



Pacific Lamprey Passage Evaluations at Hatchery Facilities in Southwest Washington State

Summary Graphic Report: 2022



Joe Skalicky
U.S. Fish and Wildlife Service
Columbia River Fish and Wildlife Conservation Office
Vancouver, WA 98683

On the cover:

Skamania Hatchery Barrier Dam (picture credit – Joe Skalicky).

Disclaimers:

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

The mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use by the federal government.

The correct citation for this report is:

Skalicky, J. J. (2022). Pacific Lamprey Passage Evaluations at Hatchery Facilities in Southwest Washington State. Summary Graphic Report: 2022. U.S. Fish & Wildlife Service, Columbia River Fish & Wildlife Conservation Office, Vancouver, Washington (USA). 60 pp.

Pacific Lamprey Passage Evaluations at Hatchery Facilities in Southwest Washington State.

Summary Report: 2022

Work funded by

Bonneville Power Administration through the
Pacific Lamprey Conservation Initiative.

and authored by

Joe Skalicky

U.S. Fish and Wildlife Service
Columbia River Fish & Wildlife Conservation Office

1211 SE Cardinal Court, Suite 100
Vancouver, WA 98683

January 2022

Page left intentionally blank

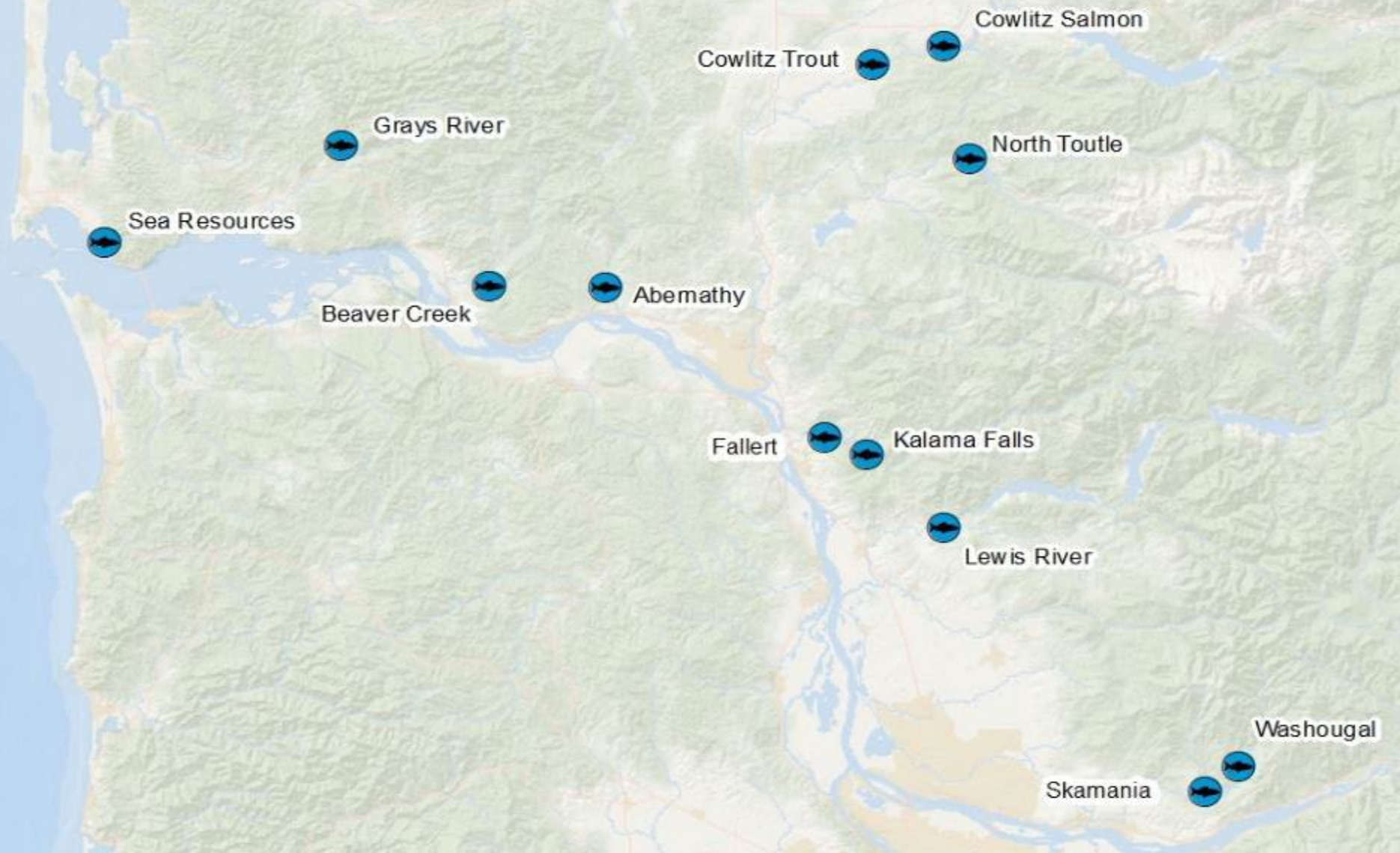
Pacific Lamprey Passage Evaluations at Hatchery Facilities in Southwest Washington State

Joe Skalicky, US Fish and Wildlife Service, Columbia River Fish and Wildlife Conservation Office, January 2022

- Broad goals were to: 1) assess hatchery fishways, barrier dams, and related passage structures that may significantly delay or preclude passage of adult Pacific Lamprey in the Lower Columbia River Basin, 2) provide practical recommendations on how to accommodate beneficial retrofits of existing structures for persons designing, operating, managing and maintaining these structures, 3) recommend additional studies to further refine and identify passage concerns.
- Throughout the Lower Columbia River Basin in SW Washington, there are approximately 15 fish hatcheries on Columbia River tributaries downstream of Bonneville Dam. Many hatcheries use barrier dams and fishways to convey adult salmon into the hatchery proper and to pond up water for gravity-fed water delivery systems. These structures could be significant barriers to adult Pacific Lamprey returning to spawn upstream. The degree to which these hatcheries limit or delay lamprey passage has not been evaluated. Previous evaluations at other hatcheries usually identified significant passage issues for Pacific Lamprey.
- USFWS staff: (1) conducted systematic fishway inspections of fishways and barrier dams at hatcheries using Pacific Lamprey-specific passage guidelines. The hatcheries assessed included Beaver Creek Hatchery, Abernathy Fish Technology Center, Fallert Creek Hatchery, Kalama Falls Hatchery, Skamania Hatchery, Washougal Hatchery, Sea Resources Hatchery, North Toutle Hatchery, Grays River Hatchery Cowlitz Trout and Cowlitz Salmon hatcheries and the Lewis River Hatchery, (2) as required, will conduct on-site presentations of findings with relevant management staff and partners, (3) produce a summary graphic report that includes issues identified, passage solutions, and recommendations for future evaluations.
- This study did not explicitly evaluate entrainment of larval lamprey into hatchery facilities.

The passage guidelines used in the evaluation to evaluate Pacific Lamprey passage are based on: Lamprey Technical Workgroup. 2022. Practical guidelines for incorporating adult Pacific lamprey passage at fishways, Version 2.0. White Paper. 50 pp + Appendixes. Available online: <https://www.pacificlamprey.org/ltwg/>

