

Three lamprey eDNA field studies: what we learned by applying eDNA methodology

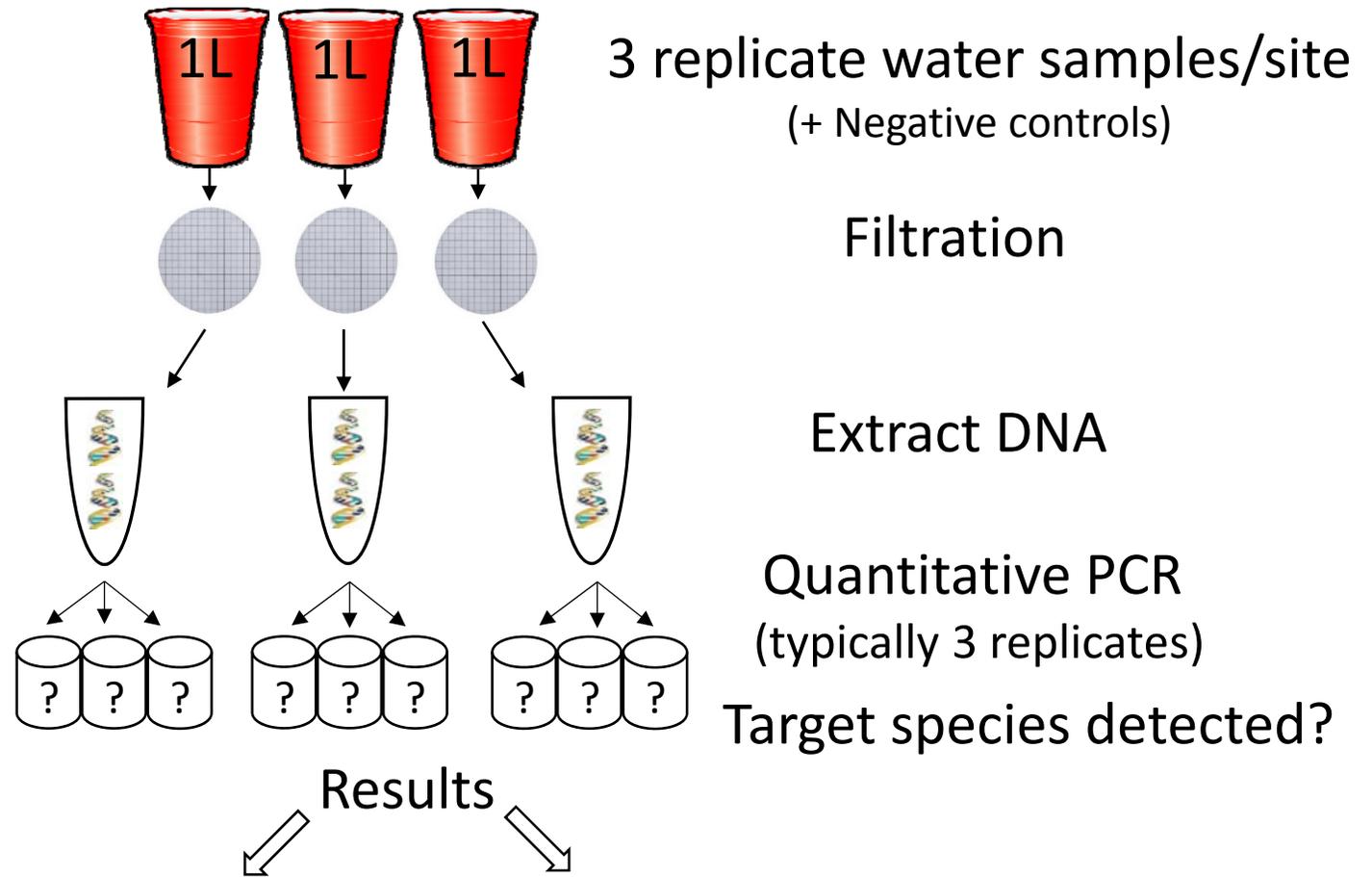
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Western Fisheries Research Center, USGS

Overview

Three lamprey field studies

1. Tracking colonization in the Elwha River following dam removal
2. Distribution and seasonal differences in eDNA across Puget Sound watersheds
3. Spatial distribution and occupancy in Chehalis River tributaries

