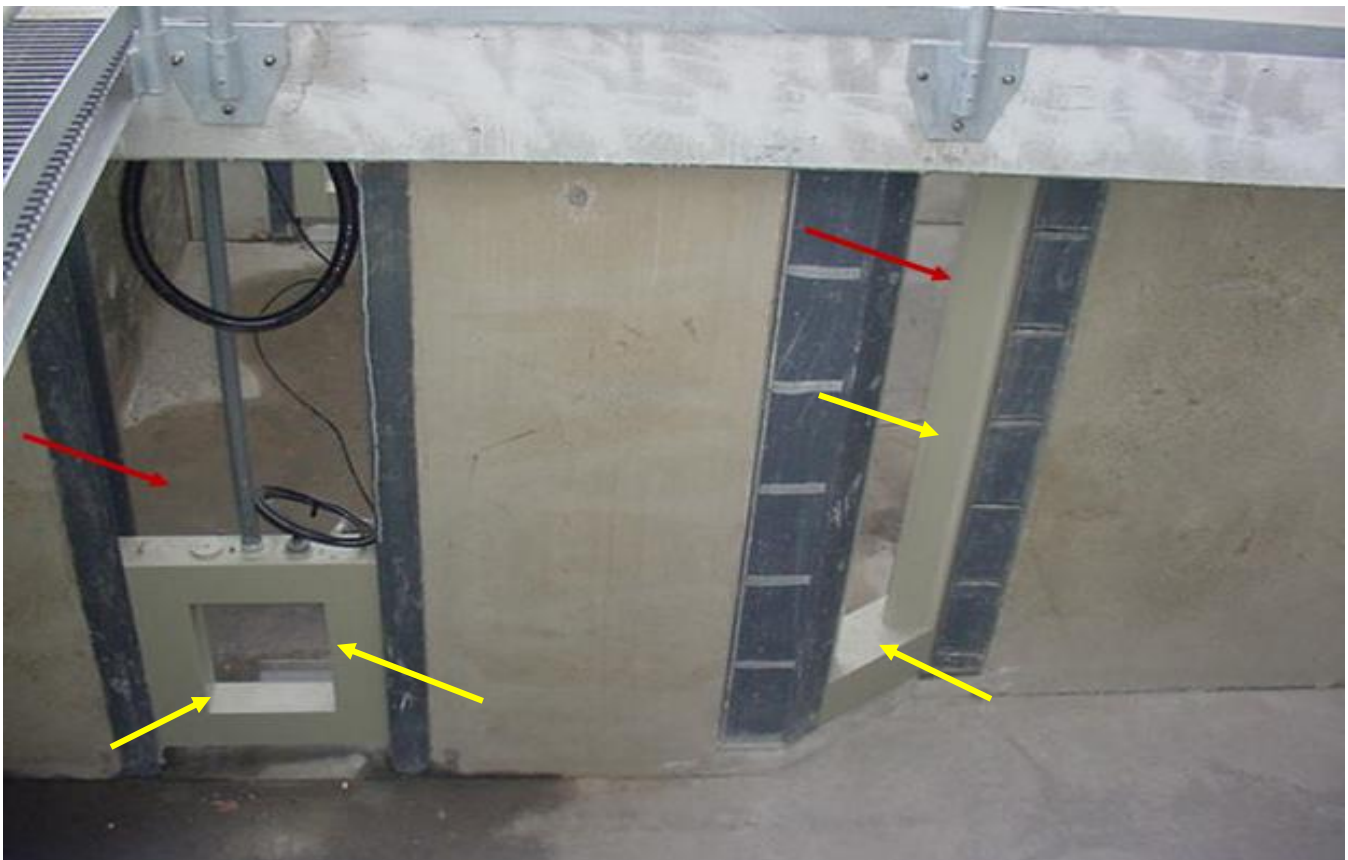
With the introduction of smaller FDX tags, researchers began tagging juvenile lamprey in 2013 for testing new passage structures and to monitor migration patterns. This led researchers and the BPA to request the PTSC re-examine the original ban on the use of FDX tags in adult lamprey research and monitoring. Lifting the ban would remove the need to pay for the upkeep on two, often conflicting, detection systems in the adult ladders and would allow for the detection of adult lamprey on the ever increasing number of FDX instream detection systems operating in the Columbia River Basin. Announced in the [February 2015 PTAGIS newsletter](#), the PTSC removed the FDX ban for lamprey tagging.

In May of 2017, FDX tagged lamprey disrupted detections at the south ladder of Prosser Dam (see the first article in [September 2017 PTAGIS Newsletter](#) for more information).

Overview

The following sections describe the adult ladder interrogation sites with antennas that may be vulnerable to interference from lamprey tagged with full duplex tags.

Lower Granite Dam Adult Fish Ladder (GRA)



Picture 1. Upper Ladder Orifice and Slot antennas

Configuration:

- 8 antennas located in the upper section of the ladder, 4 Slot and 4 orifice style.
- 8 antennas located in the lower section of the ladder, 4 slot and 4 overflow style.

- 2 antennas located at the exit of the ladder, pass-thru style.

Reference:

- Red arrows show placement of FDX antennas.
- Yellow arrows are examples of potential lamprey attachment locations.
- As picture indicates, antennas are smooth on all sides ideal for lamprey attachment anywhere within the activation field.