Hatcheries Evaluated in the Study

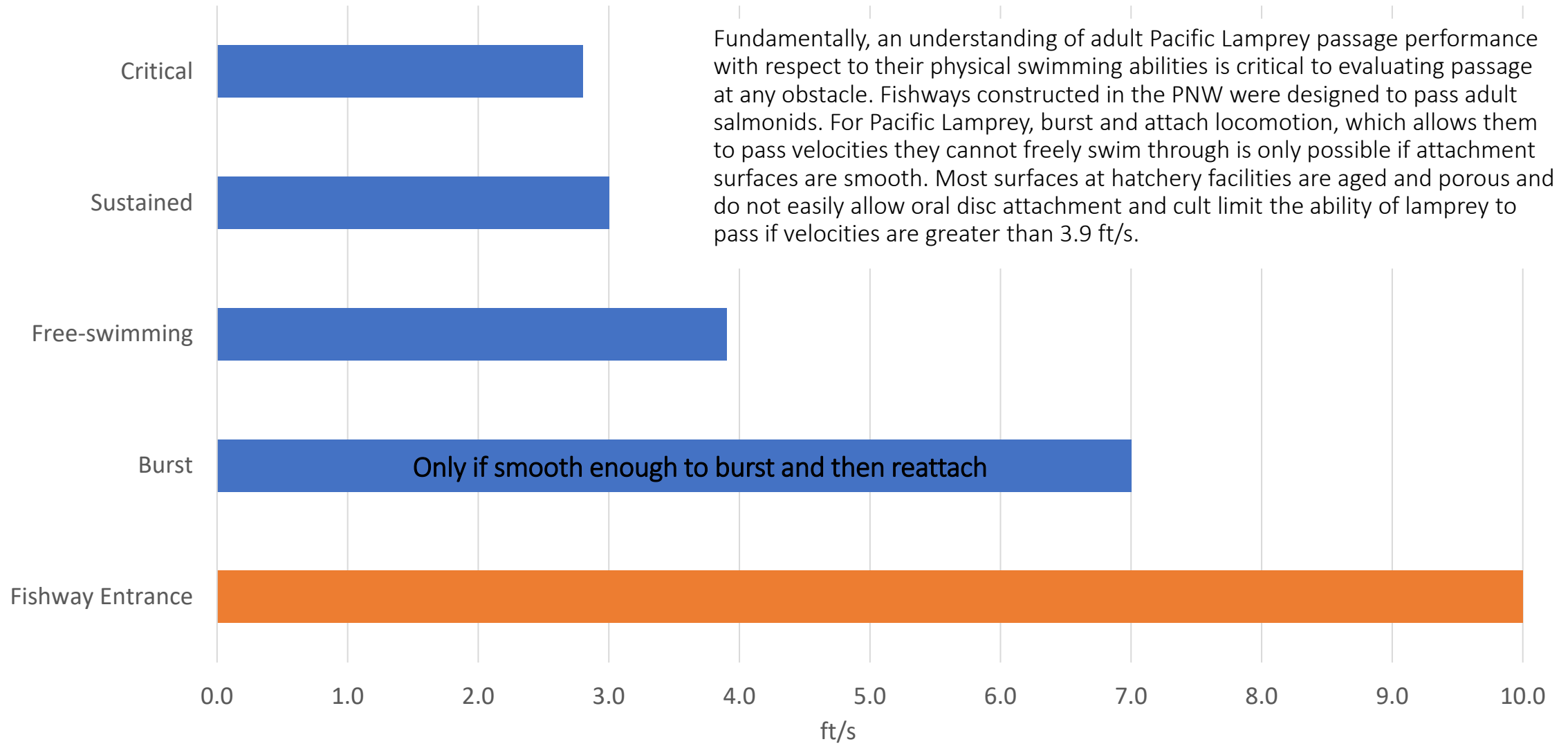


0 12.5 25 50 6 Kilometers

SW Washington Hatchery Metadata

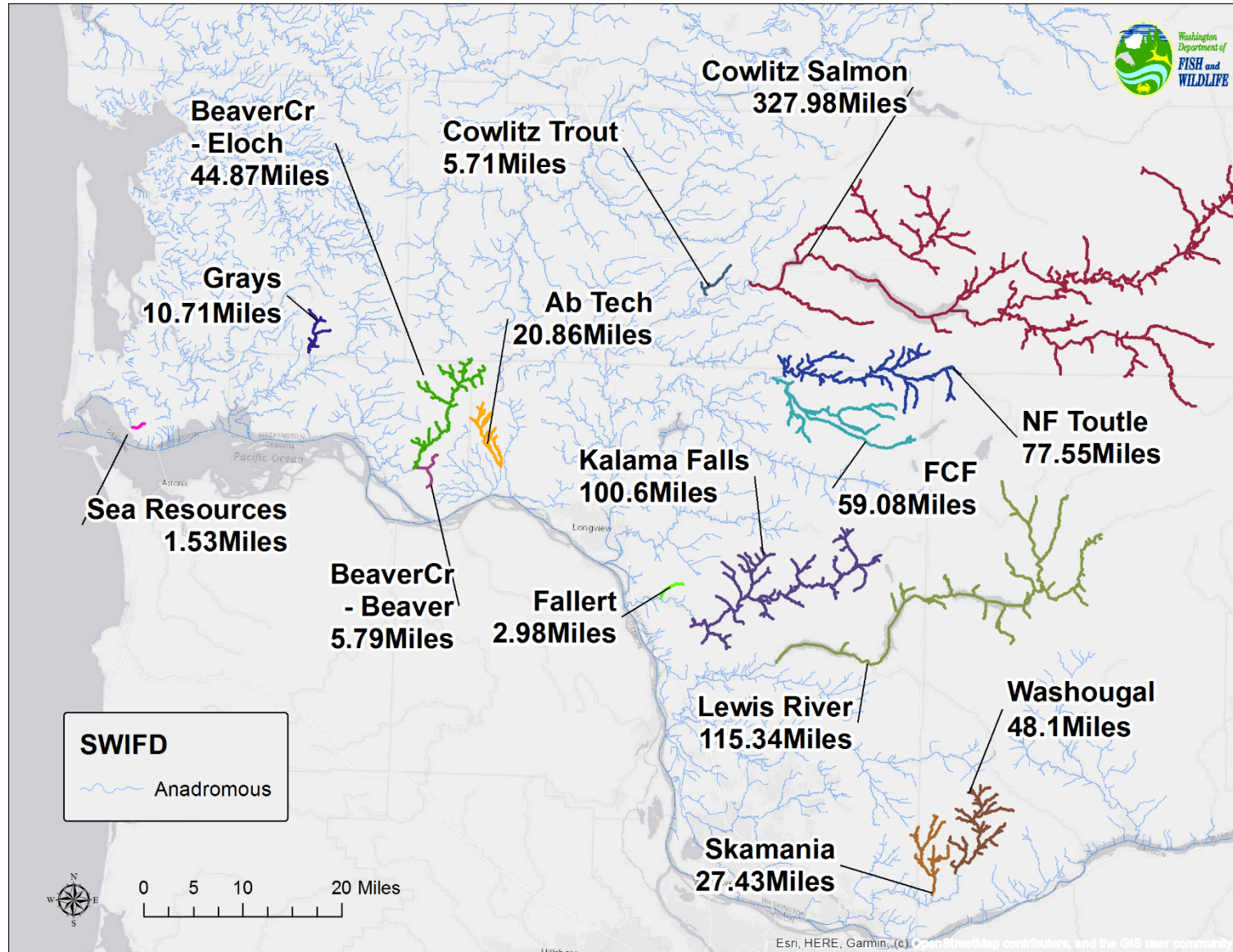
Hatchery Name	Elevation	Stream Name	Initial Year of Operation	Survey Date
Sea Resources Hatchery	20	Chinook River	1893	8/15/2020
Cowlitz Trout Hatchery	157	Blue Creek	1967	8/13/2020
Washougal Hatchery	120	Washougal River	1958	6/26/2021
Skamania Hatchery	110	West Fork Washougal River	1956	6/18/2020
Cowlitz Salmon Hatchery	250	Cowlitz River	1968	8/13/2020
Lewis River Hatchery	70	Lewis River	1932	8/13/2020
Abernathy FTC	175	Abernathy Creek	1960	8/6/2020
Beaver Creek Hatchery	30	Beaver Creek/Elochoman	1957	7/9/2020
Grays River Hatchery	80	West Fork Grays River	1961	7/9/2020
North Toutle Hatchery	860	Green River	1952	7/13/2020
North Toutle Hatchery FCF	850	North Fork Toutle River	1989	7/13/2020
Fallert Creek Hatchery	54	Fallert Creek	1895	7/12/2019
Kalama Falls Hatchery	100	Kalama River	1959	7/12/2019

Adult Pacific Lamprey Swimming Abilities*



* These swimming performance data are based on larger bodied lamprey migrating up the Columbia River. Coastal Pacific lampreys, those spawning below Bonneville Dam may have reduced swimming performance

Miles of anadromous fish habitat above each hatchery



*The mileages were calculated from the latest version of WDFW's Statewide Integrated Fish Distribution (SWIFD) database for the longest linear extent of any anadromous species documented in the SWIFD database. This includes all distribution types (Documented, Presumed, Potential, Artificial, Transported, etc.) It should be noted that lamprey can ascend some barriers that salmonids can not, and the distances could be greater than given.

Sea Resources – Chinook Hatchery

An aerial photograph showing a dense forested area. In the upper left, a road runs horizontally. Below the road, a small cluster of buildings with brown roofs is visible. A dashed white arrow points from a grey box labeled 'Hatchery' to these buildings. To the right of the hatchery, a blue arrow points to a narrow, winding stream labeled 'Chinook River'. Further to the right, a dashed white arrow points from a grey box labeled 'Weir and intake diversion' to a small structure in the stream.

Hatchery

Chinook River

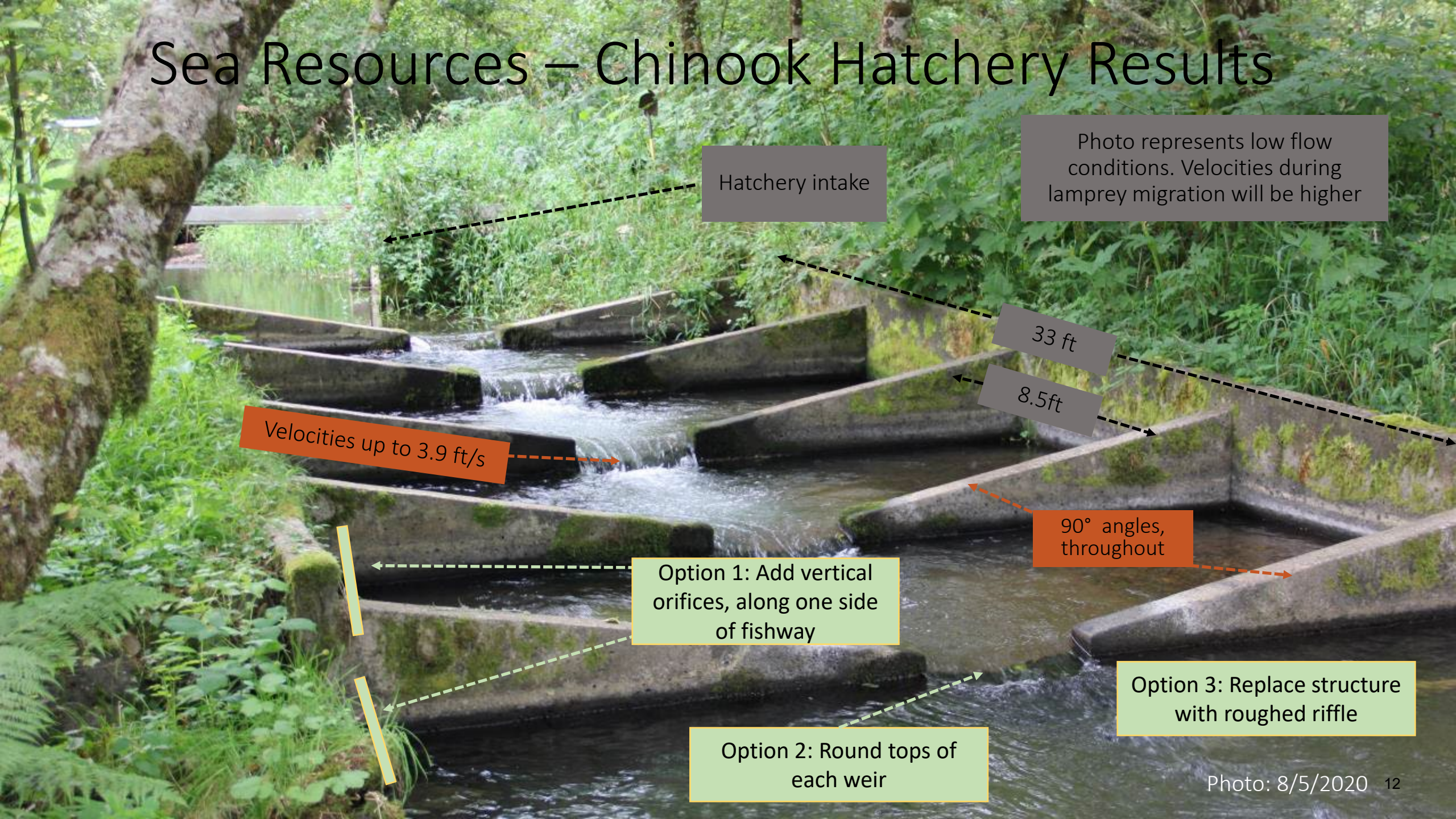
Weir and intake
diversion

Sea Resources – Chinook Hatchery



Photo: 8/5/2020¹¹

Sea Resources – Chinook Hatchery Results



Hatchery intake

Photo represents low flow conditions. Velocities during lamprey migration will be higher