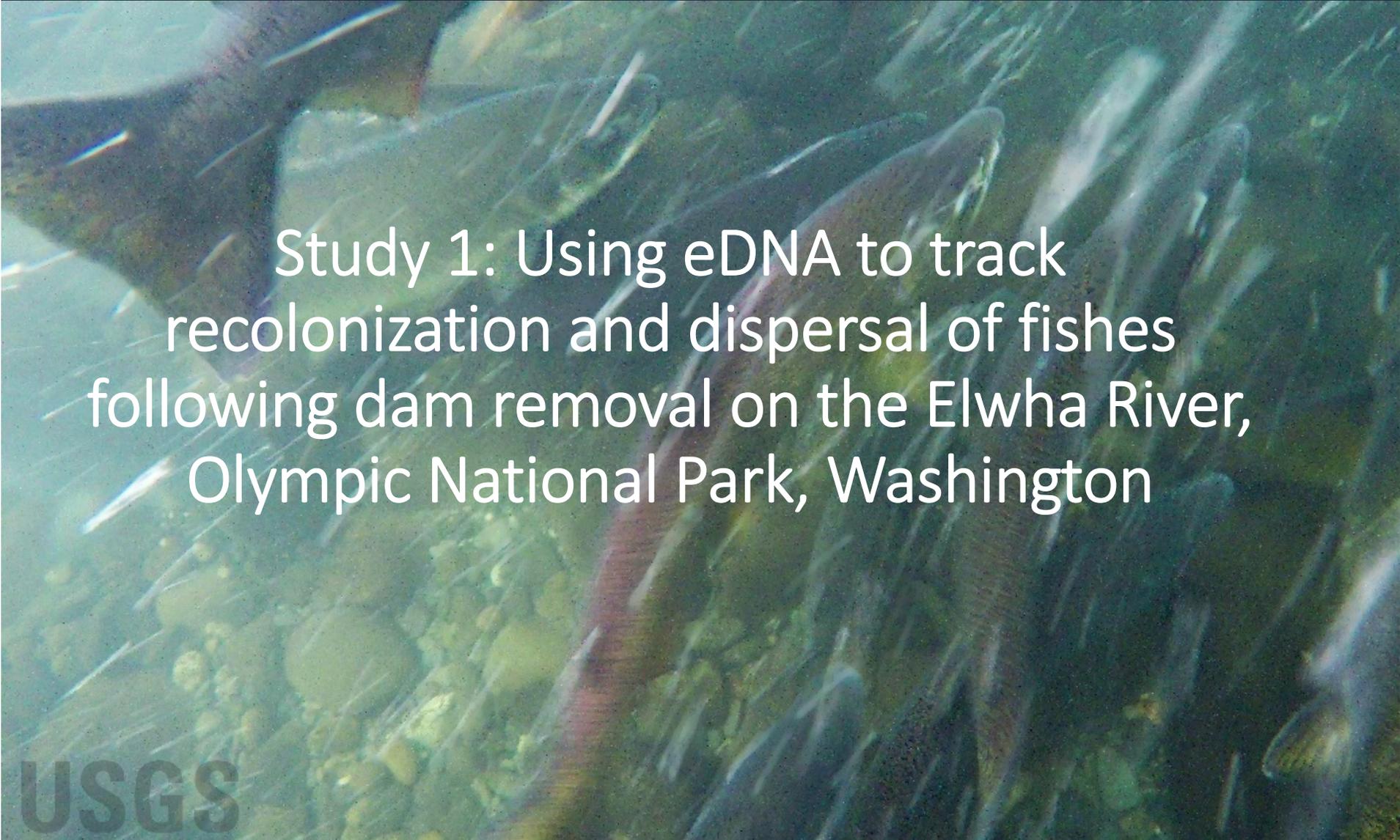
eDNA method



Number positive qPCRs

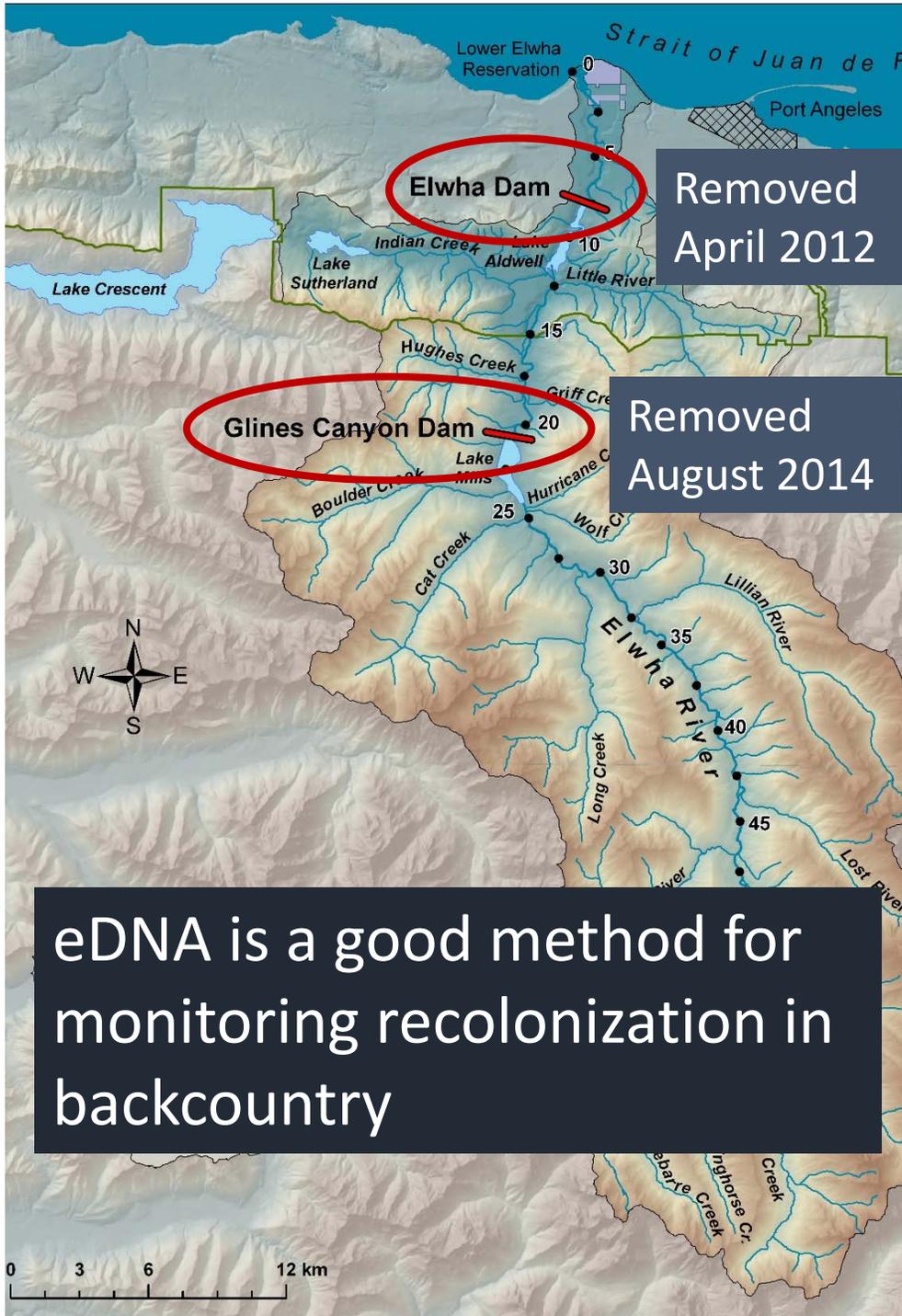
0	1	2	3	4	5	6	7	8	9
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Quantify DNA copy #

An underwater photograph showing a school of fish swimming in clear, greenish water. A diver's hand and part of a mask are visible in the upper left corner. The scene is brightly lit, with light rays filtering through the water.

Study 1: Using eDNA to track
recolonization and dispersal of fishes
following dam removal on the Elwha River,
Olympic National Park, Washington

USGS



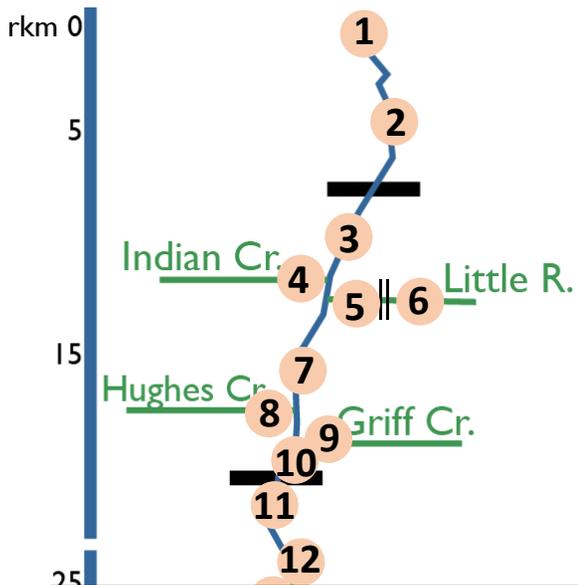
eDNA is a good method for monitoring recolonization in backcountry

Objective

Use spatial and temporal sampling of eDNA as a means for monitoring:

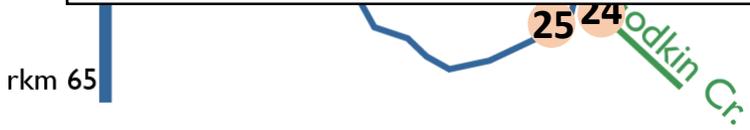
- Spatial extent of recolonization by native species
- Dispersal of non-native Brook Trout

Spatial distribution of Elwha eDNA water collections (25 sites)