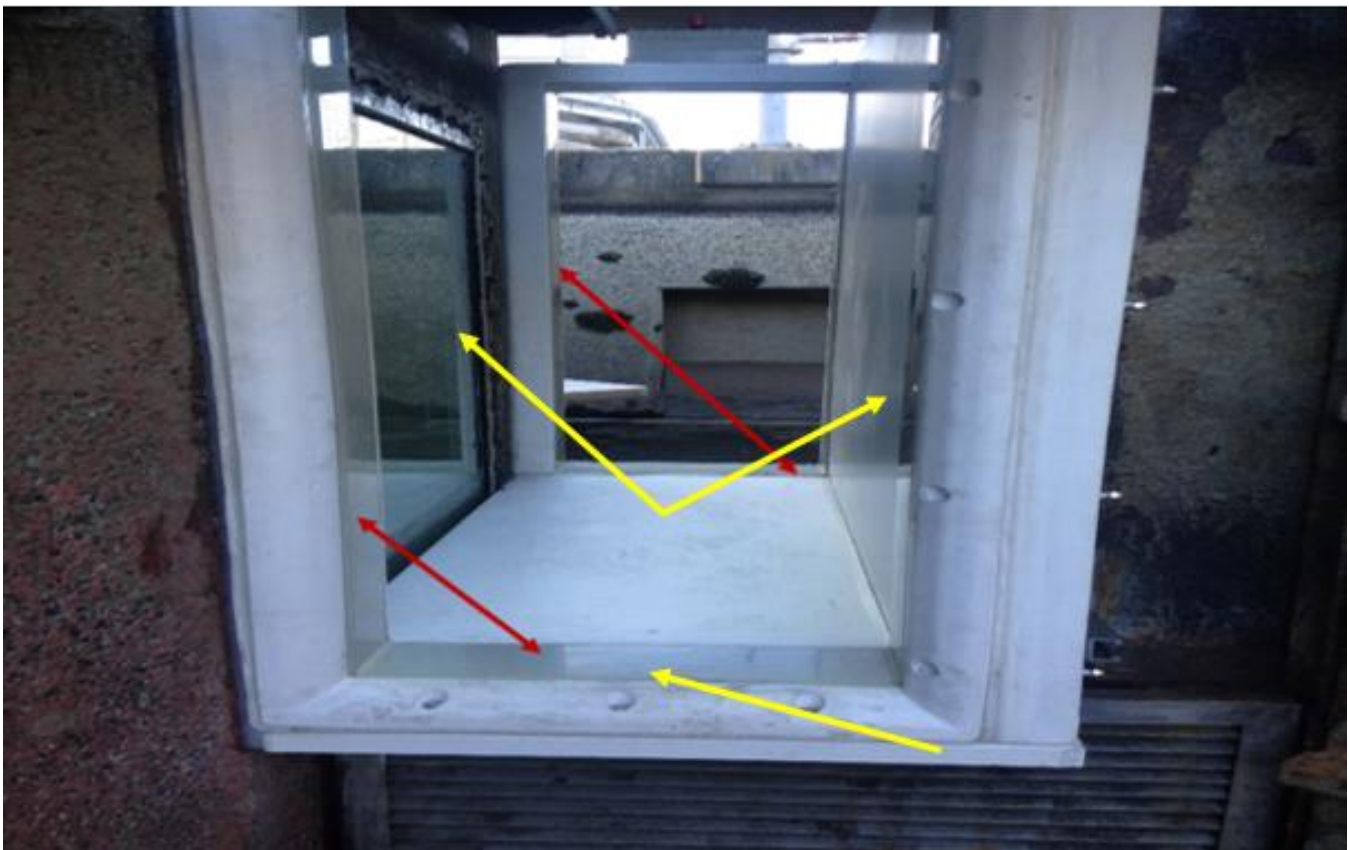
Construction:

- All antennas within the Granite ladder are fitted with guides in the each weir wall that hold the antennas in place.

Potential Impacts:

- The Lower Granite PIT tag system is the last major detection point on the Snake River and is considered to be one of the most important to the research community.
- Any disruption or degradation of PIT tag detection efficiencies within the Granite ladder could have an impact on current and on-going studies being conducted.
- FDX PIT tagged lamprey could have an adverse effect on directionality studies and detection efficiencies of adult salmonids.

Little Goose Dam Counting Window (GOA)



Picture 2. GOA Counting Window antennas

Configuration:

- Two antennas, pass-thru style, located within the confines of the counting window passage.

Reference:

- Red arrows show placement of FDX antennas.
- Yellow arrows are examples of potential lamprey attachment locations.
- Antennas are smooth on all sides ideal for lamprey attachment anywhere within the activation field.

Construction:

- Co-Polymer housing throughout entire Counting Window (CW) passage designed specifically for the FDX antennas. Entire CW assembly mounted to existing concrete and metal frame work.

Passage Characteristics:

- Slow moving water with smooth surfaces within the detection field.
- Ideal for lamprey attachment anywhere within the CW passage.

Potential Impacts:

- The two antennas are the **ONLY** opportunity to detect adult salmonids passing Little Goose Dam.
- Areas behind the picketed leads where lamprey could attach and rest within the detection field.
- FDX tagged lamprey found to be jamming the detection field would likely require the entire ladder to be de-watered in order to locate and remove the lamprey from detection field.
- Overall detection efficiencies of adult salmonids would potentially be lost or significantly reduced due to FDX tagged lamprey in the area.
- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.

Lower Monumental Counting Windows (LMA)



Picture 3. LMA north Counting Window antenna

Configuration:

North Counting Window Location:

- 2 antennas, pass-thru style, located within the confines of the counting window passage.

South Counting Window Location:

- 2 antennas, pass-thru style, located within the confines of the counting window passage.

Reference:

- Red arrows show placement of FDX antennas.
- Yellow arrows are examples of potential lamprey attachment locations.
- Antennas are smooth on all sides ideal for Lamprey attachment anywhere within the activation field.

Construction (north and south locations):

- Metal frame mounted system, Co-Polymer antennas are custom built and designed around the existing metal frame and picketed leads.

Passage Characteristics:

- Slow moving water.
- Smooth surfaces within antenna detection field, ideal for lamprey attachment.
- Areas behind the picketed leads where lamprey could attach and rest within the detection field.

