The Shocking Story of Larval Lamprey

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Bill Allen – Electronics Specialist
Hart Crowser, Inc. – Portland, Oregon

Project Sponsor and Collaborative Partners

<u>Project Sponsor:</u> Michelle Hollis, M.S.
Port of Portland, Environmental Ops., Portland, OR

<u>eDNA Lab:</u> Taal Levi, Ph.D. and Jennifer Allen
Oregon State University, Quantitative Wildlife Ecology and Conservation Lab, Corvallis, OR

<u>Lamprey Hatchery:</u> Ralph Lampman
Yakama Nation FRMP,
Pacific Lamprey Project, Prosser, WA

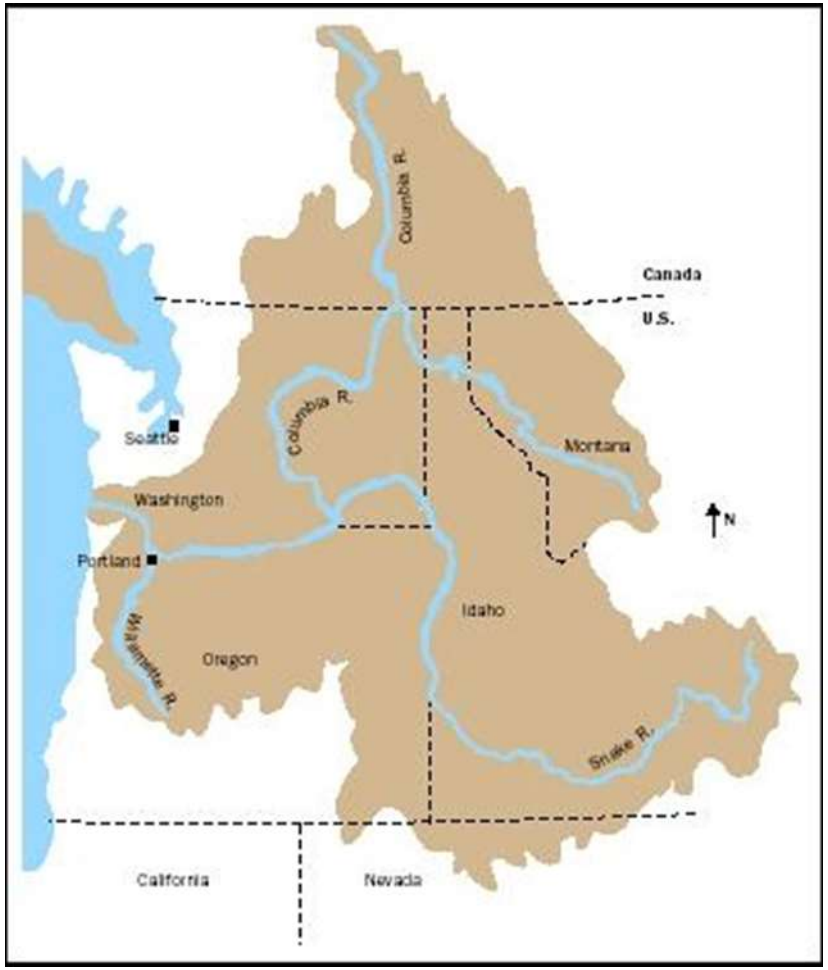
+ USACE, USFWS, ODFW, and Battelle Labs

What are Lamprey?

- Class Agnatha, the jawless fishes
- Family Petromyzonidae (stone suckers)
- Round, elongated body
- No paired fins, scales, jaws, or bones (only cartilage)
- Round sucker-like mouth for clinging and sucking
- Often mistaken for eels (however, eels have jaws)
- Lack swim bladders and must swim constantly or hold onto objects
- Adult lamprey can grow to up to three feet in length
- Feed on bodily fluids of fish and marine mammals

Lamprey Species of the Columbia and Willamette River Basin

- **Pacific Lamprey** (*Entosphenus tridentatus*, formerly *Lampetra tridentata*, “three-toothed stone sucker”)
- **Western Brook Lamprey** (*Lampetra richardsoni*)
- **River Lamprey** (*Lampetra ayresi*)