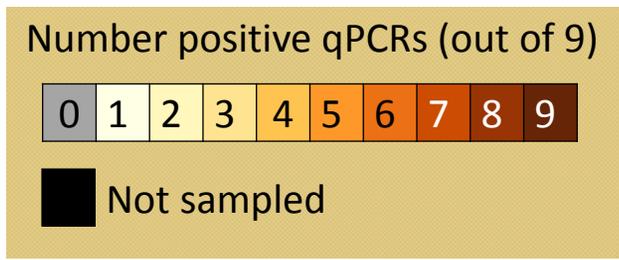
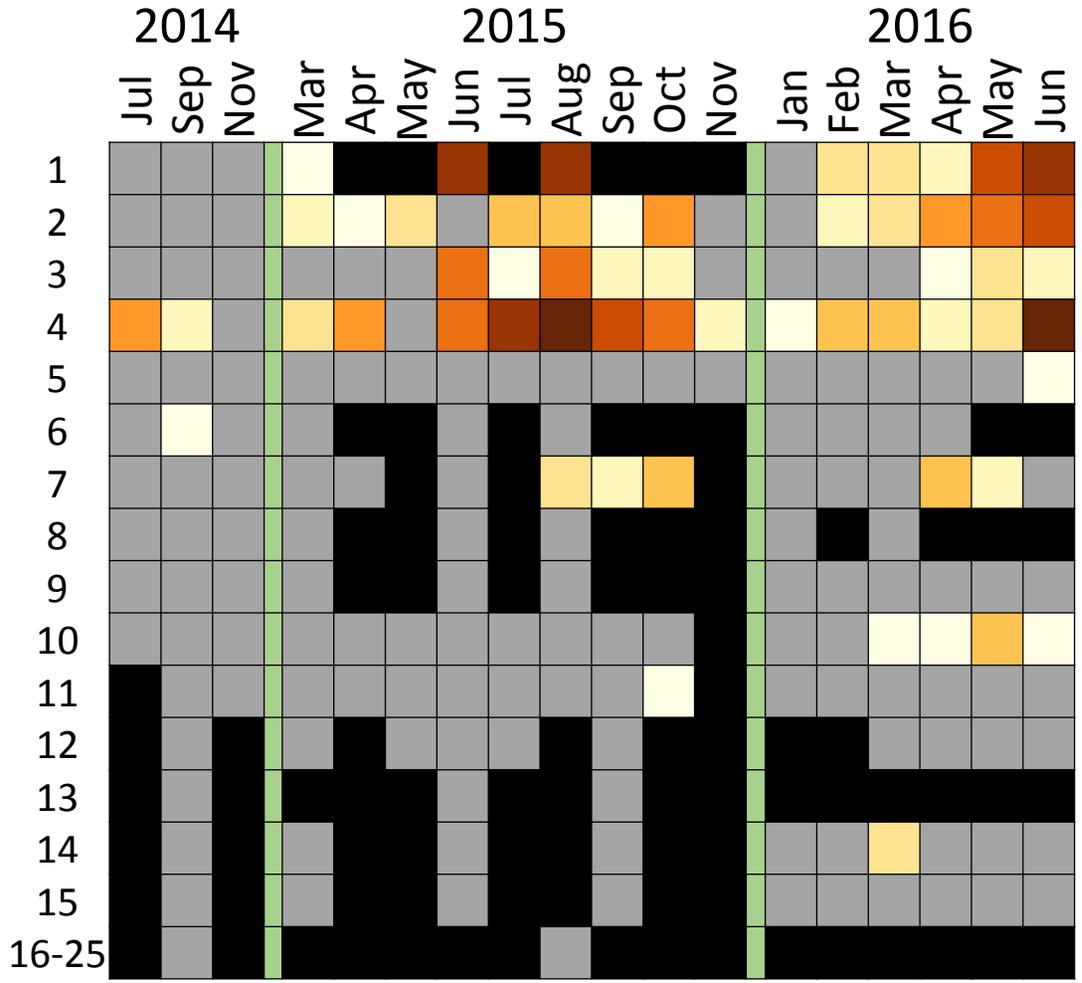
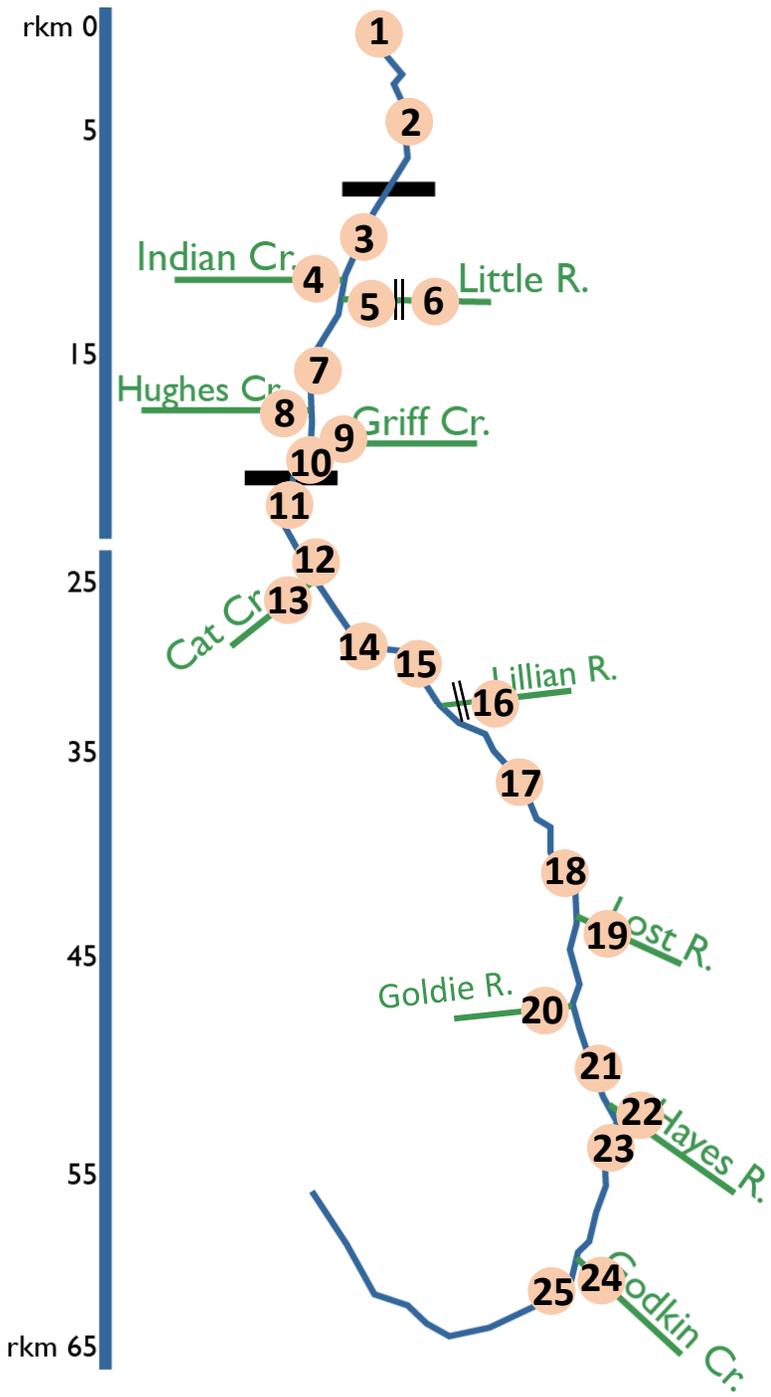


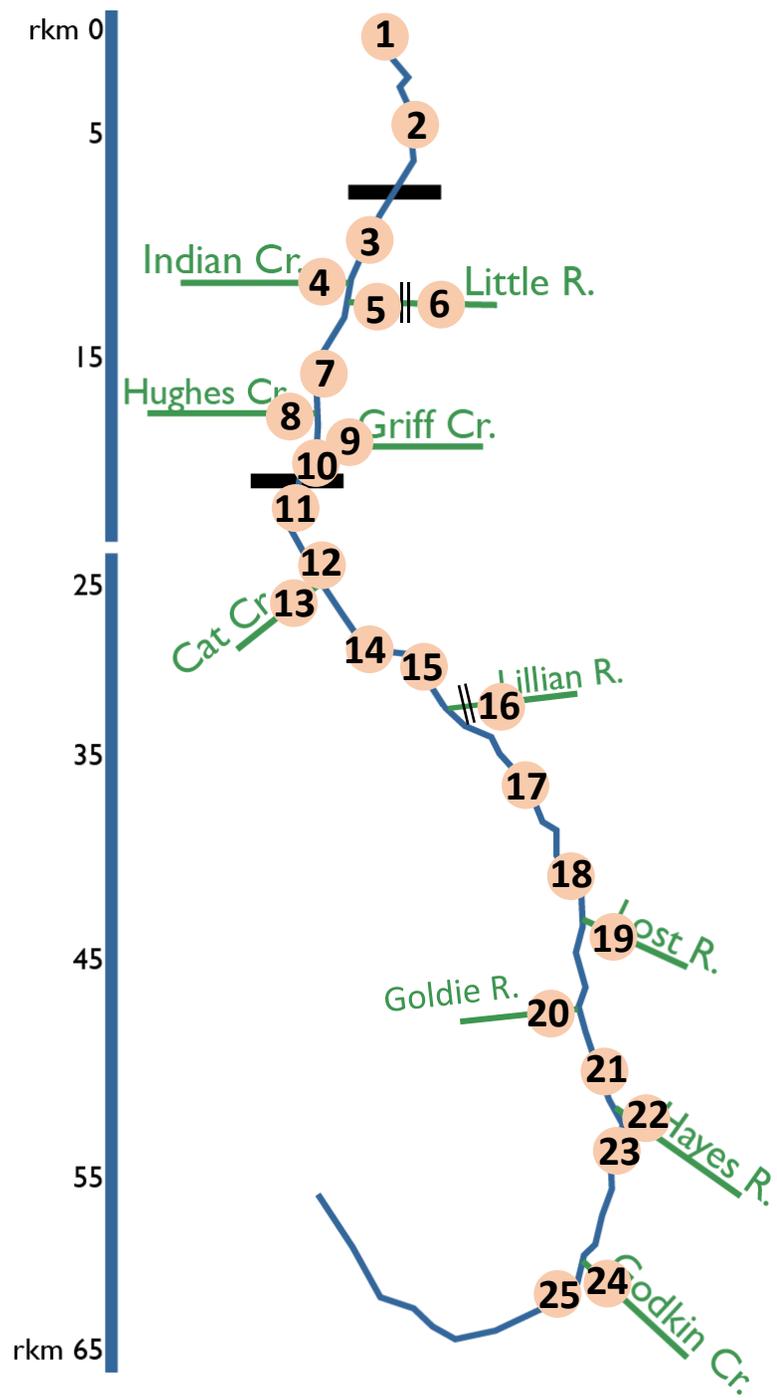
Temporal distribution of water collections