Potential Impacts (north and south locations):

- The North and South CW detection locations are the ONLY opportunity to detect adult salmonids passing Lower Monumental Dam.
- FDX tagged lamprey found to be jamming the detection field would likely require the entire ladder to be de-watered in order to locate and remove the lamprey from detection field.
- Overall detection efficiencies of adult salmonids would potentially be lost or significantly reduced due to FDX tagged lamprey in the area.
- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.

Ice Harbor Dam Adult Fish Ladder (ICH)



Picture 4. Typical Orifice and Slot antenna

Configuration:

- 8 antennas located in the upper section of the North ladder, 4 Slot and 4 orifice style.
- 8 antennas located in the upper section of the South ladder, 4 slot and 4 overflow style.

Construction:

- All antennas within the Ice Harbor ladder are either embedded in, or bolted onto the concrete of the ladder.
- In some instances, the ladder has been retro-fitted to receive a specific antenna geometry.

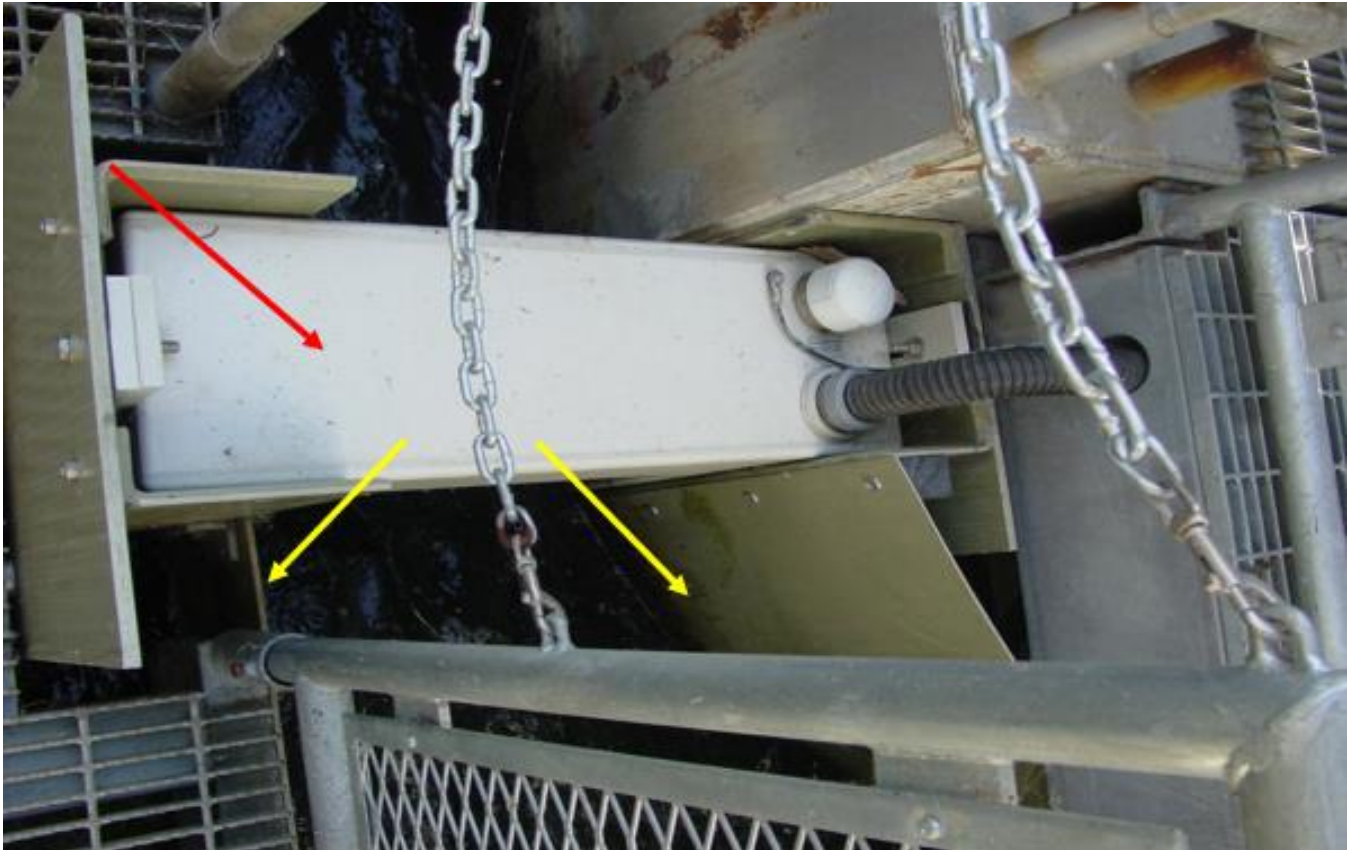
Reference:

- Red arrows show placement of FDX antennas.
- Yellow arrows are examples of potential lamprey attachment locations.
- As picture indicates, antennas are smooth on all sides ideal for lamprey attachment anywhere within the activation field.

Potential Impacts:

- The North and South CW detection locations are the ONLY opportunity to detect adult salmonids passing Ice Harbor Dam.
- FDX tagged lamprey found to be jamming the detection field would likely require the entire ladder to be de-watered in order to locate and remove the lamprey from detection field.
- Overall detection efficiencies of adult salmonids would potentially be lost or significantly reduced due to FDX tagged lamprey in the area.
- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.

McNary Dam South Counting Window (MC1)



Picture 5. MC1 PIT tag detection array configuration.

Configuration:

- Two antennas, pass-thru style, located within the confines of the counting window passage.

Construction:

- Metal frame mounted system, antennas are custom built and designed around the existing metal frame and picketed leads.

Reference:

- Red arrows show placement of FDX antenna.
- Yellow arrows are examples of potential lamprey attachment locations.
- As picture indicates, antennas are smooth on all sides ideal for lamprey attachment.