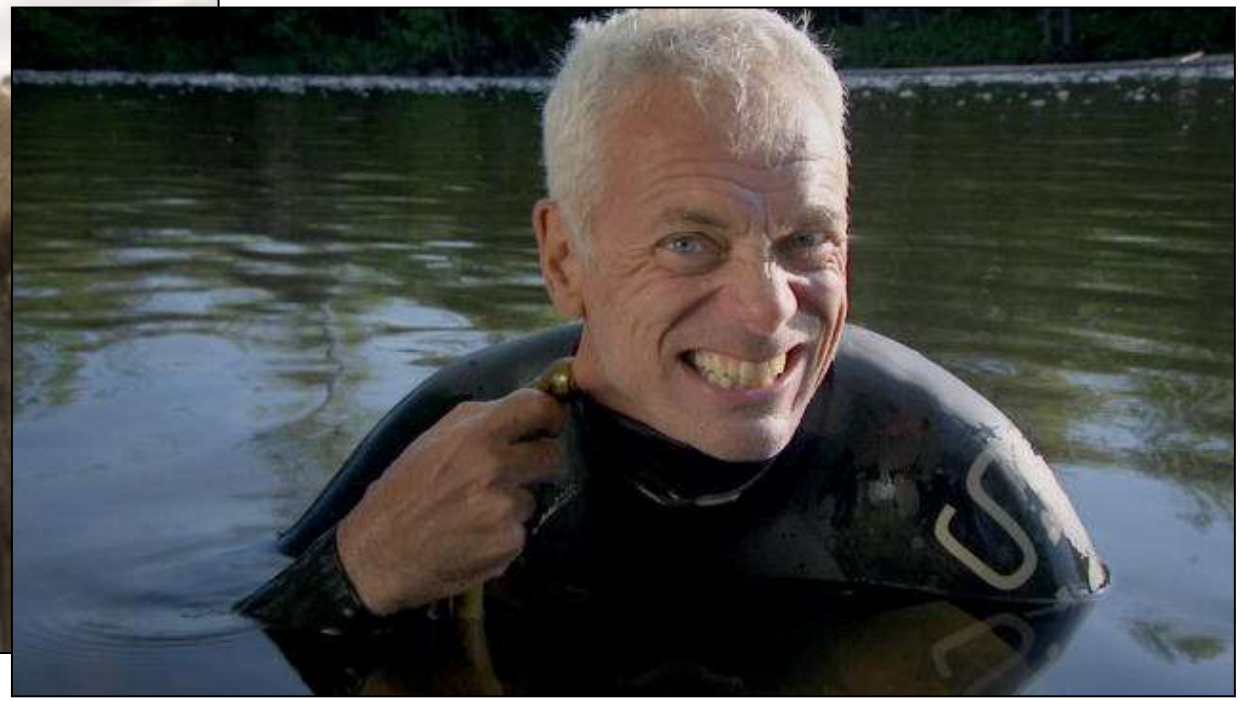


Why the interest in Lamprey?

- They are just way cool (and cute?)!
  - Class Agnatha, or jawless fishes, the most primitive of all living vertebrates
  - Oldest fish alive today with a fossil record dating back 500 million years
- Play a vital role in the ecosystem as food for mammals, fish and birds, and for nutrient cycling and storage
- Indigenous peoples harvested lampreys for subsistence, religious, medicinal, spiritual and cultural purposes for many generations

River Monsters – “Vampires of the Deep”

Jeremey Wade –
Discovery’s Animal Planet 2013



Federal and State Status

- Not currently “listed” as threatened or endangered
- Petitioned in January 2003
  - Pacific lamprey, western brook lamprey, river lamprey, and Kern brook lamprey
  - Oregon, Washington, Idaho, and California
  - Based on a decline in abundance and distribution throughout their range
- In December 2004 the USFWS determined that there was not substantial scientific or commercial information to warrant listing

Figure 1. Pacific lamprey adult upstream passage day counts at Bonneville Dam, OR (USACE 2006). Trend line fitted through regression. From Cochnauer and Claire 2009.

Lamprey Species	Status		
	Federal	OR	WA
Pacific lamprey	SOC	SV	Monitor
River lamprey	SOC	None	-
Western brook lamprey	None	SV	Monitor

USFWS 2010 Best Management Practices

Reasons for Decline:

- lack of passage; dewatering and reduced flows; poisoning; poor water quality; dredging (channel maintenance and mining); stream and floodplain degradation (channelization, loss of side channel habitat, scouring); ocean conditions (loss of prey, increase in predators); predation by nonnative fish species

Conservation Measures:

- provide lamprey passage
- protect ammocoete habitat
- restore stream channel complexity