2014							Jul	Aug	Sep	Oct	Nov	Dec
2015	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

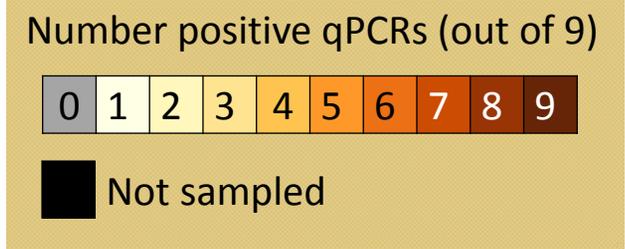
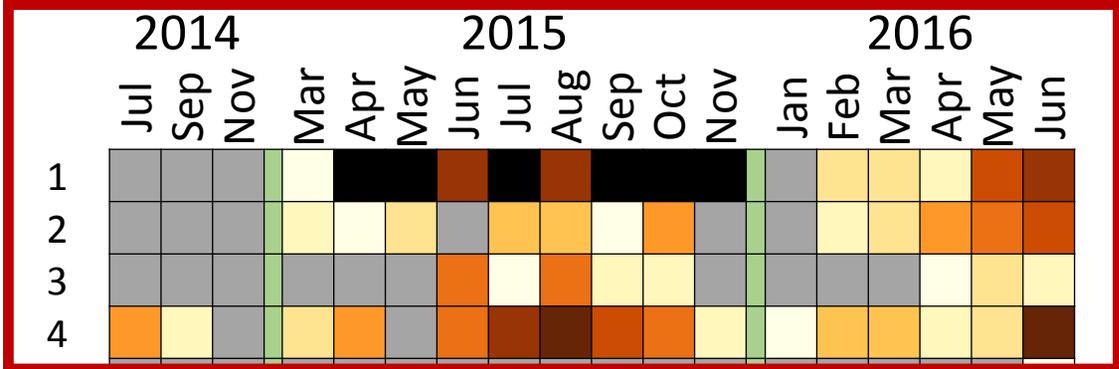


Pacific Lamprey eDNA detection

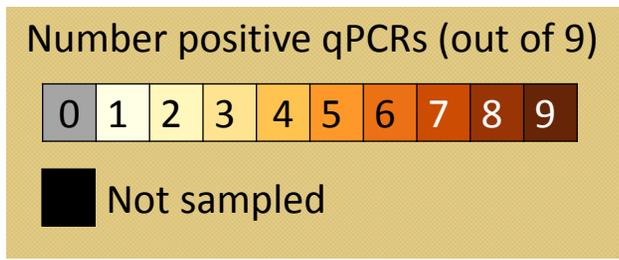
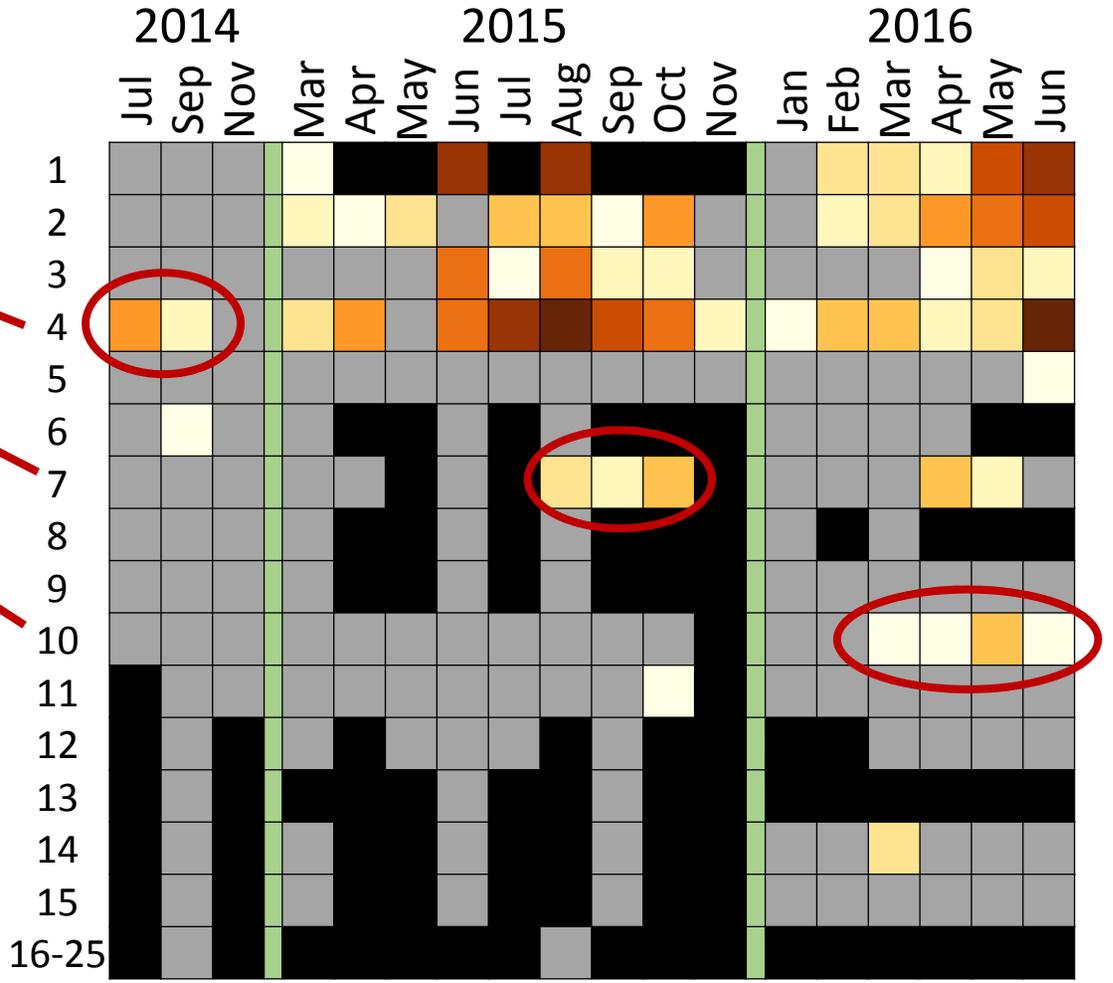
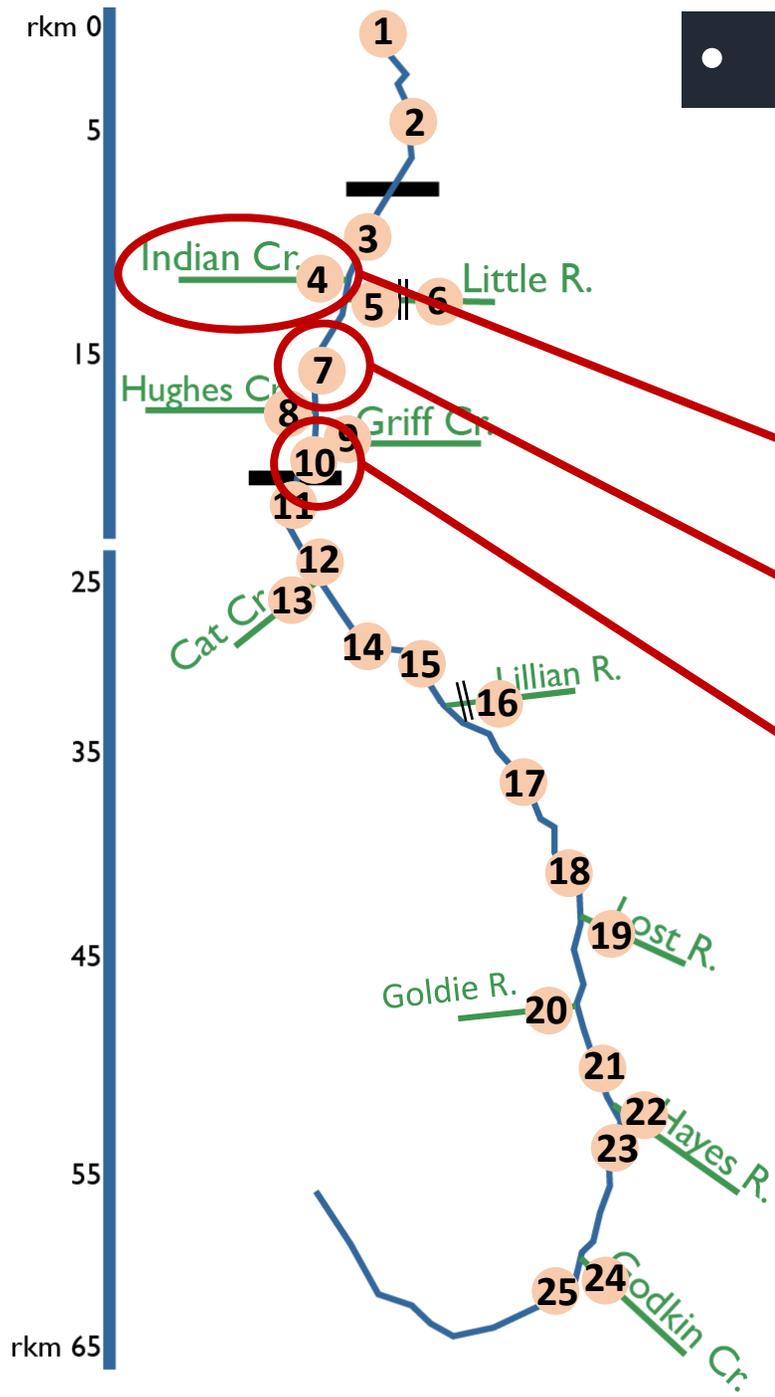