33 ft

8.5 ft

Velocities up to 3.9 ft/s

Option 1: Add vertical orifices, along one side of fishway

90° angles, throughout

Option 2: Round tops of each weir

Option 3: Replace structure with roughed riffle

Sea Resources Hatchery Results:

- No dams or passage-related structures are located at the hatchery, proper
 - Seasonal weir is/was used to convey salmon into hatchery
 - When used, weir pickets are spaced 1.5" apart, enabling adult passage
- Diversion and intake are located ~2,000 ft upstream of hatchery
- V-notched weirs are used to pond up water for the hatchery water intake
- Passage could be an issue at most flows (90° angles and velocities up to 3.9 ft/s)
 - Velocities (8/5/2020) ranged from 1.2 – 3.9 ft/s, with heavy moss on weirs
- Recommend re-assessing at spring flows, during active migration
- Recommend option 1), adding lamprey specific orifices adjacent to weir walls
- Recommend option 2) replace with roughed riffle. Will enable passage of all native fishes
- Larval Pacific and Lampetra species observed above hatchery
- Increased predation risk due to delay below weirs
- Hatchery staff have not observed larval or adult lampreys in or around hatchery

Grays River Hatchery - WDFW

Grays River

Grays River Hatchery

Grays River Hatchery – WDFW – Upstream Diversion & Intake



Photo: 7/09/2020



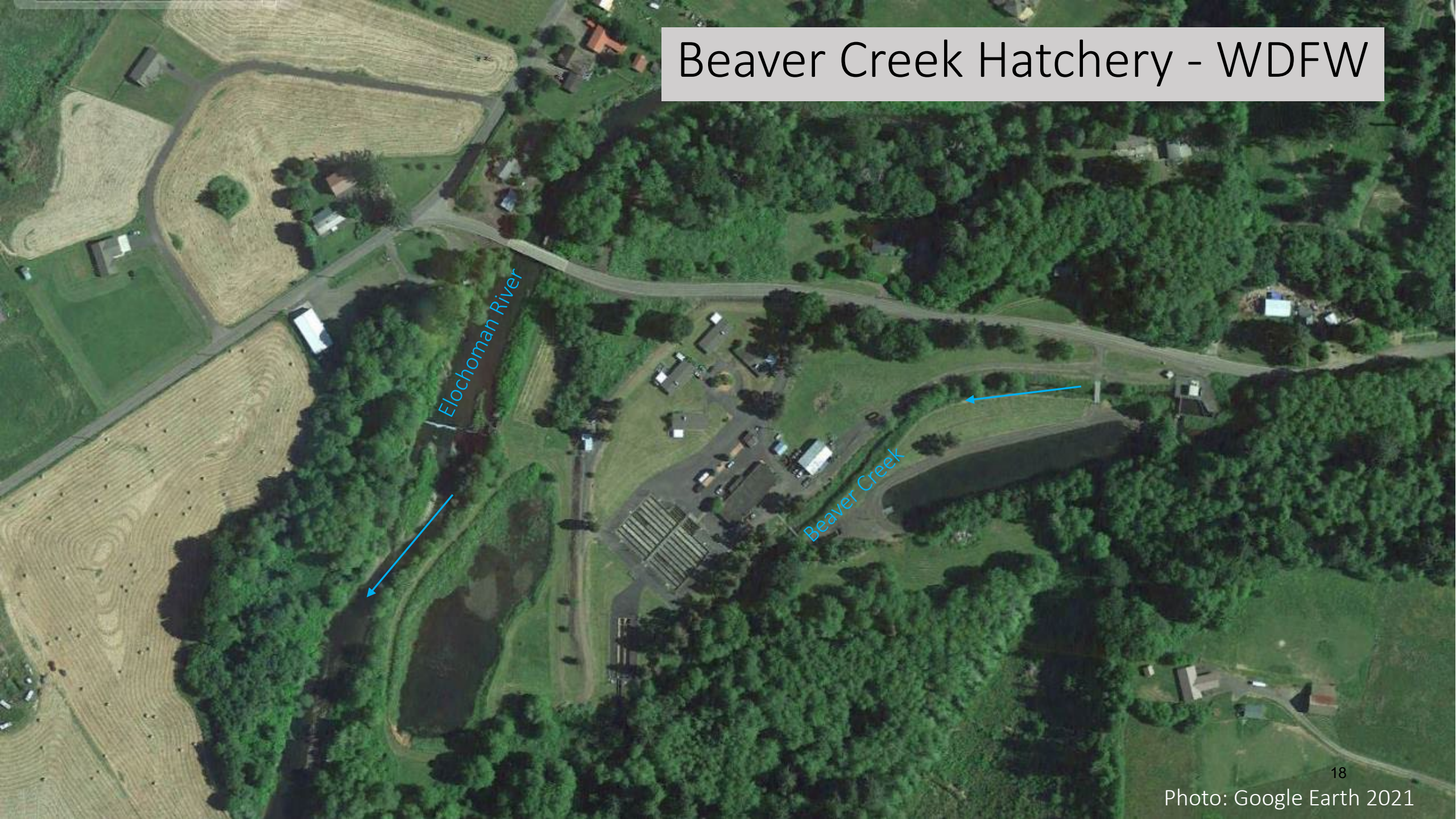
Hatchery is 0.6 miles
downstream

This section of Grays
River downstream of
diversion is
dewatered during low
flows

Grays River Hatchery Results:

- No barrier dam is associated with the fish ladder at the hatchery proper
- Hatchery is currently shut down and scheduled for decommissioning
- Upstream diversion and partial diversion dam are out of compliance
 - River between the diversion and hatchery is dewatered in some low-flow years
 - Diversion channel is dewatered seasonally.
 - Larval Pacific lamprey were observed in the abatement pond
- Cowlitz Tribe is seeking funding (Jan 2022) to remove the diversion structure
 - No recommendations suggested, pending removal

Beaver Creek Hatchery - WDFW



Elochoman River fishway, barrier dam, and pumped intake

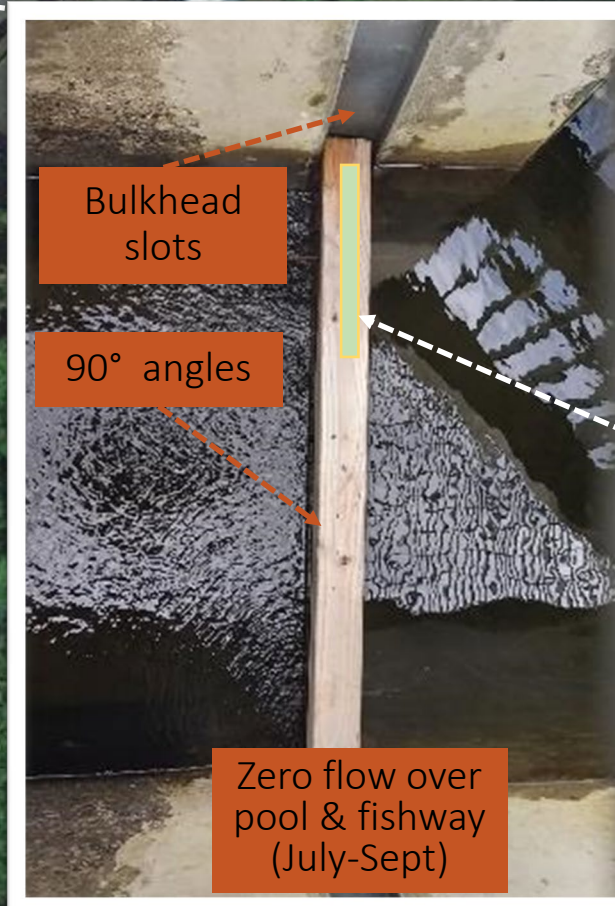
Beaver Creek Fishway, Barrier Dam, and intake

Elochoman River

Beaver Creek



No dam at adult fishway entrance



Options:

- Evaluate passage of lamprey weirs
- Assess velocities during operation

Beaver Creek Hatchery Results:

- Two barrier dams, fishways, and diversions are associated with the hatchery.
 - Seasonal weir is used to convey salmon into the hatchery (likely but unknown)
- Beaver Creek fishway(on Beaver Creek) has a new and novel lamprey passage wear
 - Operated seasonally. Not aware of any efficacy assessments
 - Adult salmon ladder downstream adjacent to the hatchery does not have a barrier dam
- Elochoman fishway suffers from a lack of water (July-Sep.)
 - Dam (head) is not high enough to pond up adequate water.
 - During low flows, the fishway does not function
 - Sheet pile dam appears to be failing
 - All 90 angles, no orifices
 - Option to replace with roughened riffle?
- Recommend re-assessing at spring migration flows
- Recommend concrete or aluminum ramps on the sheet pile dam, on both ends.
- Consider adding lamprey-specific orifices, either vertical or horizontal depending on the infrastructure
- Many smaller-bodied native fishes are likely blocked permanently.
- Larval Pacific and Lampetra species observed above the hatchery in the Elochoman
- Adults observed in fishway in hatchery ladder on Beaver Creek
- Increased predation risk below barriers