Pacific Lamprey Life Cycle

Adults live in ocean 1-3 years and feed on host fish

Adults migrate to freshwater and reside there about a year

Adults develop teeth on sucking disk for parasitic feeding

Adults spawn in gravel nest then die

Larvae transform to juveniles (macropthalmia) and migrate to the ocean

Ammocoetes live in silt/sand substrates and filter feed for 3 - 7 years

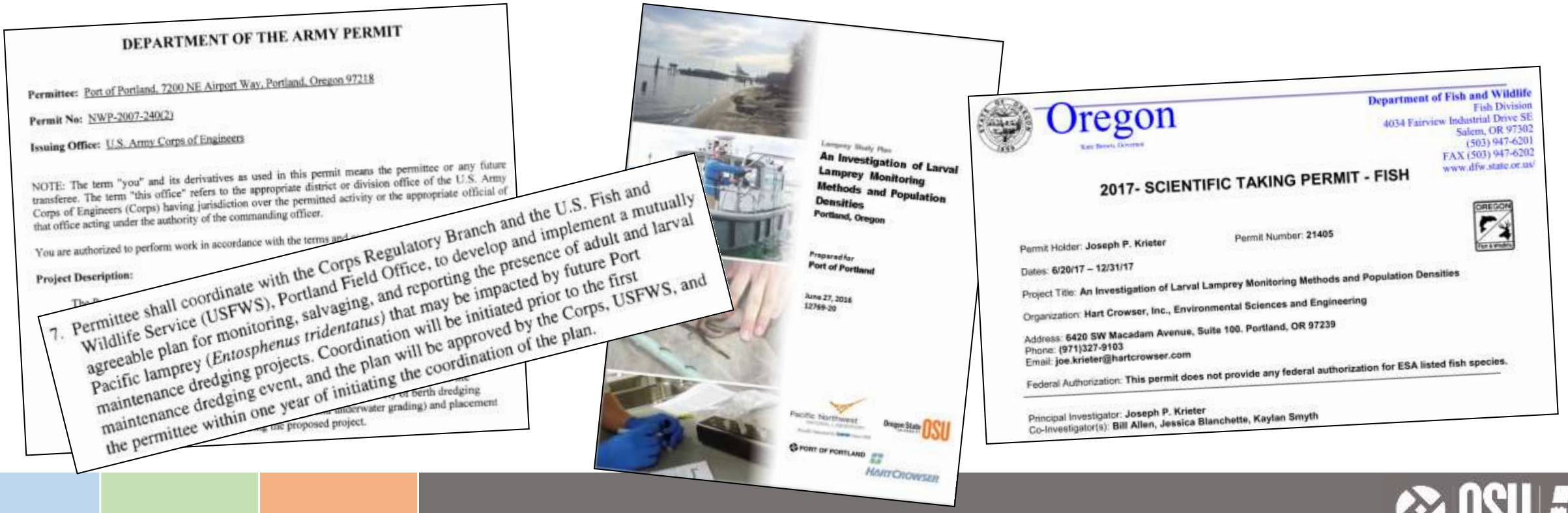
Eggs hatch into larvae (ammocoetes) and drift downstream to slow velocity area

Streif, B. 2009. American Fisheries Society Symposium 73. Published by the American Fisheries Society.
ISBN: 978-1-934874-13-4

Pacific Lamprey Larva (Ammocoetes)

Permit Conditions - Abbreviated

Terminal-Wide Berth Maintenance Program USACE Permit Special Condition #7 - Develop a plan addressing Pacific lamprey that may be impacted by berth maintenance activities



DEPARTMENT OF THE ARMY PERMIT

Permittee: Port of Portland, 7200 NE Airport Way, Portland, Oregon 97218

Permit No: NWP-2007-240(2)

Issuing Office: U.S. Army Corps of Engineers

NOTE: The term "you" and its derivatives as used in this permit means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the U.S. Army Corps of Engineers (Corps) having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and

Project Description:

7. Permittee shall coordinate with the Corps Regulatory Branch and the U.S. Fish and Wildlife Service (USFWS), Portland Field Office, to develop and implement a mutually agreeable plan for monitoring, salvaging, and reporting the presence of adult and larval Pacific lamprey (*Entosphenus tridentatus*) that may be impacted by future Port maintenance dredging projects. Coordination will be initiated prior to the first maintenance dredging event, and the plan will be approved by the Corps, USFWS, and the permittee within one year of initiating the coordination of the plan.

of berth dredging
underwater grading) and placement
the proposed project.

Lamprey Study Plan

An Investigation of Larval Lamprey Monitoring Methods and Population Densities

Portland, Oregon

Prepared for
Port of Portland

June 27, 2016
12769-20

Pacific Northwest
Oregon State OSU
PORT OF PORTLAND
HARTCROWSER

Oregon
Kate Brown, Governor

Department of Fish and Wildlife
Fish Division
4034 Fairview Industrial Drive SE
Salem, OR 97302
(503) 947-6201
FAX (503) 947-6202
www.dfw.state.or.us/

2017- SCIENTIFIC TAKING PERMIT - FISH

Permit Holder: **Joseph P. Krieter** Permit Number: **21405**

Dates: **6/20/17 – 12/31/17**

Project Title: **An Investigation of Larval Lamprey Monitoring Methods and Population Densities**

Organization: **Hart Crowser, Inc., Environmental Sciences and Engineering**

Address: **6420 SW Macadam Avenue, Suite 100. Portland, OR 97239**
Phone: **(971)327-9103**
Email: **joe.krieter@hartcrowser.com**

Federal Authorization: **This permit does not provide any federal authorization for ESA listed fish species.**

Principal Investigator: **Joseph P. Krieter**
Co-Investigator(s): **Bill Allen, Jessica Blanchette, Kaylan Smyth**

Challenges and Solutions

- Many unknowns regarding the presence of ammocoetes
  - Low density, patchy distribution, very little habitat preference information
- Very challenging sampling conditions and restrictions
  - 45+ ft. water depths, limited visibility
  - Very small and burrowed organisms that are highly mobile
  - Water temperature restrictions on electrofishing (64.4^{o}F)
- Few successful sampling methods
  - USFWS electrified suction dredge
  - PNNL deep water electrofishing platform