Passage Characteristics:

- Slow moving water.
- Smooth surfaces within antenna detection field, ideal for lamprey attachment.
- Areas behind the picketed leads where lamprey could and become entrained.

Potential Impacts:

- The two MC1 CW antennas are the last opportunity to detect adult salmonids passing over the Oregon side fish ladder.
- FDX tagged lamprey found to be jamming the detection field would likely require the entire ladder to be de-watered in order to locate and remove the lamprey from detection field.

- Overall detection efficiencies of adult salmonids potentially lost or significantly reduced due to FDX tagged lamprey in the area.
- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.

McNary Dam South Counting Window (MC1)

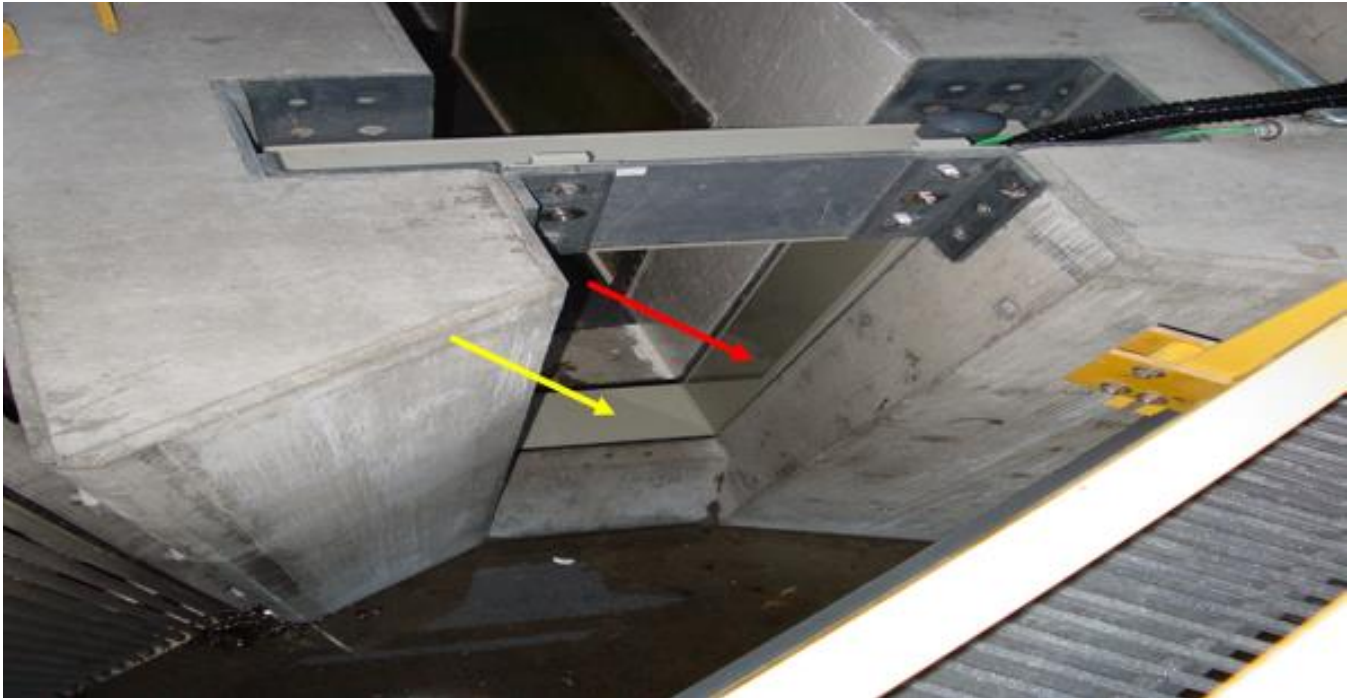


Picture 5a. MC1 Spacer section where lamprey have become entrained.

Reference:

- Red arrows show placement of FDX antenna.
- Yellow arrow show location in spacer where FDX PIT tags could potentially be trapped and degrade detection efficiencies.

McNary Dam North Counting Window (MC2)



Picture 6. MC2 PIT tag detection array.

Configuration:

- Three antennas, pass-thru style, located within the confines of the counting window passage.

Construction:

- Custom formed concrete throughout the entire counting window area.

Reference:

- Red arrows show placement of FDX antenna.
- Yellow arrows are examples of potential lamprey attachment locations.
- As picture indicates, antennas are smooth on all sides ideal for lamprey attachment.