Abernathy Fish Technology Center - USFWS



Abernathy Fish Technology Center - USFWS



All Constructed
with 90° angles

Adult Fishway entrance

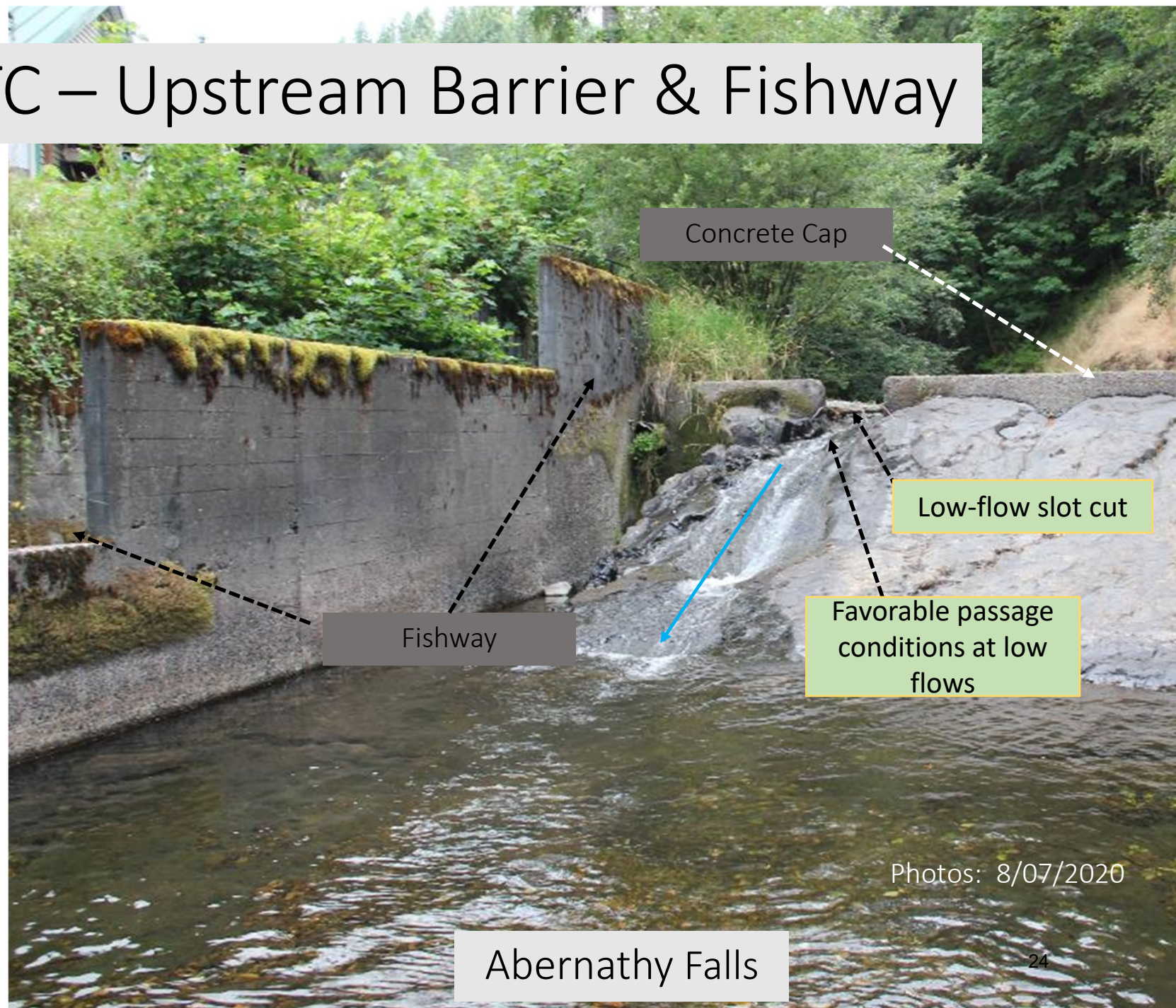
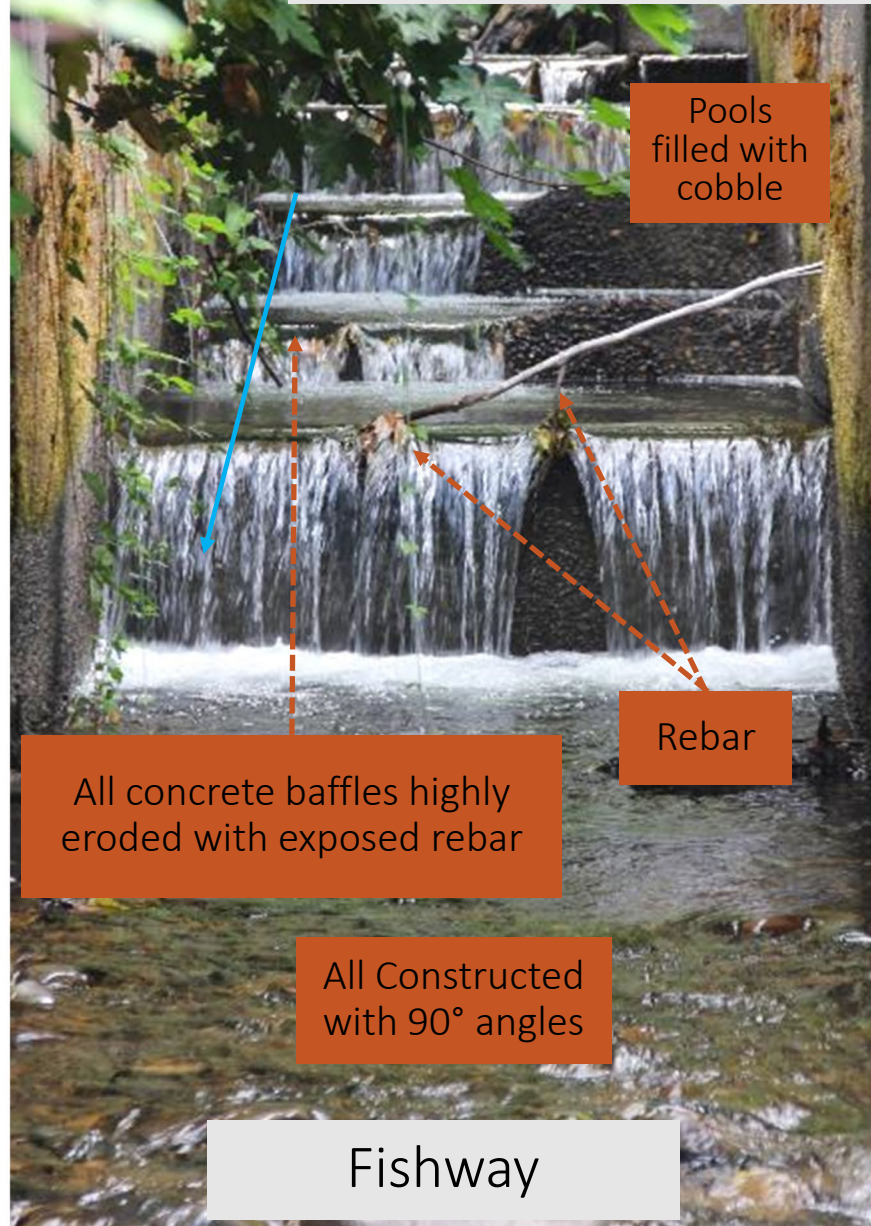
Electrode
(bulkhead) slots

Electrified weir and concrete structure added in 2004

Abernathy Fish Technology Center - USFWS

All Constructed
with 90° angles

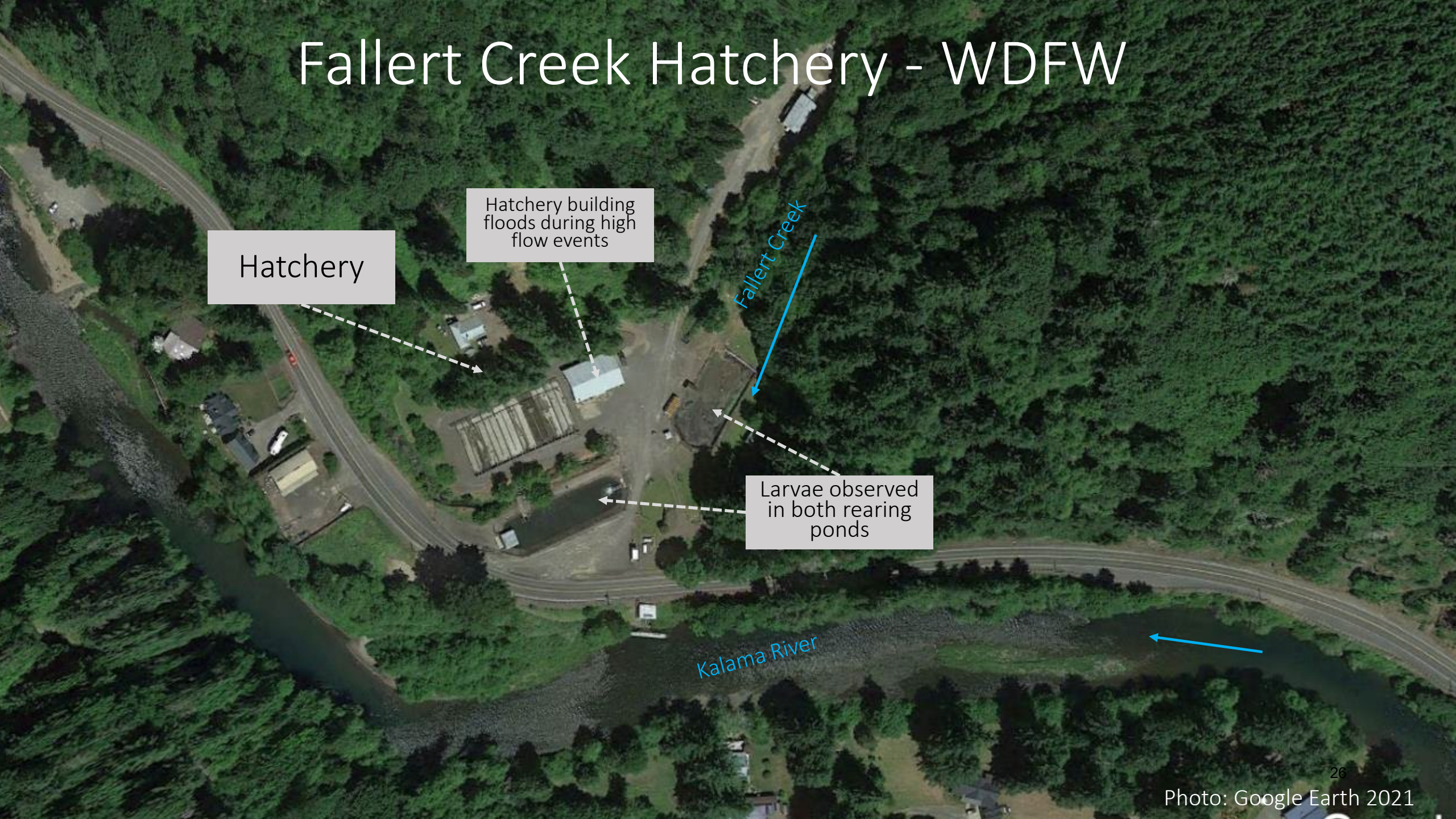
Abernathy FTC – Upstream Barrier & Fishway