Mueller, R.P., E.V. Arntzen, M. Nabelek, B.L. Miller, K. Klett & R.A. Harnish. 2012. Laboratory testing of a modified electroshocking system designed for deepwater juvenile lamprey sampling. Transactions of the American Fisheries Society 141(3):841-845

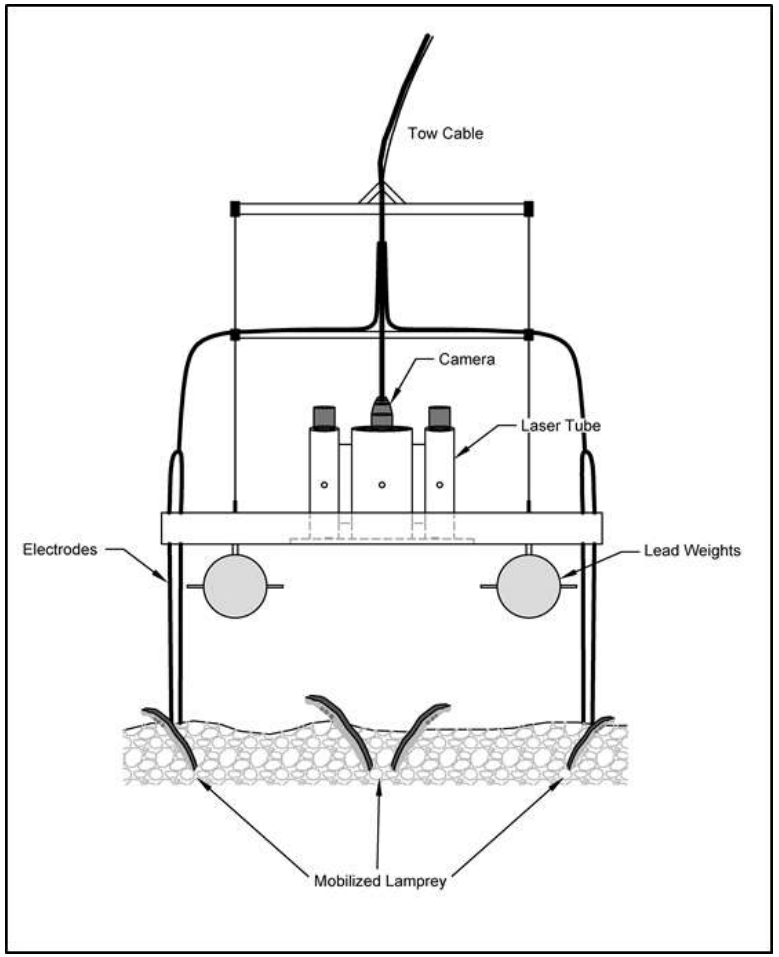
Larval Lamprey Electrofishing System (LLES)

Operator console

- Modified ETS electrofishing unit
- Camera and LED controls
- Dual color video monitors
- DVR

Sampling Sled

- Two hydraulic sounding weights
- Dual electrofishing anodes / cathodes
- Low-light color drop camera
- Paired scaling lasers
- External lighting equipment
- Custom welded frame and sheathed cable bundle



LLES Advantages and Disadvantages

<u>Advantages</u>

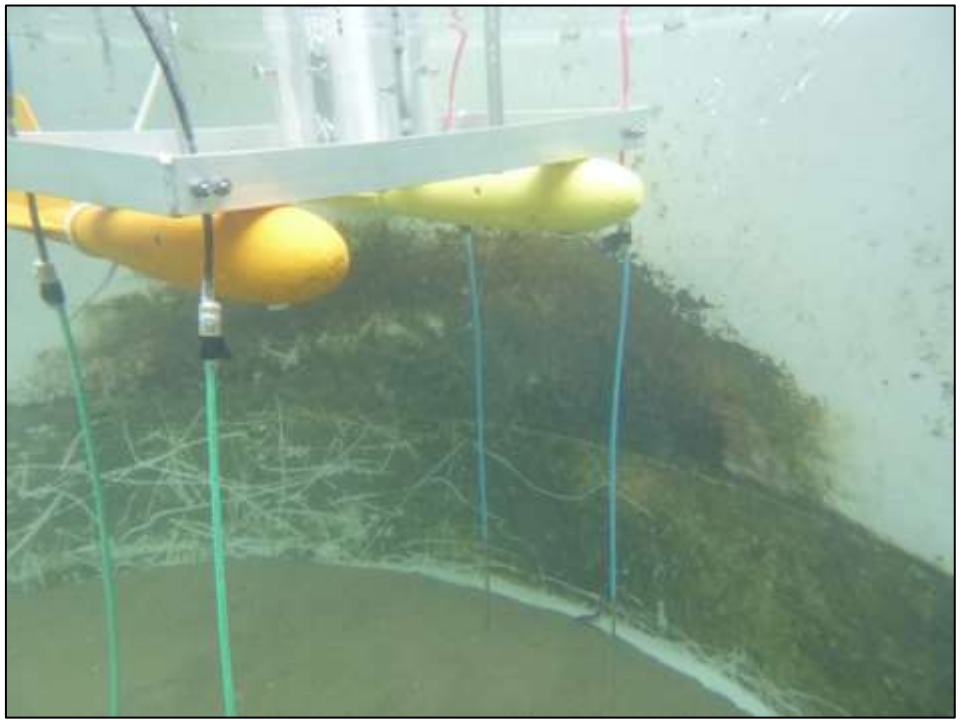
- Builds upon prior accepted studies
- Relatively efficient sampling
- Small crew