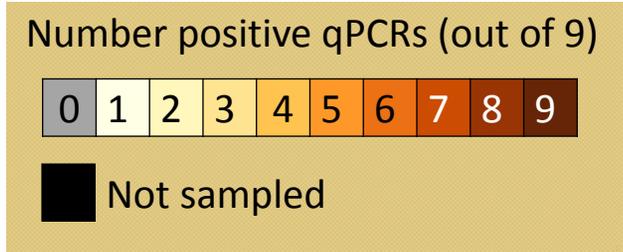
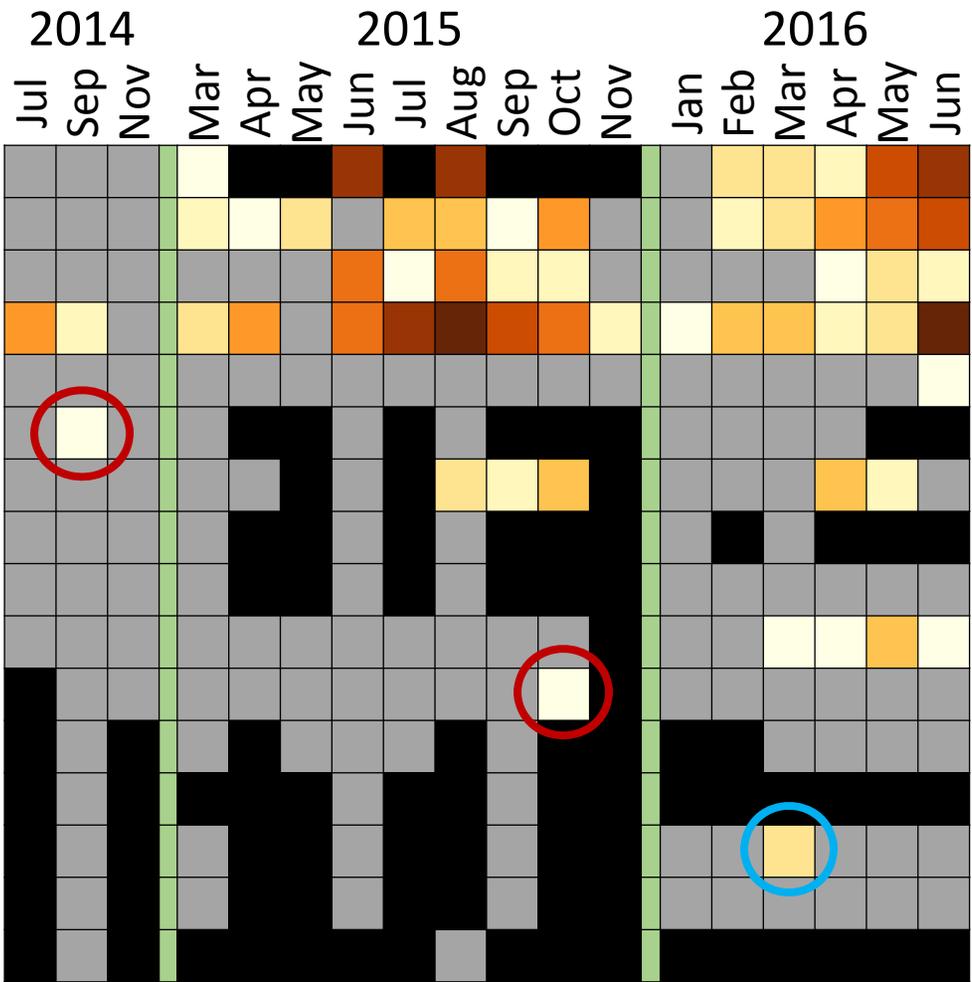
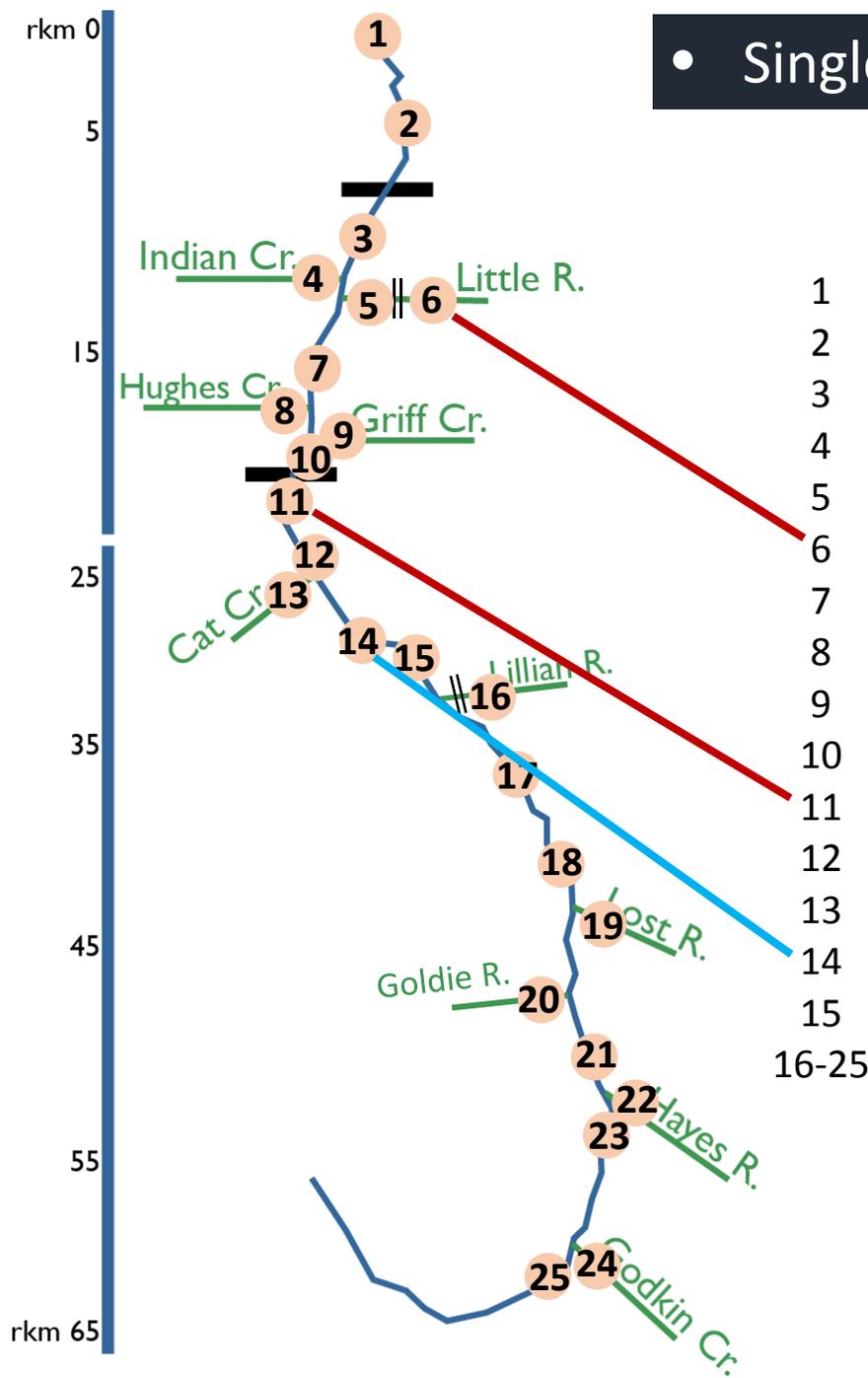
eDNA detections increase over time