Abernathy Fish Technology Center Results:

- Downstream electric weir installed in 2004 by Smith-Root
 - Seasonally operated from 2004 – 2019 to intercept and guide fish into the hatchery for sorting. Generally, from Oct – April/May (overlaps lamprey migration)
 - 90° corners and electrode slots could limit passage
 - Increased predation risks below
- Upstream diversion & fishway built into the side of natural falls
 - Fishway is highly eroded and out of compliance
 - New intake and retrofitted fishway planned for 2023
 - Modified falls appear to be passable by lamprey at conducive flows (lower)
 - New fishway retrofits are planned to accommodate lamprey passage elements (Summer 2023)
- Larval Pacific and Lampetra species have both been observed above the upper diversion

Fallert Creek Hatchery - WDFW




Hatchery

Hatchery building
floods during high
flow events

Fallert Creek

Larvae observed
in both rearing
ponds

Kalama River



6" Iron weir (railroad tie)

Remove or replace
with nature-like
fishway

Fallert Creek Hatchery - WDFW

Photo: 8/13/2020²⁷

Fallert Creek Upstream Intake



No fish ladder

Intake Screens

29 ft

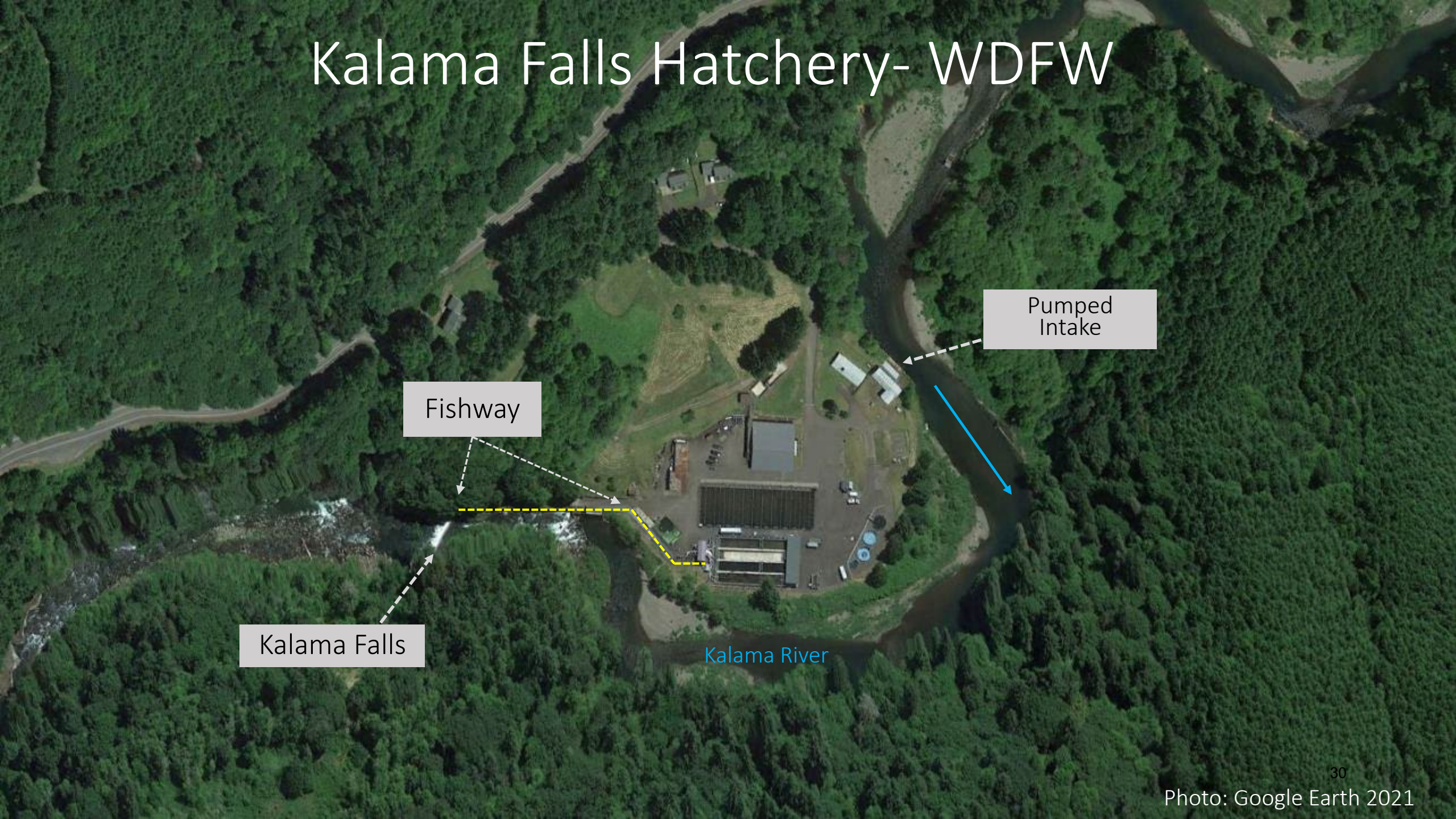
4 ft

Option: Replace structure with
roughed riffle

Fallert Creek Hatchery Results:

- No fishway or ladder exists at the hatchery. Brood fish are transferred from the Kalama Falls Hatchery to Fallert Creek.
 - Small iron weir does exist at the hatchery and should be replaced with roughed riffle or other – function unclear
 - Larval lamprey (hundreds) have been observed in hatchery ponds
 - Consider new screens with smaller openings (0.75 or 1.0 mm)
- Upstream diversion – No ladder or fish passage
 - WDFW has determined passage is necessary
 - WDFW has requested funds to replace intake (Ten-year plan (2021 -2031))
 - Located 1,700 feet upstream of the hatchery
 - New intake & screen with fishway could accommodate lamprey passage elements. Consider roughened riffle.

Kalama Falls Hatchery- WDFW



Fishway

Pumped
Intake

Kalama Falls

Kalama River

Vertical Slot fishway upstream of entrance

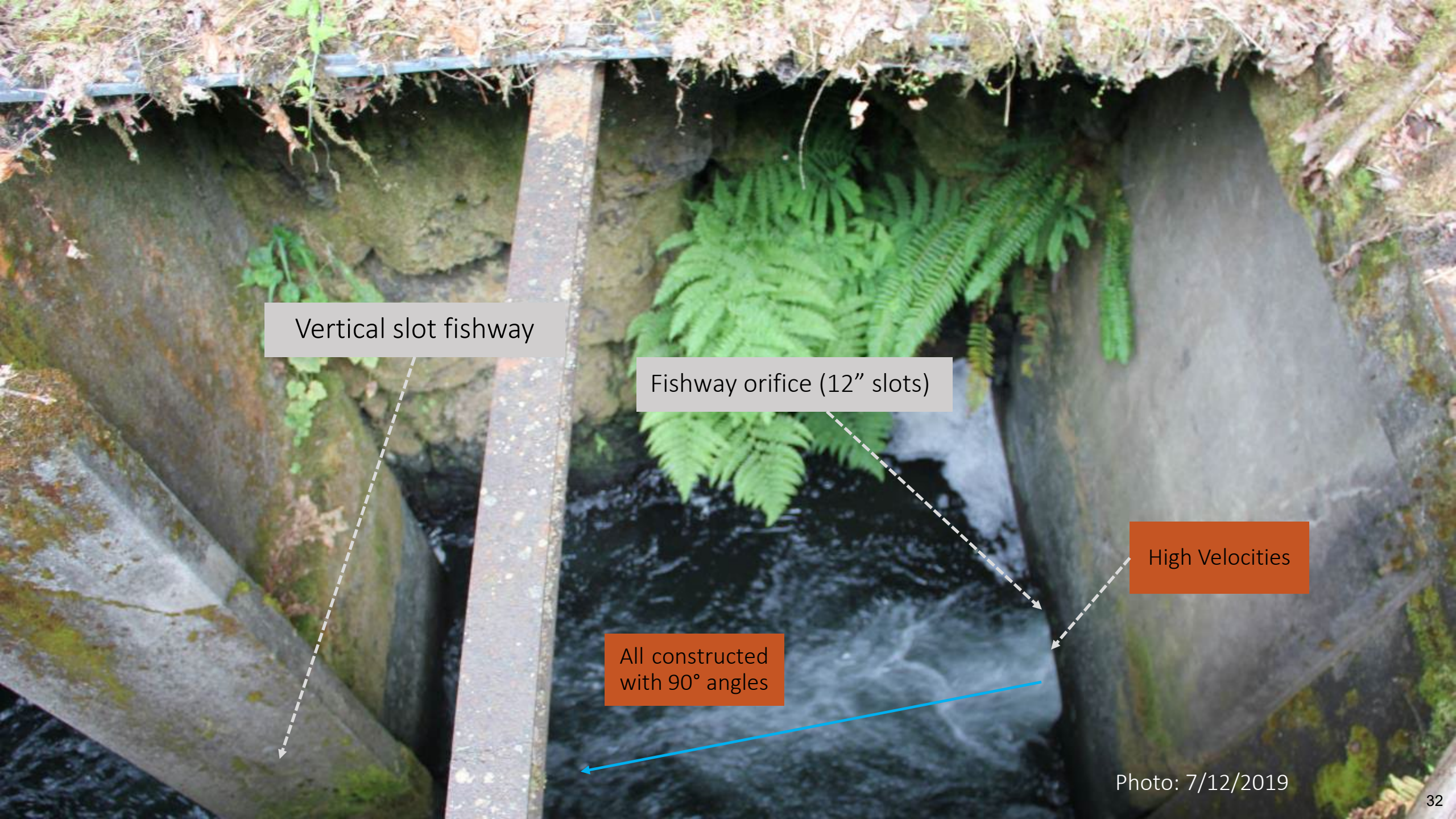
All constructed with 90° angles

Photo: 7/12/2019

Kalama Falls with concrete and steel cap added

Fall height = 10.3 ft

Fishway entrance



Vertical slot fishway

Fishway orifice (12" slots)