<u>Disadvantages</u>

- Requires clear water conditions
- Cannot distinguish ammocoetes by species

LLES Testing – Prosser Fish Hatchery

- Known density, species and origin (10 PL / m^2)
- Three trials conducted
- Resulting in 94% to 57% accuracy; similar to prior studies




2017-03-24 10:11:30
SARTEK
LLES Video Footage

LLES Sampling

- Three shipping terminals, one reference site;
- 12 transects, 400 sampling stations, 50 ft. x 50 ft. grid;
- 30-60 seconds @150 VDC, 4 Hz, 25 percent duty cycle and a 3:1 burst pulse rate;
- 3-7 minutes for maneuvering between stations;
- Approx. 3 ft^2 sampling area, 18 inches off the bottom.

Name That Fish!

Name That Fish!

White Sturgeon

Name That Fish!

Sediment Grab Sampling

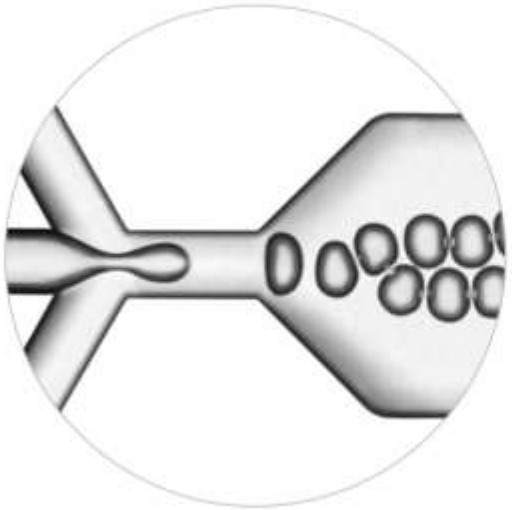
- Collected for eDNA analysis for a subset (10%) of sites
- Petite ponar dredge sampler
- Sterile techniques
- One 50 mL sample and two replicates
- Delivered frozen to OSU for extraction and ddPCR

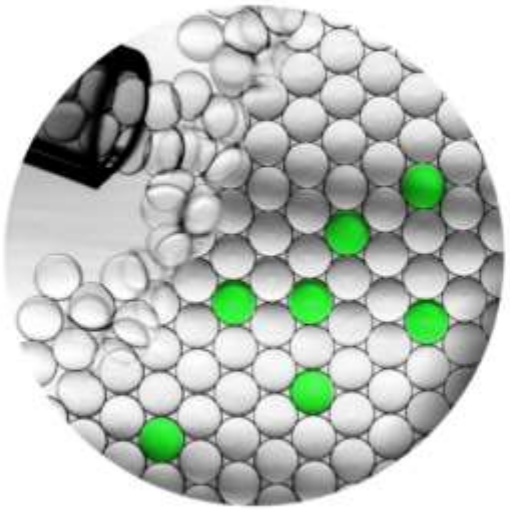
eDNA

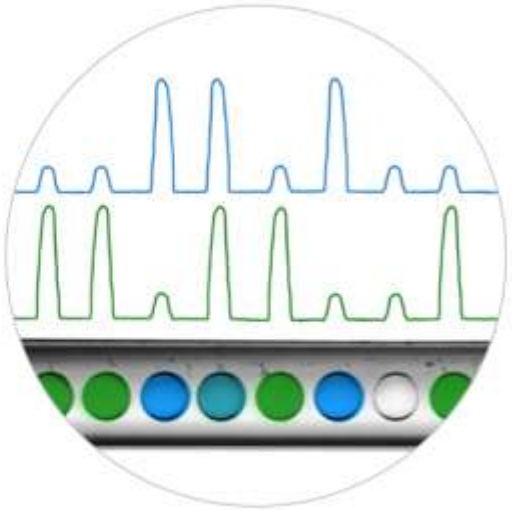
- “Genetic material obtained directly from environmental samples (soil, sediment, water, etc.) without any obvious signs of biological source material”
- Advantages
  - Non-invasive
  - Highly sensitive
  - Short degradation time
  - Cost-efficient
- Disadvantages
  - No info. about DNA source (life stage, condition, etc.)
  - DNA can be detected from sources other than target

From: P.H. Thomsen and E. Willersley. 2015. Environmental DNA – An Emerging Tool in Conservation for Monitoring Past and Present Biodiversity. Biological Conservation. Vol 183. pp. 4 – 18.