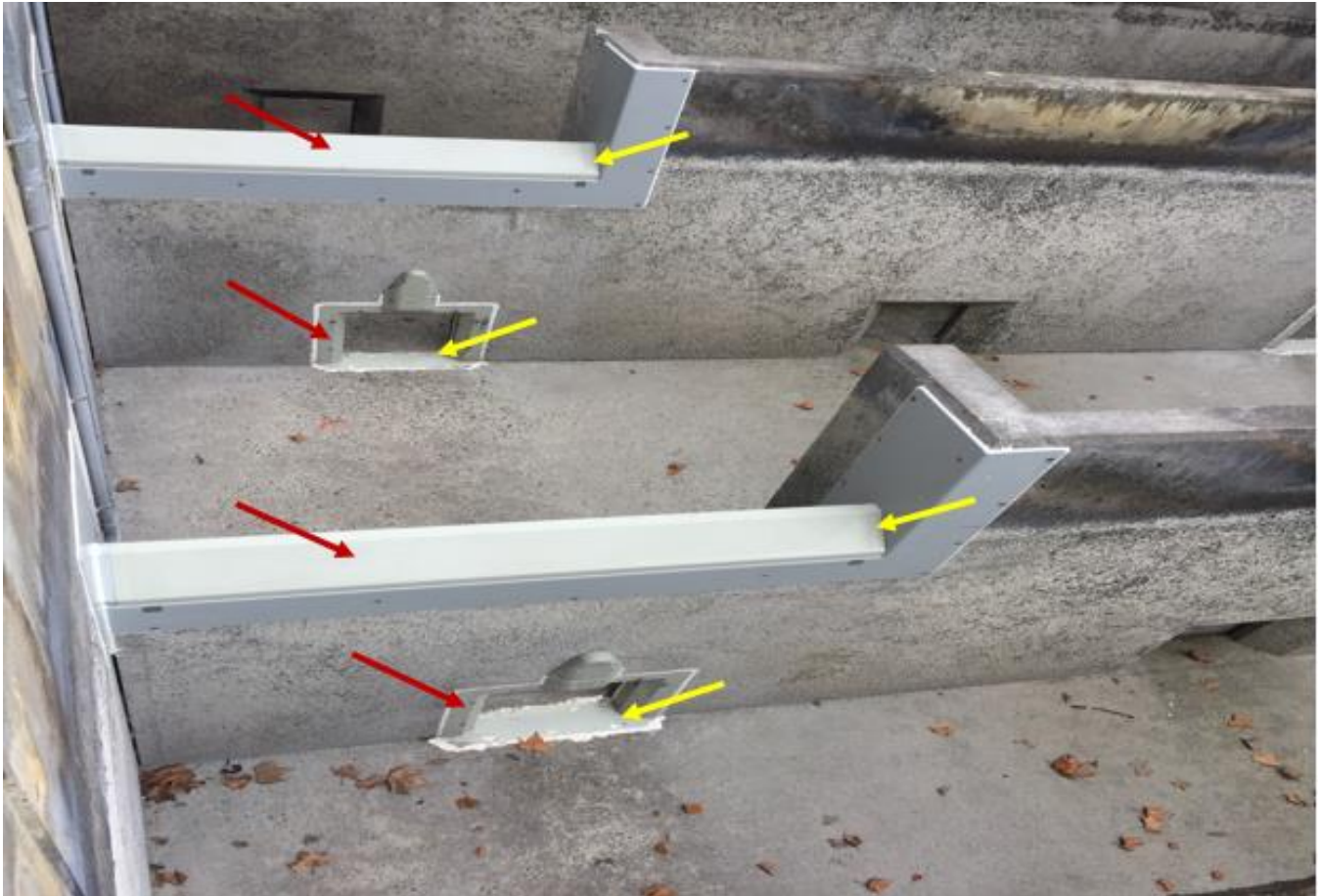
Passage Characteristics:

- Slow moving water.
- Smooth surfaces within antenna detection field, ideal for lamprey attachment.

Potential Impacts:

- The three MC2 CW antennas are the last opportunity to detect adult salmonids passing over the Washington side fish ladder.
- FDX tagged lamprey found to be jamming the detection field would likely require the entire ladder to be de-watered in order to locate and remove the lamprey from detection field.
- Overall detection efficiencies of adult salmonids potentially lost or significantly reduced due to FDX tagged lamprey in the area.
- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.

John Day Dam Adult Fish Ladders (JO1 and JO2):



Picture 7. Typical JO1 and JO2 Weir and Overflow Antennas

Configuration:

JDA North Ladder (JO2)

- 8 antennas, 4 slot and 4 overflow style located in the middle section of the ladder just downstream of the counting window.

JDA South Ladder (JO1)

- 8 antennas, 4 slot and 4 overflow style located in the middle section of the ladder just downstream of the counting window,

Construction:

- All antennas within the JDA North and South ladders are either embedded in or bolted onto the concrete of the ladder.
- In some instances, the ladder has been retro-fitted to receive a specific antenna geometry.

Reference:

- Red arrows show placement of FDX antennas.
- Yellow arrows are examples of potential lamprey attachment locations.
- As picture indicates, antennas are smooth on all sides ideal for lamprey attachment.

Passage Characteristics:

- Slow but turbulent moving water.

- Smooth surfaces within antenna detection field, ideal for lamprey attachment.

Potential Impacts:

- The JDA North and South PIT tag system is the last major detection point on the Columbia River to implement PIT tag detection. Detection on these two ladders closes a gap in detections on the Columbia River system and very important to the PIT tag researchers.
- Any disruption or degradation of PIT tag detection efficiencies within the JDA North or South ladders could have an impact on current and on-going studies being conducted.
- Overall detection efficiencies of adult salmonids would potentially be lost or significantly reduced due to FDX tagged lamprey in the area.
- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.

The Dalles Dam North (TD2) East Counting Window (TD1)



Picture 8. Typical TD1 and TD2 Counting Window antenna

TD1 Configuration:

- 2 antennas, pass-thru style, located within the confines of the counting window passage

TD1 Construction:

- Metal frame mounted system, Co-Polymer antennas are custom built and designed around the existing metal frame and picketed leads

TD2 Configuration:

- 2 antennas, pass-thru style, located within the confines of the counting window passage

TD2 Construction:

- Metal frame mounted system, Co-Polymer antennas are custom built and designed around the existing metal frame and picketed leads

Reference:

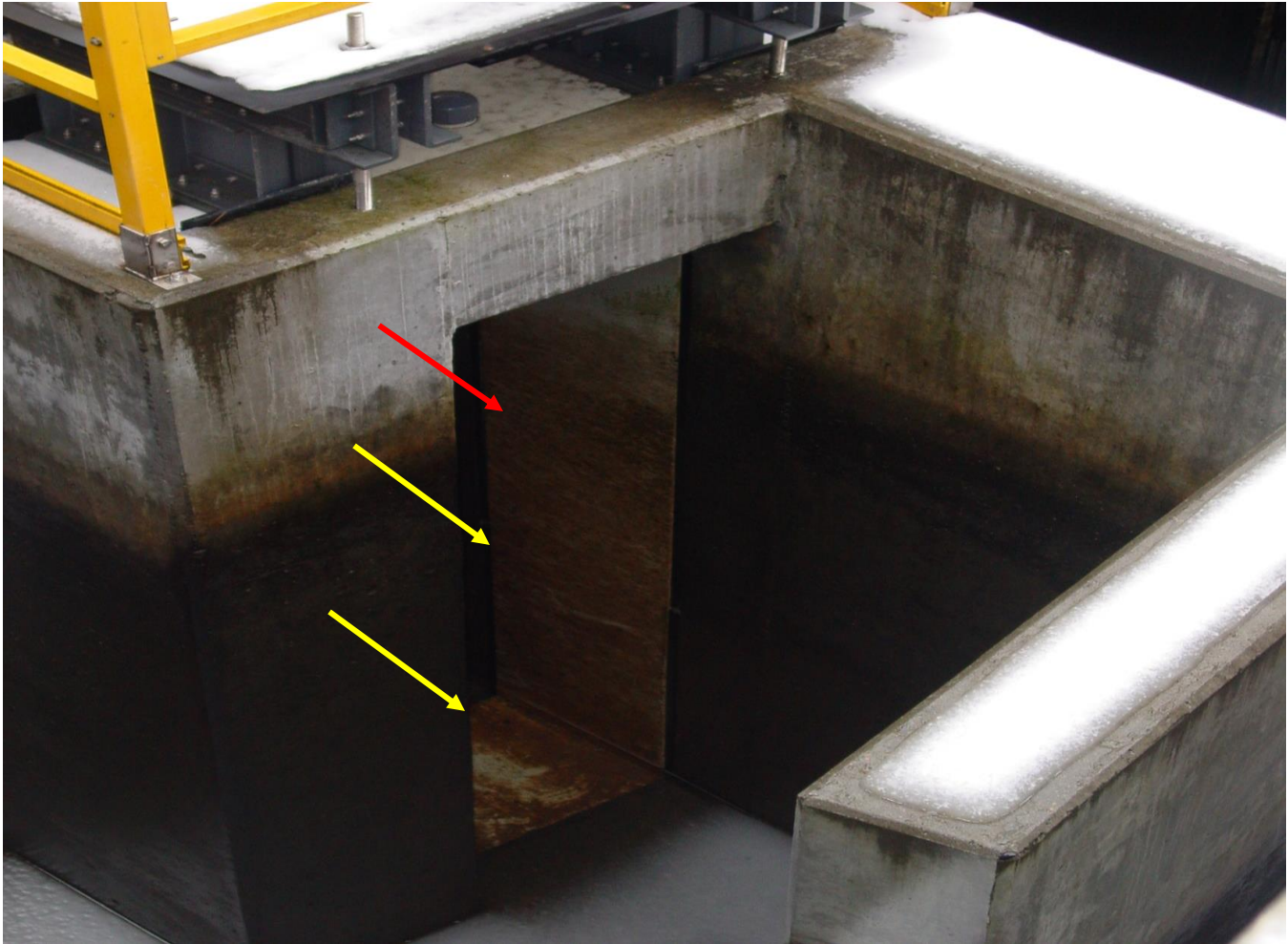
- RED arrows show placement of FDX antennas.
- Yellow arrows are examples of potential lamprey attachment locations.
- As picture indicates, antennas are smooth on all sides ideal for Lamprey attachment.

Passage Characteristics (TD1 and TD2):

- Slow moving water
- Smooth surfaces within antenna detection field, ideal for lamprey attachment
- Areas behind the picketed leads where lamprey could and become entrained

Potential Impacts (TD1 and TD2):

- The two counting window locations are the ONLY opportunity to detect adult salmonids transiting The Dalles dam
- FDX tagged lamprey found to be jamming the detection field would likely require the entire ladder to be de-watered in order to locate and remove the lamprey from detection field
- Overall detection efficiencies of adult salmonids potentially lost or significantly reduced due to FDX tagged lamprey in the area
- Directionality information of adult salmonids potentially lost or significantly reduced
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted



Picture 9. Typical BO1 and BO4 Slot antenna

Configuration:

- 4 Slot style antennas located in the upper ladder section near exit
- Typical for Bradford Is. and WA. Shore ladder.

Construction:

- All 4 slot antennas within the BO1 ladder are either embedded in, or bolted onto the concrete of the ladder.

Reference:

- Red arrows show placement of FDX antennas.
- Yellow arrows are examples of potential lamprey attachment locations.
- As picture indicates, antennas are smooth on all sides ideal for Lamprey attachment.

Passage Characteristics (BO1 and BO4):

- Slow but turbulent moving water.
- Smooth surfaces within antenna detection field, ideal for lamprey attachment

Potential Impacts:

- Overall detection efficiencies of adult salmonids would potentially be lost or significantly reduced due to FDX tagged lamprey in the area.
- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.
- Any disruption or degradation of PIT tag detection efficiencies within the BO1 or BO2 ladder could have an impact on current and on-going studies being conducted.
- FDX PIT tagged lamprey could have an adverse effect on directionality studies of adult salmonids.

Lyle Falls Adult channel (LFF)



Picture 10. Typical LFF Orifice antenna

Configuration:

- 3 Slot style antennas located in the adult fish way bypass channel.

Construction:

- All 3 slot antennas within the bypass channel are embedded in the concrete of the ladder.
- The adult fish way was built to accommodate these antennas.

Reference:

- Red arrows show placement of FDX antennas.
- Yellow arrows are examples of potential lamprey attachment locations.
- As picture indicates, antennas are smooth on all sides ideal for Lamprey attachment.