High Velocities

All constructed
with 90° angles

Photo: 7/12/2019



New fishway section

AWS flow depends
on river Stage

Likely volitional lamprey passage through
AWS trash rack

All constructed
with 90° angles

Older fishway section

Kalama Falls Hatchery Results:

- Concrete cap was added to the top of Kalama Falls to increase the height
- Fishway extends from the base of falls upstream 264 ft to the hatchery
 - Built into the side of the basalt channel wall
 - Not possible to widely assess velocities. Only the upper section was accessible and all were >5ft/s. Velocities in the lower section visually appeared higher
 - Lower 2/3 fishway is old and roughened
 - Fishway entrance is narrow with high velocities
 - 2 adult lamprey were observed in the adult trap in 2019
 - Unidentified larval lampreys in raceways
 - Consider monitoring likely passage at river AWS
- Considering the overall length, head differential, and age of the project, recommend a tagging study of adults before anything structural is done

Lewis River Hatchery - WDFW

Fishway

Pumped
Intake

Lewis River

Cedar Creek

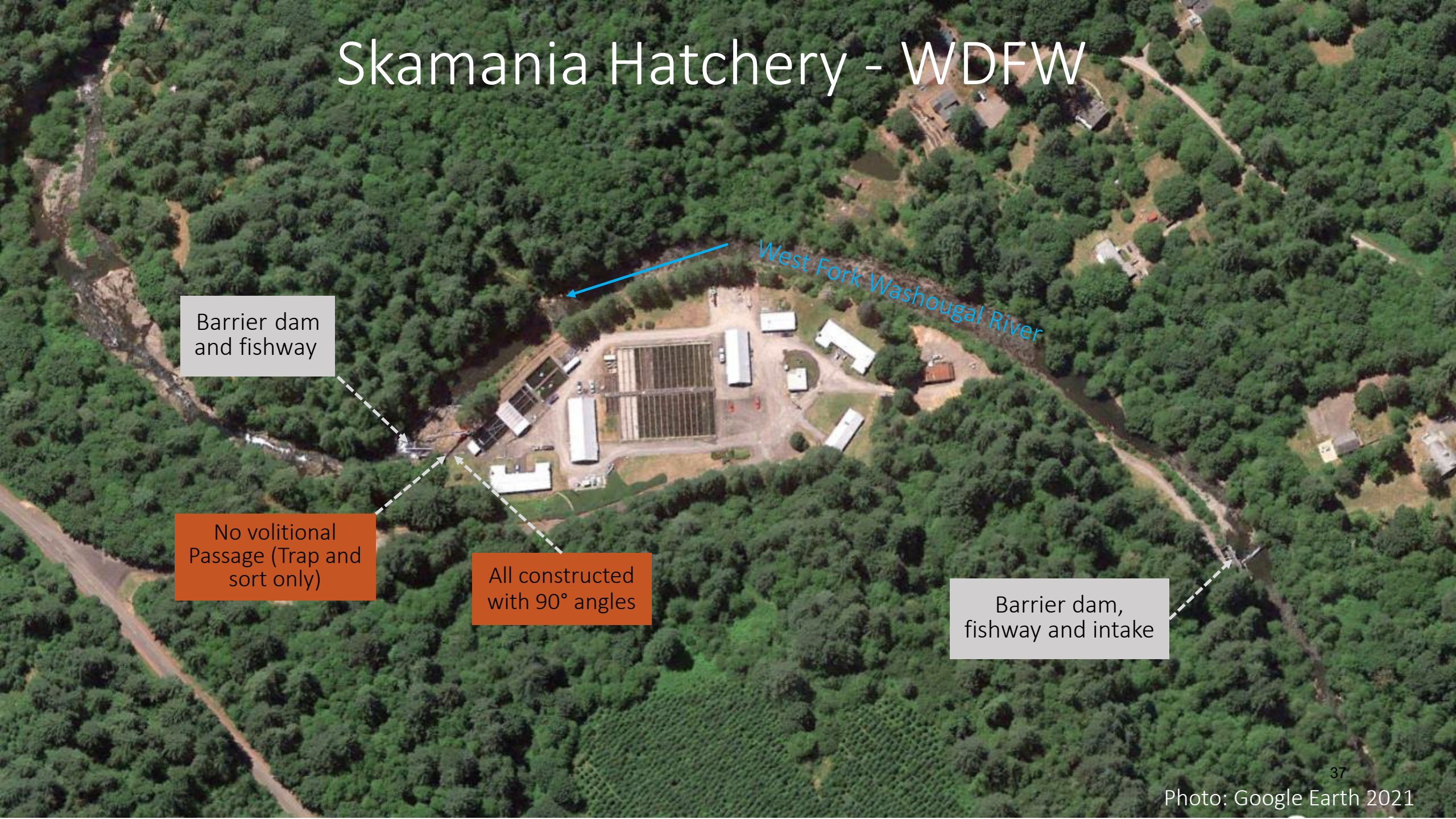
Photo: Google Earth 2021

Lewis Hatchery Results:

- No barrier dam exists at the hatchery
 - Most of the ladder is a Denil-Type Steeppass fishway and should preclude any lamprey passage if they choose to attempt it
 - Entrance velocities appear high but were not accessible
 - No actions are recommended at the facility.
 - No observations of adults or larvae by the hatchery by staff



Skamania Hatchery - WDFW



Barrier dam
and fishway

West Fork Washougal River

No volitional
Passage (Trap and
sort only)

All constructed
with 90° angles

Barrier dam,
fishway and intake

Skamania Hatchery – Downstream Barrier Dam

Possible adult passage
(burst & attach) lower
flows only

Barrier dam
rebuilt in 2017

Skamania Hatchery – Upstream Barrier Dam

Possible adult passage
(burst & attach) lower
flow only

Fishway rebuild in 2012
but difunctional at higher
flows. Fishway fills with
cobble.

Fishway

Photo: 6/12/2020

Skamania Hatchery Results:

- Downstream barrier and ladder
 - Possible passage over new barrier dam that was rebuilt in 2017
 - Ladder leads directly into the hatchery. No volitional fish passage
 - Entrance velocities appear high but were not accessible
 - No actions are recommended at this structure for the time being
 - No observations of adults or larvae at the hatchery by staff
 - Larval lamprey occupancy surveys above project resulted in zero lamprey observations
- Upstream barrier and ladder
 - Possible passage over barrier dam at lower flows.
 - Ladder only operated seasonally at lower flows. Likely outside of adult upstream migration
 - Passage through ladder uncertain as it was dewatered during survey

Washougal Hatchery - WDFW



Washougal Hatchery – Downstream Barrier

Permanent
weir section

Seasonal weir
(not present)

Seasonal fishway (Aug
– Feb) not operational
during site visit

Washougal Hatchery – Upstream Barrier & Ladder



4.0 ft. high barrier
dam

Possible adult passage
(burst & attach)

Fishway

Photo: 6/26/2020

Washougal Hatchery – Upstream Barrier & Ladder

4 ft. high barrier dam

Fishway velocities
up to 5.15 ft/s
during visit

Fishway

All constructed
with 90° angles

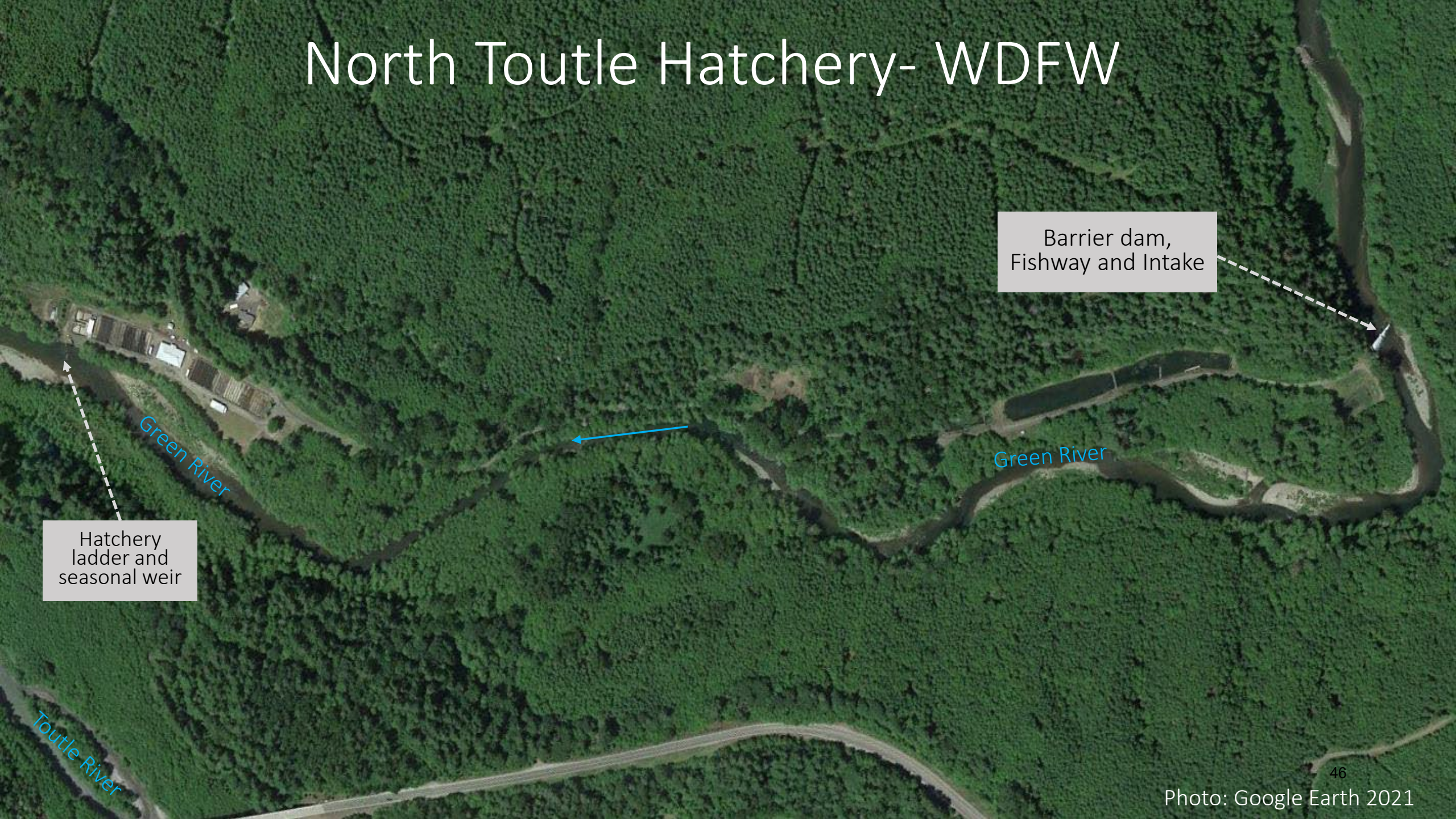
Washougal River Rd

Washougal Hatchery Results:

Two barriers and fishways exist, one upstream and one downstream

- Downstream barrier comprised of a permanent weir to guide salmon into the hatchery fishway, and a seasonal weir is added (Aug-Feb) permanent weir to guide hatchery returns into the fishway
 - Weir pickets (1.5-inch spacing) facilitate adult lamprey passage through. These are not installed during active spring adult lamprey migration
 - No actions recommended at the downstream barrier
- Upstream barrier and fishway seasonally operated as a trap
 - Velocities currently limiting passage in the fishway
 - Recommend reassessing during spring migration flows
 - Recommend smoother barrier dam surfaces along both ends
 - Pacific lamprey have been documenting above hatchery

North Toutle Hatchery- WDFW



Barrier dam,
Fishway and Intake

Hatchery
ladder and
seasonal weir

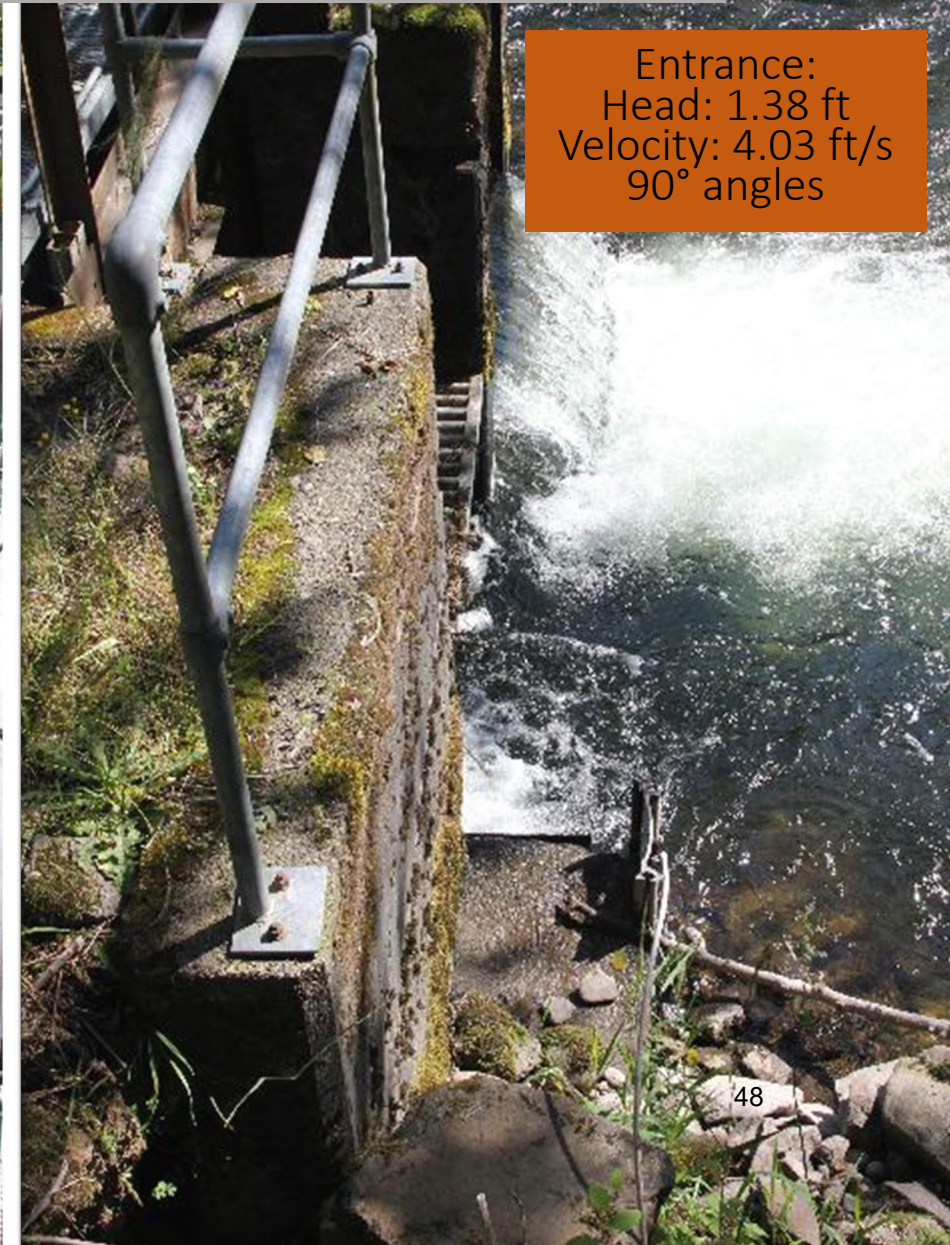
Green River

Toutle River

North Toutle - Upstream Dam, Fishway and Intake




North Toutle - Fishway and Entrance



North Toutle Hatchery Results:

- Downstream
 - No barrier dam exists at the hatchery
 - Seasonal weir used to convey fish into hatchery (spacing 1.5’)
 - The downstream was fishway dewatered during the visit
- Upstream barrier dam, fishway, and intake
 - Fishway operates all year with volitional salmon passage
 - Entrance velocities exceed lamprey swimming speeds
 - Recommend ramps on the dam and smoothing surfaces
 - Recommend adding attachment surfaces to the entrance and adding lamprey orifices to the pool and weir fishway baffles
 - Thousands of larval pacific lamprey observed in earthen ponds
 - Recommend reassessing during spring migration flows
 - Replacing the dam with a nature-like fishway could be a viable solution

North Toutle Fish Collection Facility



Spillway apron
fell off, leaving a
12' drop

An aerial photograph of the North Toutle Fish Collection Facility. The image shows a river flowing from the top left towards the bottom right. A concrete spillway structure is visible in the center, with water cascading over it. To the right of the spillway is a fishway. The surrounding area is heavily forested with green trees. There are some buildings and parking areas near the facility. A dashed white line points from the text box to the spillway apron.

No volitional
passage, trap
and haul only

Issues with salmonids
finding/using fishway.
USACE is considering
options

North Toutle Sediment Retention Dam

Located 1.6 miles
upstream of North Toutle
Fish Collection Facility

No passage
facilities

Cowlitz Trout Hatchery - Tacoma Power

Blue Creek

Blue Creek

Barrier Dam

Pumped Intake

Cowlitz River

Cowlitz Trout Hatchery Results:

- No barrier dam exists at the hatchery
 - All eggs and juvenile salmonids are transported from the upstream salmon hatchery
- Barrier on Blue Creek
 - Dewatered during the visit
 - Verify removal as per FERC license
- No further actions are recommended at this time.

Cowlitz Salmon Hatchery - Tacoma Power

Electrified Barrier
Dam and Fishway

Cowlitz River

Mayfield Dam, 2.4
miles upstream.
No passage.

Cowlitz Salmon Hatchery Results:

- Large electrified barrier dam exists at the hatchery
 - Fishway leads to the hatchery
 - No adult lamprey have been observed in the facility
- Mayfield Dam 2.4 miles upstream (~850 ft high) with no fishway
- Many miles of habitat exists downstream of the hatchery and dam
- Predation below the barrier on adult lamprey could be significant
- No further actions are recommended

Potential Remediations and additional Assessments

Barrier Dam Remediations

1. Replace barrier dam with roughened riffle or nature-like fishway
2. Round 90° corners on barrier dam.
3. Install basic aluminum ramps to facilitate contiguous passage routes
4. Install Lamprey Passage Device (LPS) or Lamprey Passage Tube (LPT) as appropriate
5. Install seasonal lamprey tiles over either end of the barrier dam, if applicable.
6. Power wash passage routes on all relevant surfaces to remove moss and detritus.
7. Grind and smooth rough surfaces of all relevant passage routes. Apply grout to smooth as required.

Fishway Remediations

1. Round 90° corners within and around the fishway
2. Install exclusion plating around the fishway entrance as required if a preferable passage route is available.
3. Install exclusion pickets (0.7") around the hatchery water return to the river.
4. Cut orifices in fishway weirs and consider the use of lamprey tiles, if applicable.
5. Reduce nighttime fishway flows if possible and when relevant.
6. Install plates over fishway grating when relevant.
7. Install "saddle" plates over the ends of fishway baffle boards to provide a smooth route of passage over.
8. Install rest boxes within the fishway when relevant.

Passage Assessments

1. Assess passage delay and success (active radio or acoustic tag study).
2. Conduct Pacific Lamprey redd surveys above the dam to inform passage success.
3. Conduct larval Pacific Lamprey surveys above the dam to inform passage success.
4. Conduct further physical assessments during the active adult upstream passage season.
5. Conduct nighttime assessments within and around the fishway and barrier dam to observe behavior and success.
6. Install cameras to observe nighttime passage behavior, passage metrics, and predation.