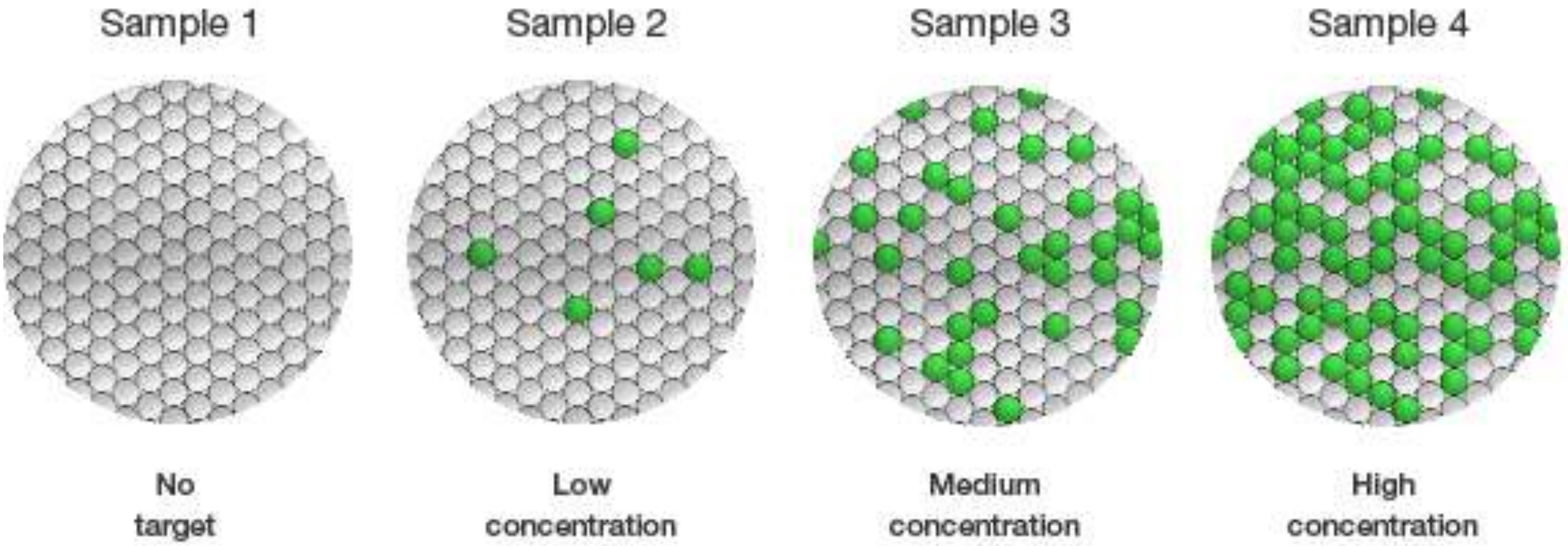
Absolute quantification with Droplet digital PCR