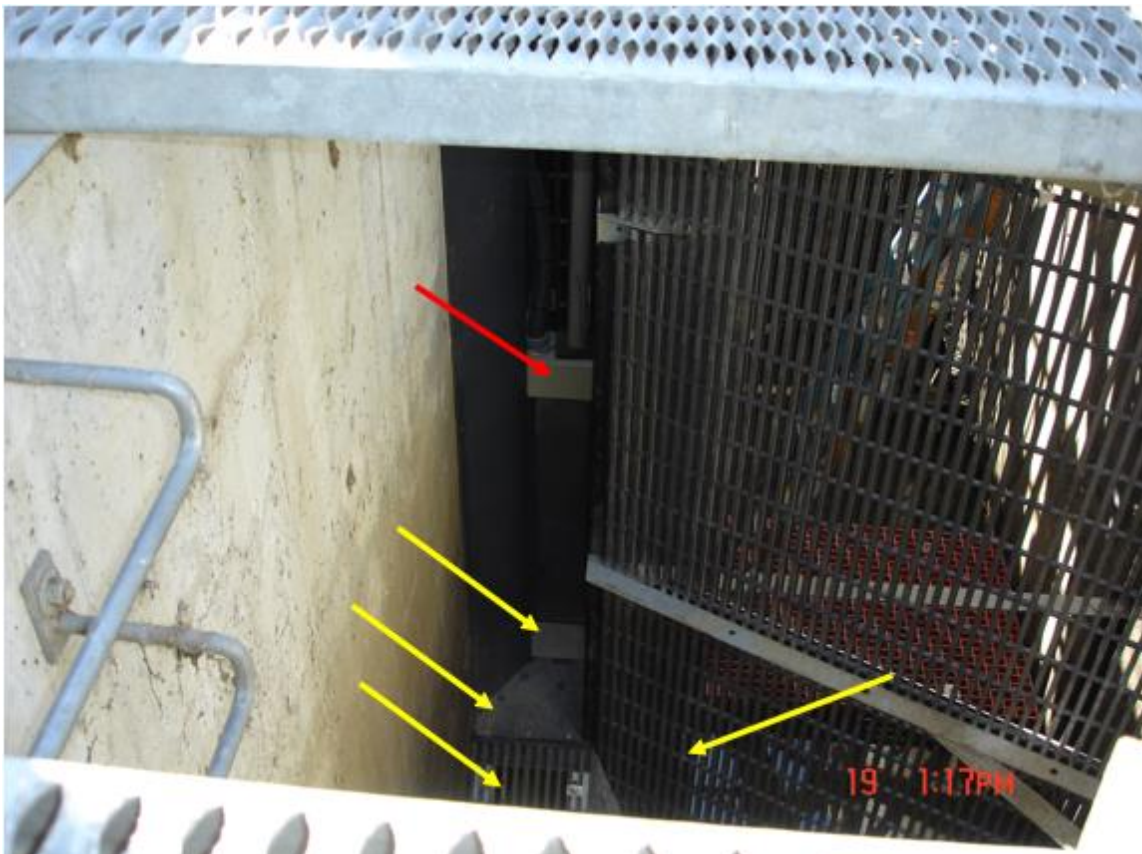
Passage Characteristics:

- Slow moving water.
- Smooth surfaces within antenna detection field, ideal for lamprey attachment.

Potential Impacts:

- The Lyle Falls PIT tag system is the first major detection point on the Klickitat River.
- Any disruption or degradation of PIT tag detection efficiencies could have an impact on current and on-going studies being conducted.
- Overall detection efficiencies of adult salmonids would potentially be lost or significantly reduced due to FDX tagged lamprey in the area.
- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.
- FDX PIT tagged lamprey could have an adverse effect on directionality studies of adult salmonids.

Prosser Chandler Dam (PRO)



Picture 11. Typical PRO Counting Window antenna

Configuration:

- 3 counting window locations within Chandler Dam, Left, Center and Right counting windows.
- 2 pass-thru style antennas per counting window.

Construction:

Fiberglass materials through out with a mix of existing steel reinforcement.

Reference:

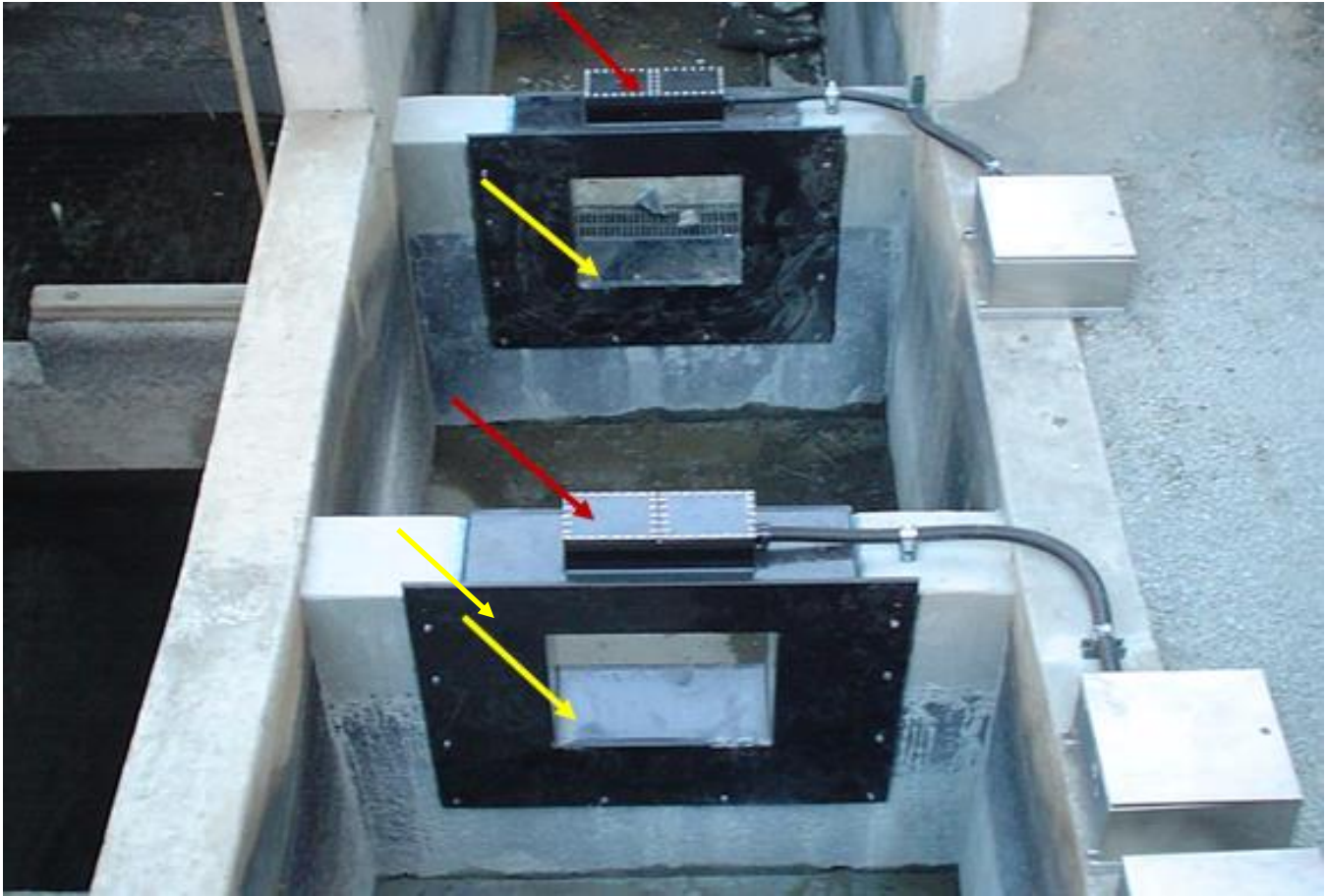
- Red arrows show placement of FDX antennas.
- Yellow arrows are examples of potential lamprey attachment and entrainment locations.
- As picture indicates, antennas are smooth on all sides ideal for lamprey attachment.