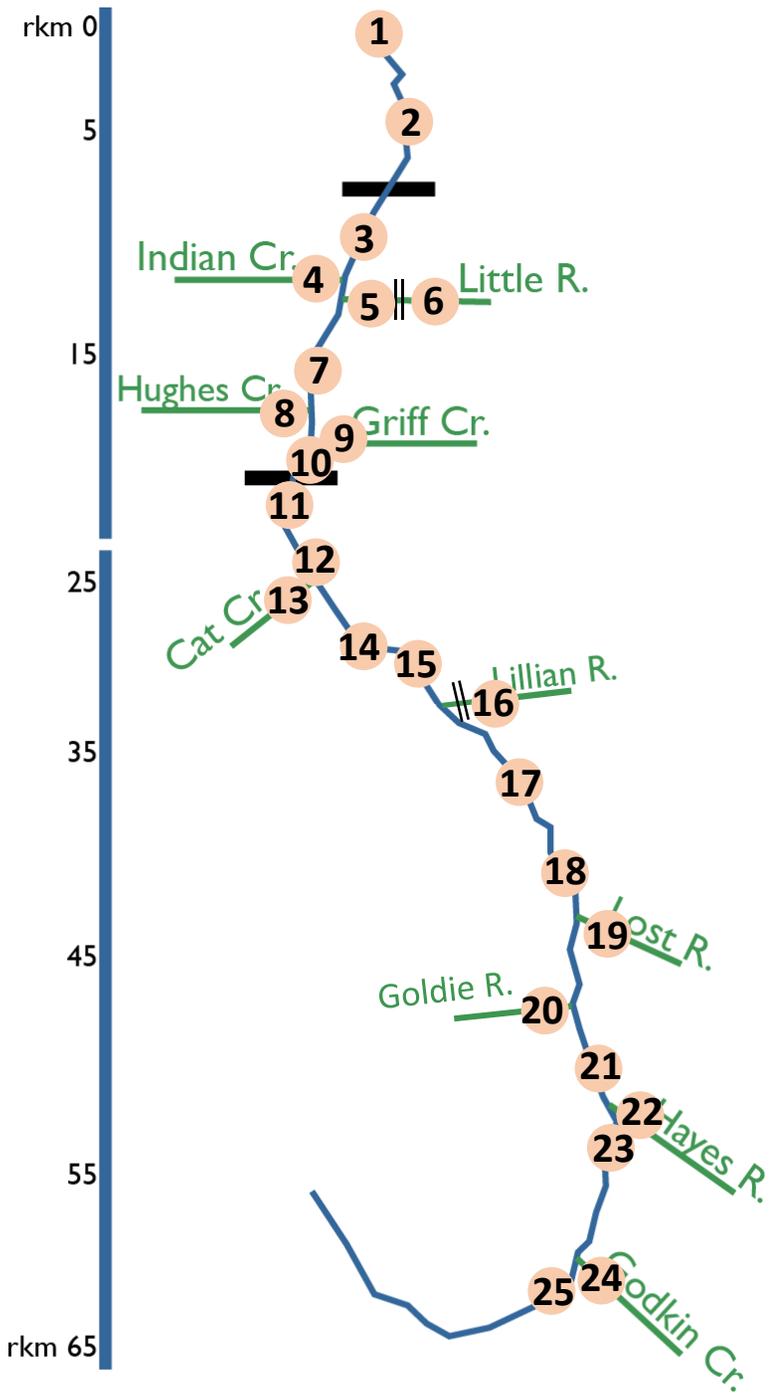


• Detections progress upstream over time

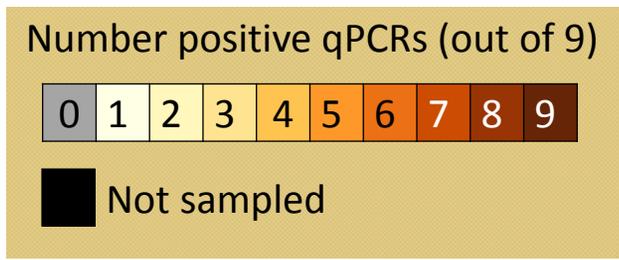
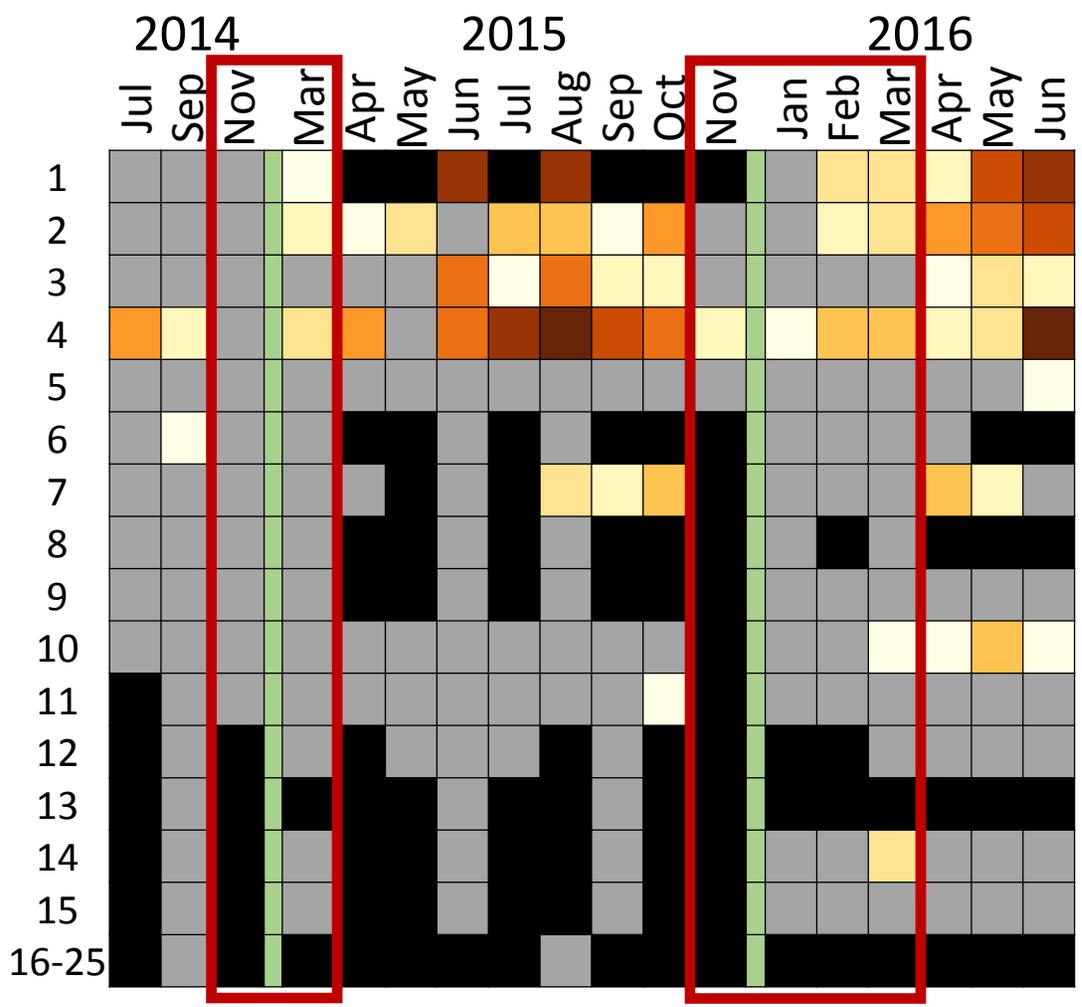