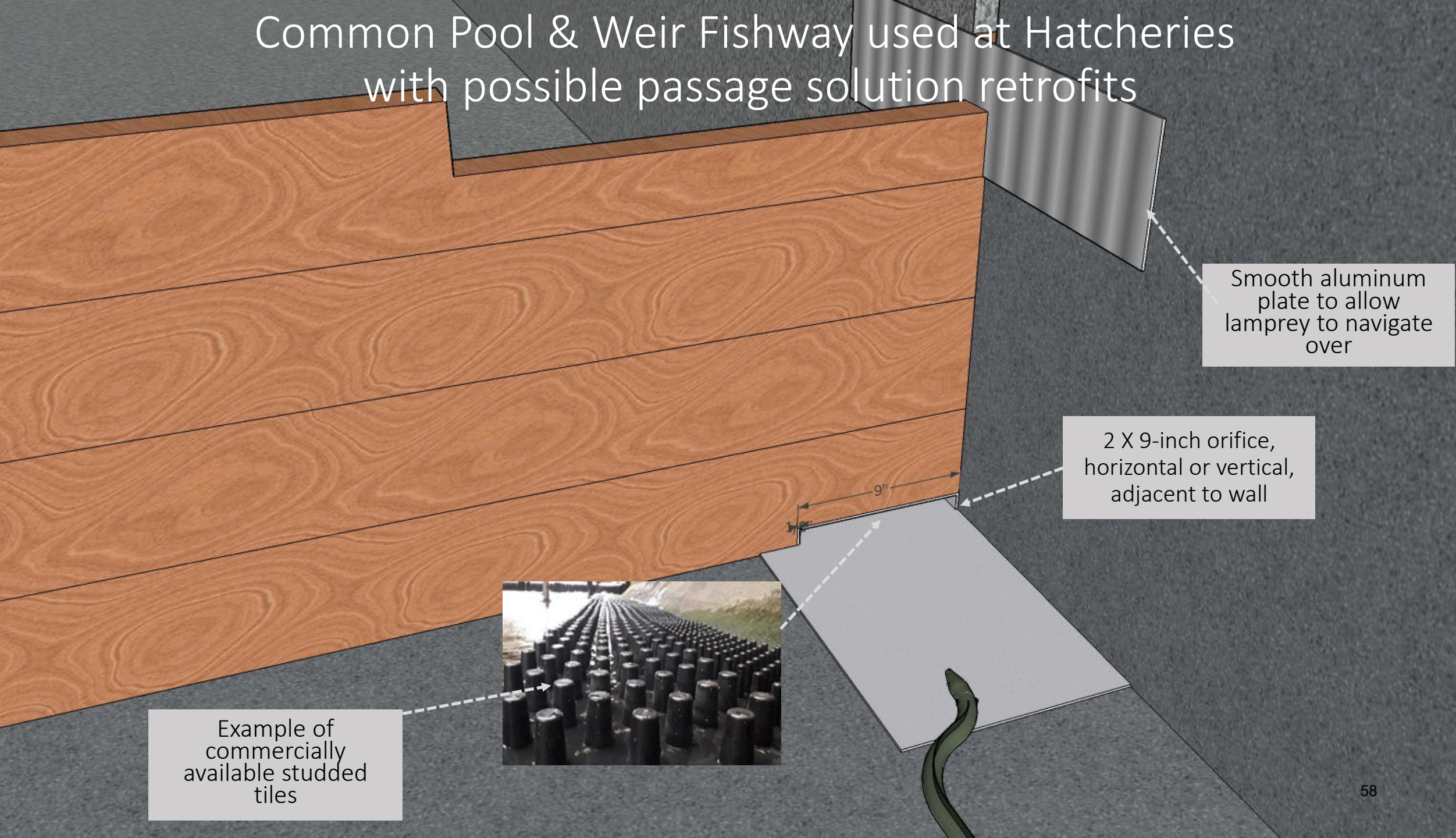
Conclusions

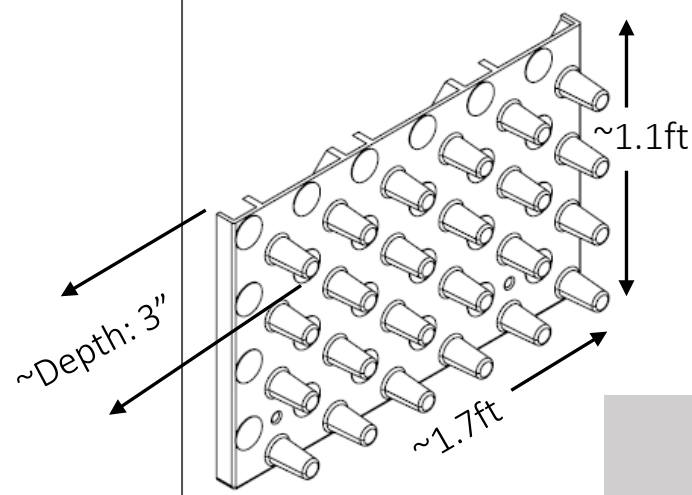
1. Many of the hatcheries assessed in the evaluation are old, deteriorating, and at least partially non-compliant with State Federal standards and require significant repairs and major upgrades. This is the time to incorporate lamprey passage elements into a modern fishway.
2. Hatchery fishways are designed to pass adult salmonids, often limiting or excluding passage to native fishes due to high velocities (>5 ft/s) and significant jump heights. Lampreys cannot jump and many native fishes have reduced jumping abilities.
3. Reduced passage proficiency at these hatcheries can greatly increase predation on adult lamprey.
4. Smooth attachment surfaces for burst and attach swimming are generally lacking and limiting.
5. Rounding 90 corners over dams and with fishways can often improve passage alone.
6. Cutting lamprey-sized orifices within fishways could dramatically improve passage.
7. Water velocities in the study were generally measured during low flows and should be considered minimums.
8. Improving passage for Pacific Lamprey is unlikely to improve or provide passage for other lamprey species.

Acknowledgements

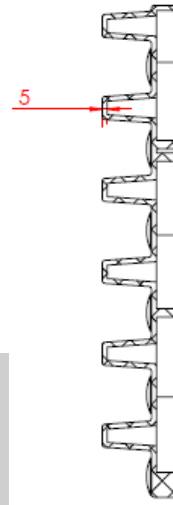
Funding was provided by the Bonneville Power Administration in cooperation with the Pacific Lamprey Conservation Initiative. Jared McKey and Amy Horstman provided field assistance.

Common Pool & Weir Fishway used at Hatcheries with possible passage solution retrofits

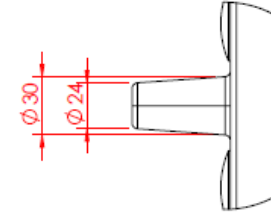




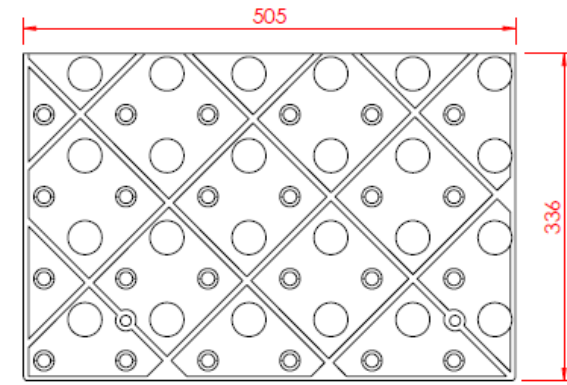
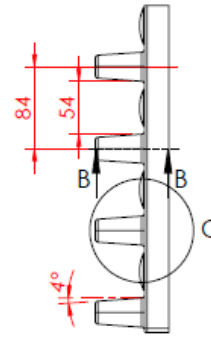
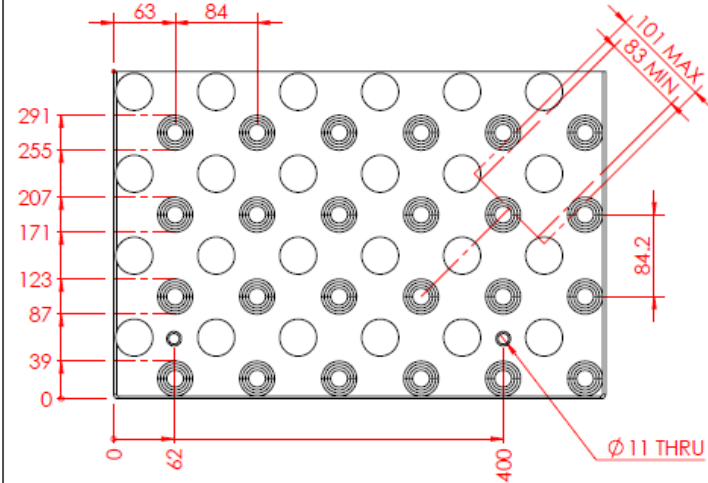
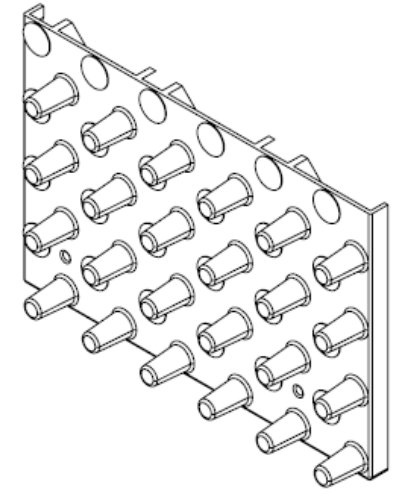
Example of
commercially
available studded
tiles



SECTION B-B



DETAIL C
SCALE 2 : 5



REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	First Issue		

PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS
DRAWING IS THE SOLE PROPERTY OF
BERRY & ESCOTT ENGINEERING LTD. ANY
REPRODUCTION IN PART OR AS A WHOLE
WITHOUT THE WRITTEN PERMISSION OF
BERRY & ESCOTT ENGINEERING LTD IS
PROHIBITED.

DIMENSIONS ARE IN MM TOLERANCES: UOS FABRICATION ANGULAR: MACH BEND ONE PLACE DECIMAL TWO PLACE DECIMAL THREE PLACE DECIMAL	>1m \pm 1.0 \pm 0.25° \pm 0.5° \pm 0.1 \pm 0.05 \pm 0.02	NAME	DATE
MATERIAL FINISH	Black Copolymer Natural	DRAWN	17/07/2018
DO NOT SCALE DRAWING	SCALE - 1:5 WEIGHT: 1482.85	CHECKED	17/07/2018
	SHEET 1 of 1	SIZE	A3

BERRY & ESCOTT
ENGINEERING
Telephone: 01278 444861
TECHNICAL@BERRYENGINEERING.CO.UK
DRAWING NAME
LAMPREY PANEL - 8 ROWS -
333MM
DWG. NO. 515-MD-101c- Lamprey Big
Studs Only Tile - B

**U.S. Fish & Wildlife Service
Columbia River Fish & Wildlife Conservation Office
1211 SE Cardinal Court, Suite 100
Vancouver, WA 98683**



January 2022