Passage Characteristics:

- Slow but turbulent moving water.
- Smooth surfaces within antenna detection field, ideal for lamprey attachment
- Areas behind the picketed leads where lamprey could attach and rest within the detection field.

Potential Impacts:

- Any disruption or degradation of PIT tag detection efficiencies within the 3 counting windows could have an impact on current and on-going studies being conducted.
- **FDX tagged lamprey found to be jamming the detection field would likely require the entire ladder to be de-watered in order to locate and remove the lamprey from detection field. This situation has happened in the past. This event was extensively documented by PTAGIS. [PIT tag Interrogation Site: Prosser \(PRO\) Chandler Dam, Prosser WA.](#)**
- Overall detection efficiencies of adult salmonids would potentially be lost or significantly reduced due to FDX tagged lamprey in the area.
- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.



Picture 12. Typical ROZ Orifice antenna

Configuration:

- 3 pass-thru style antennas located in 3 weir walls.

Construction:

- Concrete surroundings retro-fitted for the antenna geometry.

Reference:

- Black arrows show placement of FDX antennas.
- As picture indicates, antennas are smooth on all sides ideal for lamprey attachment.

Passage Characteristics:

- Slow but turbulent moving water.

Potential Impacts:

- Any disruption or degradation of PIT tag detection efficiencies within the 3 ladder antennas could have an impact on current and on-going studies being conducted.
- FDX tagged lamprey found to be jamming the detection field would likely require the entire ladder to be de-watered in order to locate and remove the lamprey from detection field.
- Overall detection efficiencies of adult salmonids would potentially be lost or significantly reduced due to FDX tagged lamprey in the area.

- Directionality information of adult salmonids potentially lost or significantly reduced.
- Regional studies that rely on accurate and high detection rates at this site could be negatively impacted.

Summary

Lamprey tagged with FDX tags that latch themselves to areas within the RF activation field create what is known as “*Tag Collision*”. Tag Collisions occur when two tags of the same type (i.e., FDX tags) are in or near the RF activation field. Tags that are fully energized will cancel out other tags eliminating further detections. A tag near or just within the activation field will create interference that degrades the ability to detect other tags, (i.e., lower the hits per tag.) Either situation degrades the efficiency of the entire PIT tag array. Tag readers such as the Biomark Inc. FS-2020 and IS-1001 , incorporate a “Dual Mode “ function which allows the reader to detect FDX and HDX tags simultaneously based on a switched timing and delay sequence between the two tag types.

Through extensive lab testing *Ref. [FS2020 Dual Mode Performance Evaluation 9 January 2014. V.0.1](#)* and recent in-situ testing at The Dalles Dam, TD1, TD2 counting window locations, it was determined that operating the Biomark FS-2020 readers in Dual Mode has no negative effect on salmonid FDX detections while detecting HDX tags. Based on these conclusions, and no objections from the PIT tag Steering Committee (PTSC), Dual Mode detection has been enabled at the following detection locations; McNary Dam, MC1 and MC2 counting windows, The Dalles Dam, TD1 and TD2 counting windows , Bonneville Dam, BO1 and BO4 Slot antennas only, Roza Dam Ladder antennas, and Prosser (Chandler)Dam Left, Center and Right counting windows.

Conclusion

The introduction of Pacific Lamprey tagged with FDX tags, either as adults or juveniles, will inevitably have a negative impact on detection rates of FDX tagged salmonids within adult fish passage routes. To what degree is unknown. As previously documented, incidences of FDX tagged Lamprey shutting down detection points, e.g. Chandler Dam, 2017, Roza Dam, 2015, have occurred, and in some instances , required disruption in fish passage operations to remove the tag from the detection field. The Pacific States Marine Fisheries Commission - PTAGIS Field Operations, does not have regulatory authority to mandate the use of certain tag types in a given species.

For the technical reasons mentioned in this document and to avoid compromising the contiguous salmon data set spanning over 16 years, The Pacific States Marine Fisheries Commission - PTAGIS Field Operations, strongly recommends the use of HDX tags in adult lamprey, therefore avoiding the use of FDX tags.