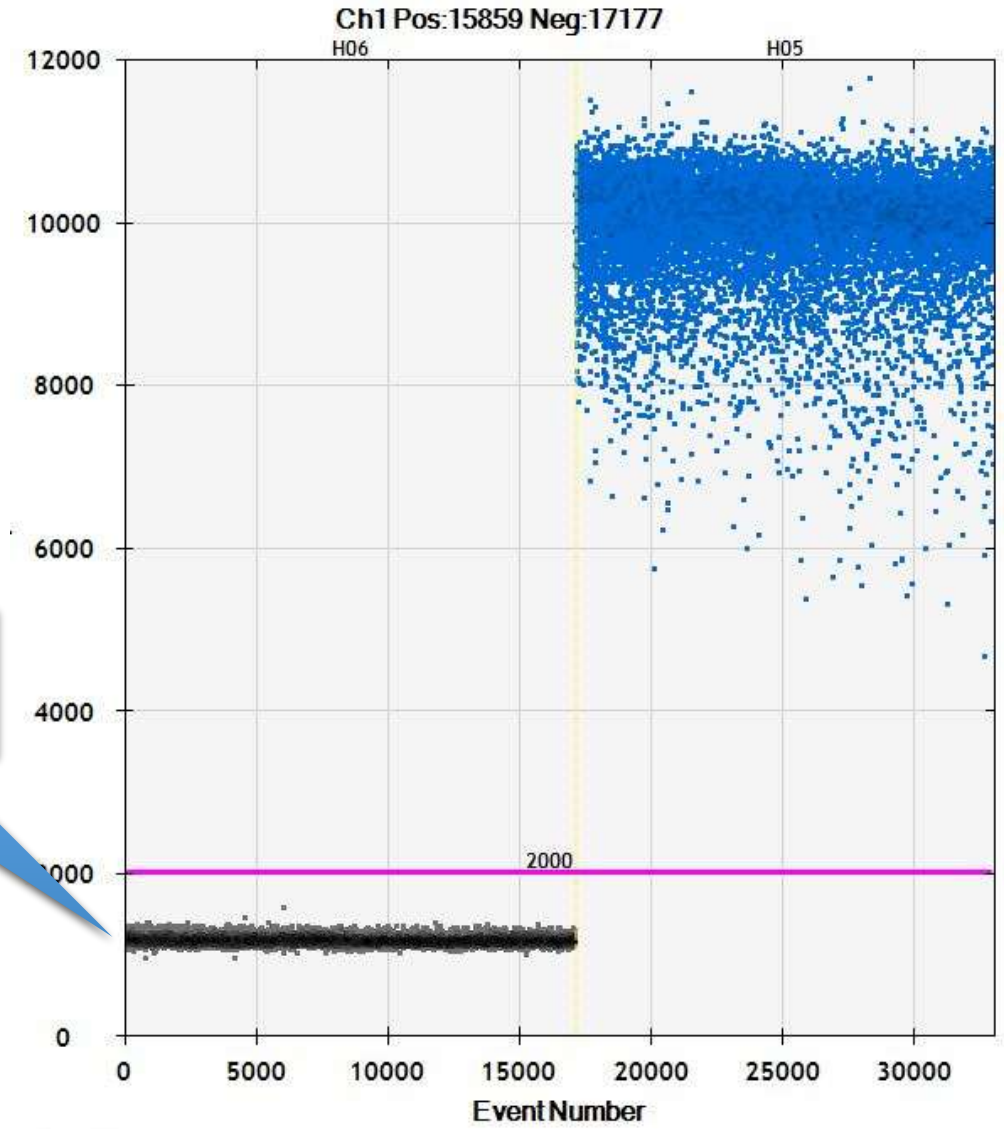




Absolute Quantification



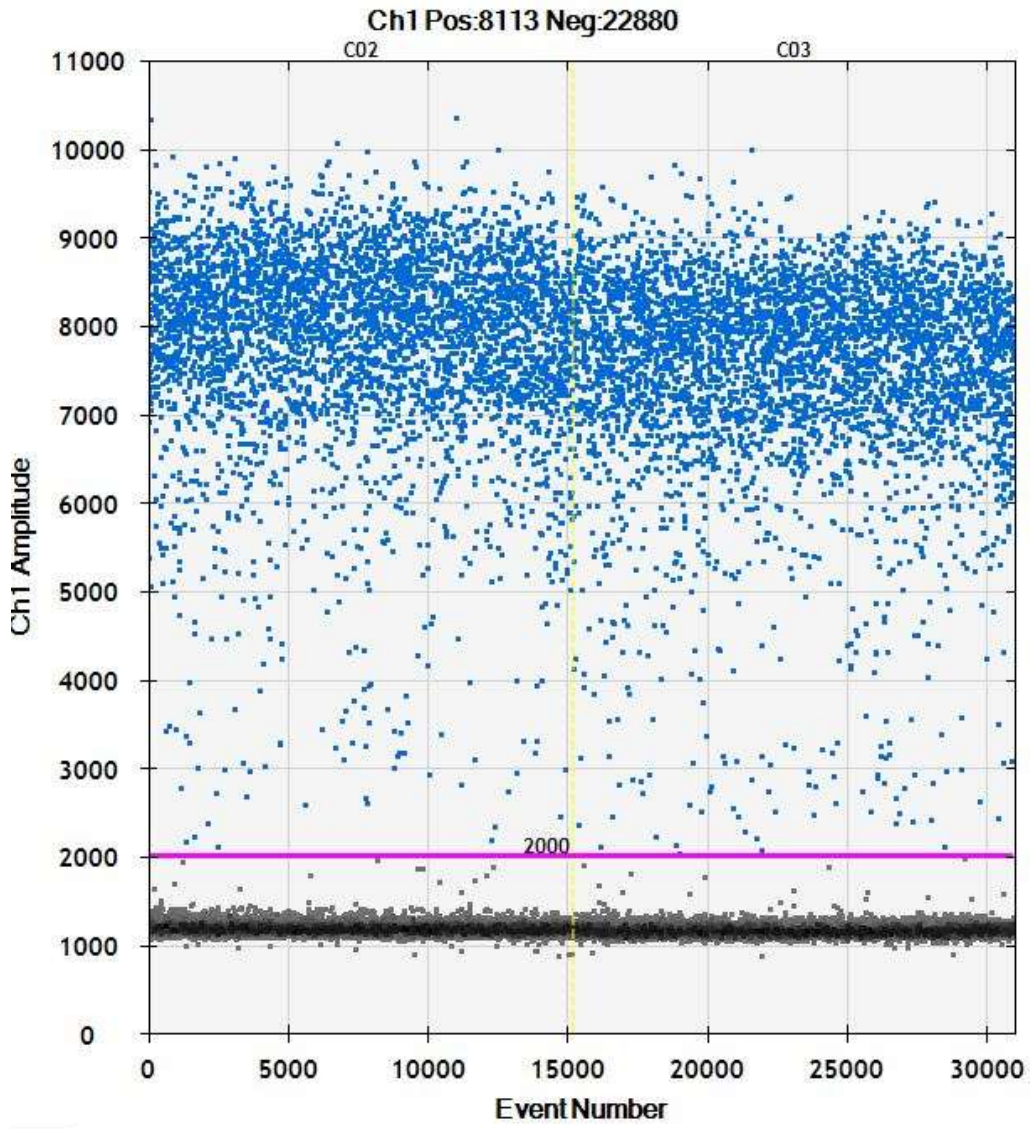
Positive and Negative Controls



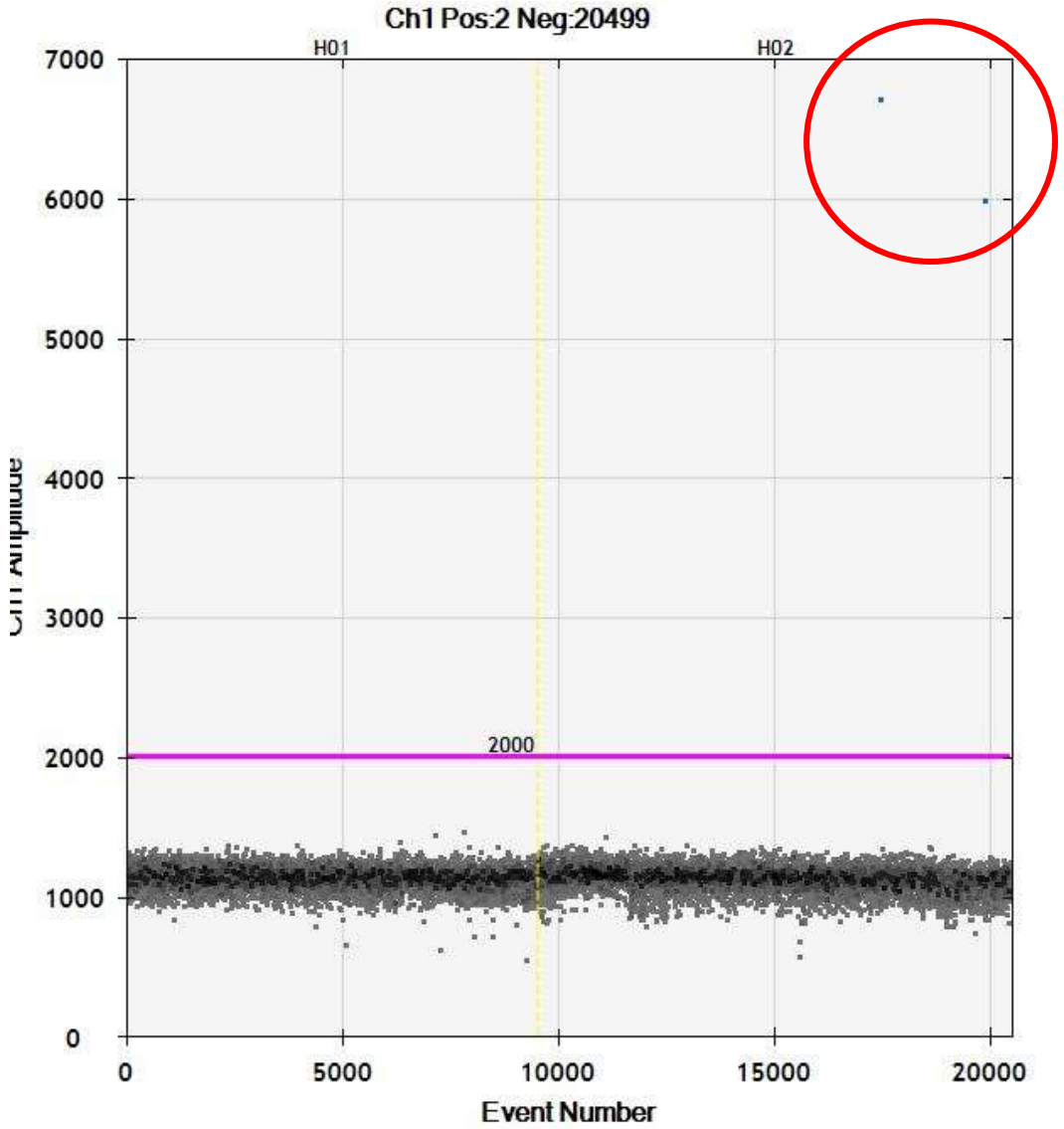
Lamprey tissue

No template control

Abundant



Rare



Preliminary Results – Nearly There…

- Successful LLES testing results and overcoming water clarity issues upon initial deployment.
- Successful eDNA data collection, extraction and analytical techniques developed by OSU.
- Surveys and analyses incomplete at this time, but no LLES lamprey detections yet at POP berthing areas.
- Requested sampling extension from ODFW.
- Anticipate first year report in early 2018.

Thank You!

Please send us your questions and comments:

Sampling Questions:

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