- Single detections interpreted with caution

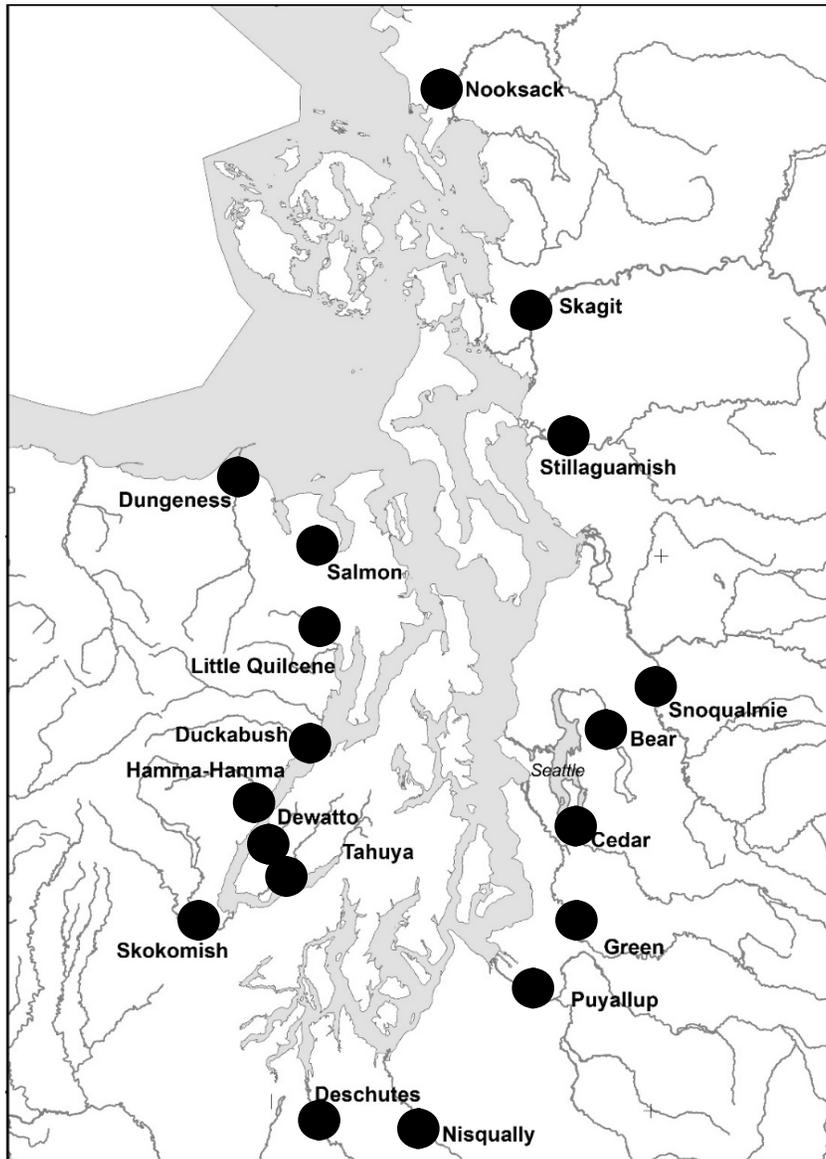




• Detections differ across months



Study 2: Distribution and seasonal differences in Pacific Lamprey and *Lampetra* spp eDNA across 18 Puget Sound watersheds



Study questions:

1. How well does eDNA reflect known species distributions?
2. Are there seasonal differences in detection?

Sampling:

Fall: October 9 – November 13, 2014

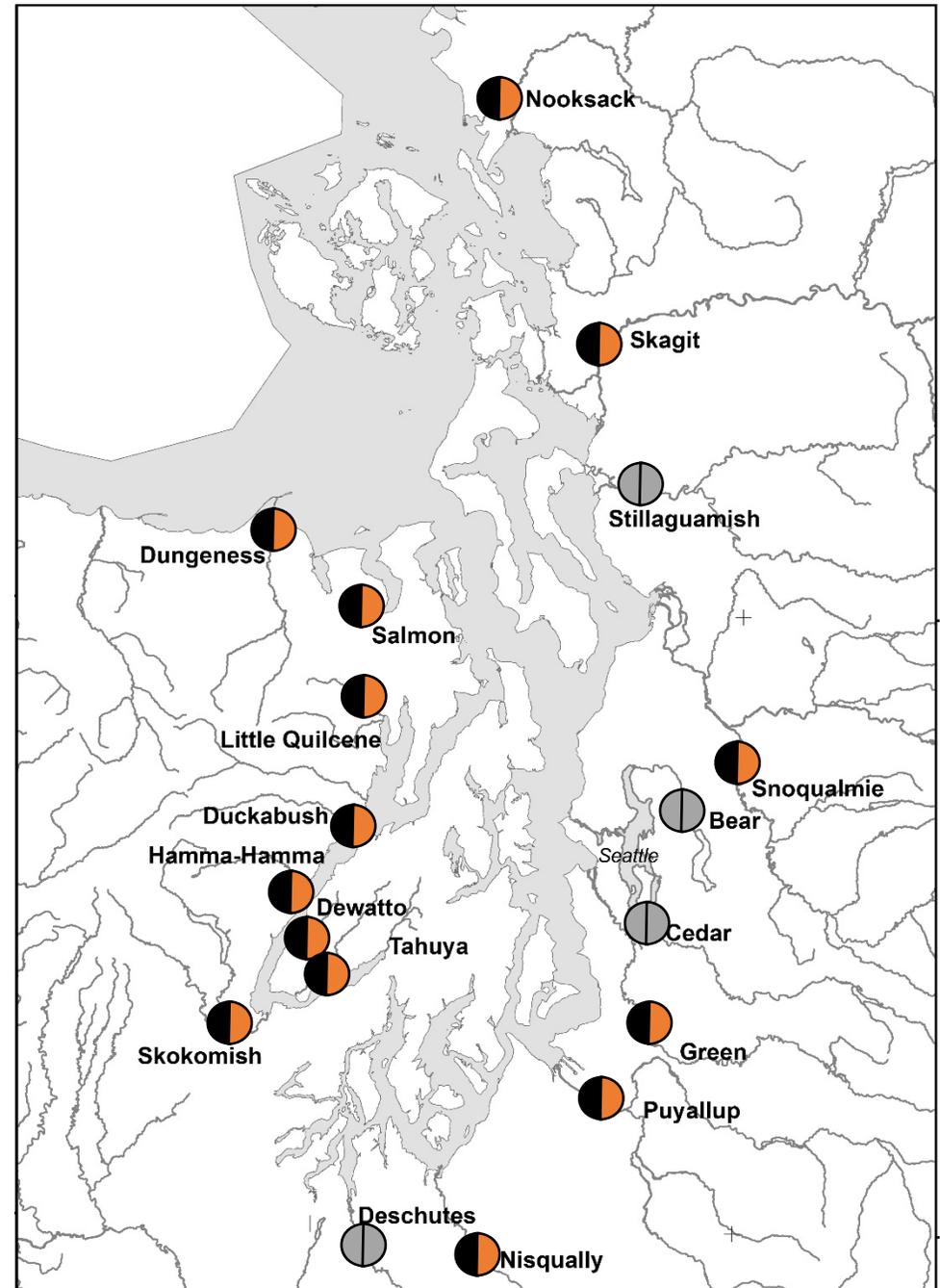
Spring: May 6 – June 30, 2015,

Manuscript in review

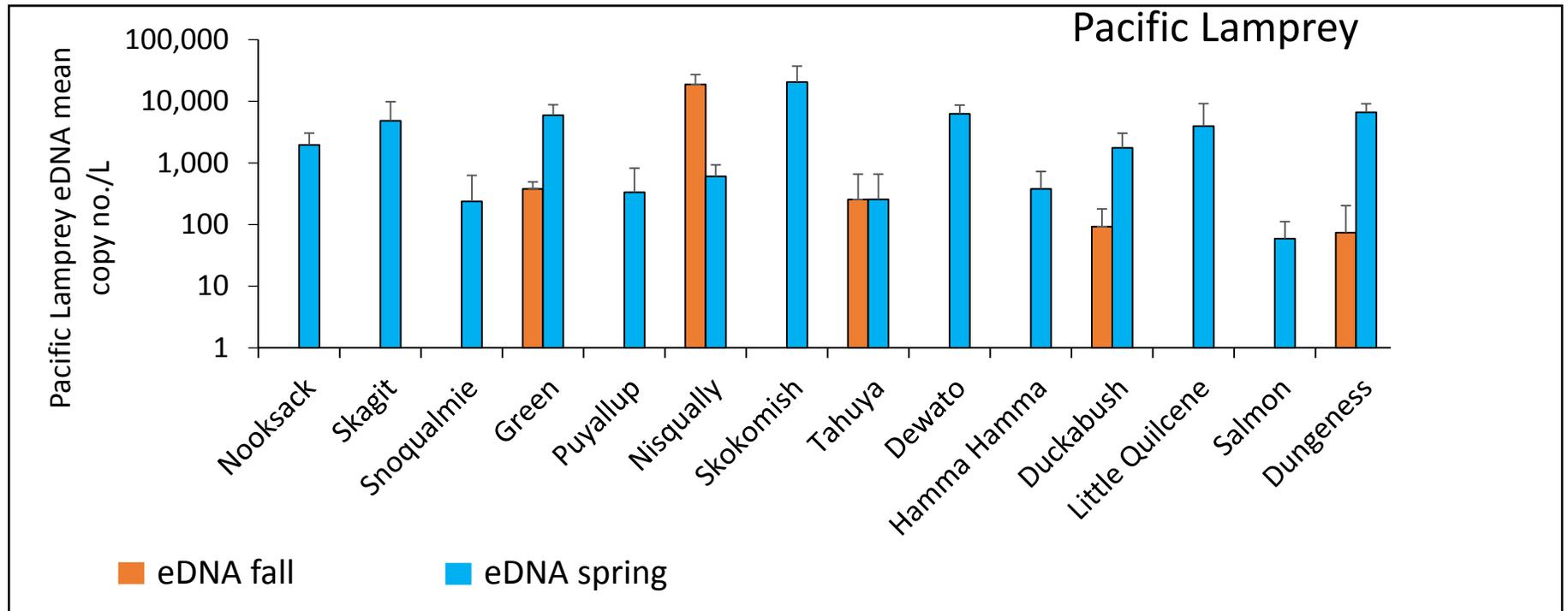
How well does eDNA reflect Pacific Lamprey distribution?

- Pacific Lamprey known occurrence
 - most data are from 2011
- eDNA detected
- Not present or eDNA not detected

- Application of eDNA replicated the known Pacific Lamprey distribution

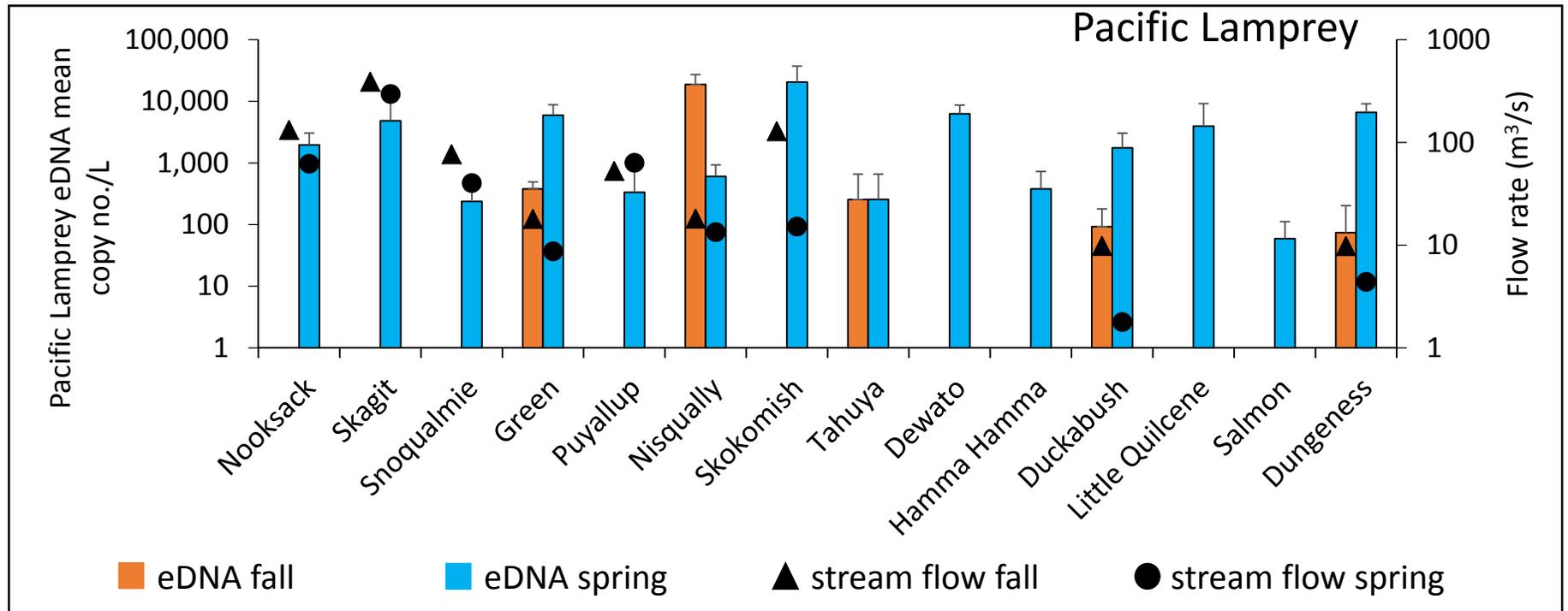


Are there seasonal differences in eDNA detection?



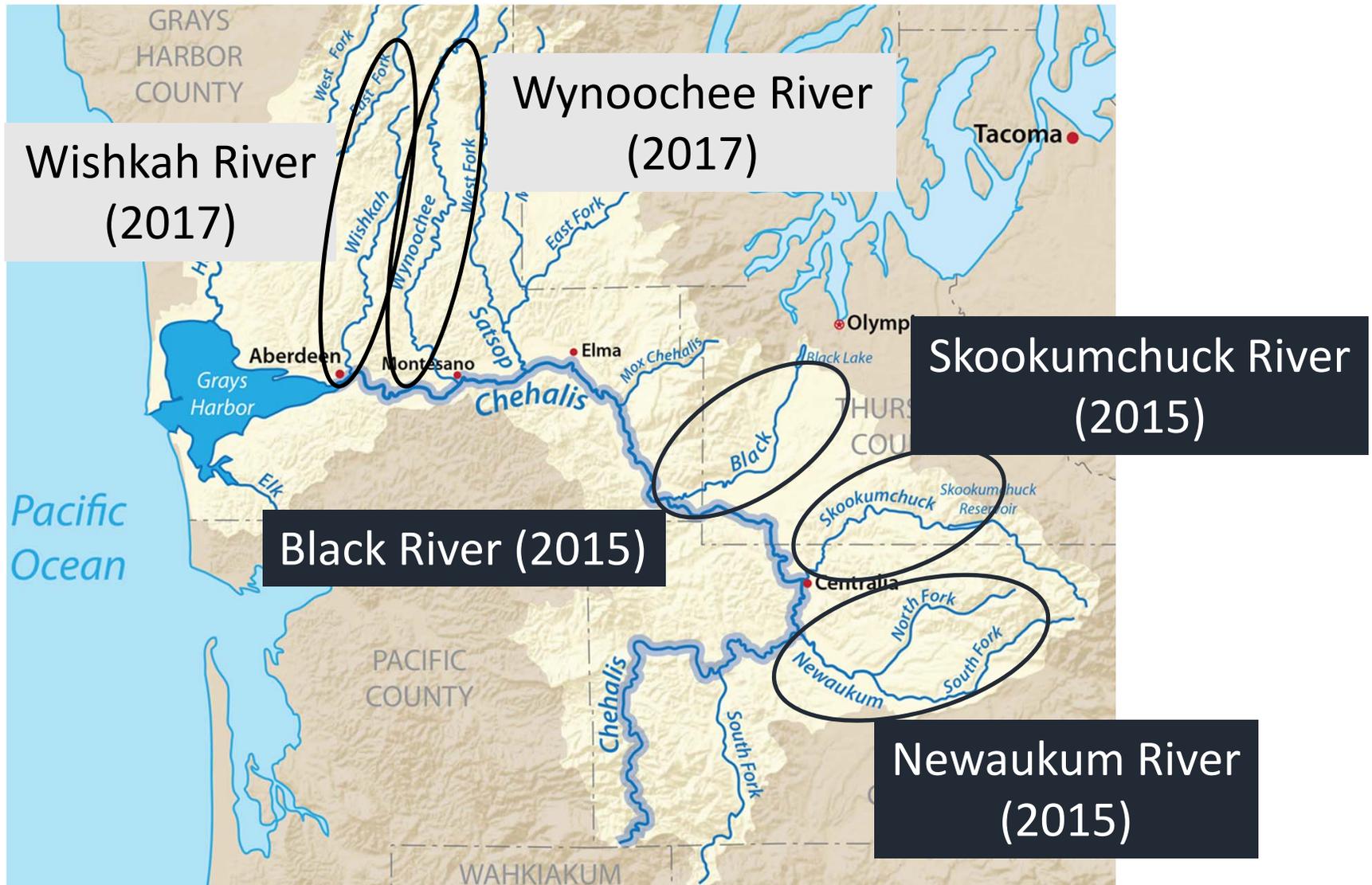
- eDNA concentration higher in spring (better detection)
- 14 streams positive in spring, 5 streams positive in fall
 - False negative results for 9 streams

Are there seasonal differences in eDNA detection?



- Possible causes for lower detection in fall:
 - Flow rate
 - Life history

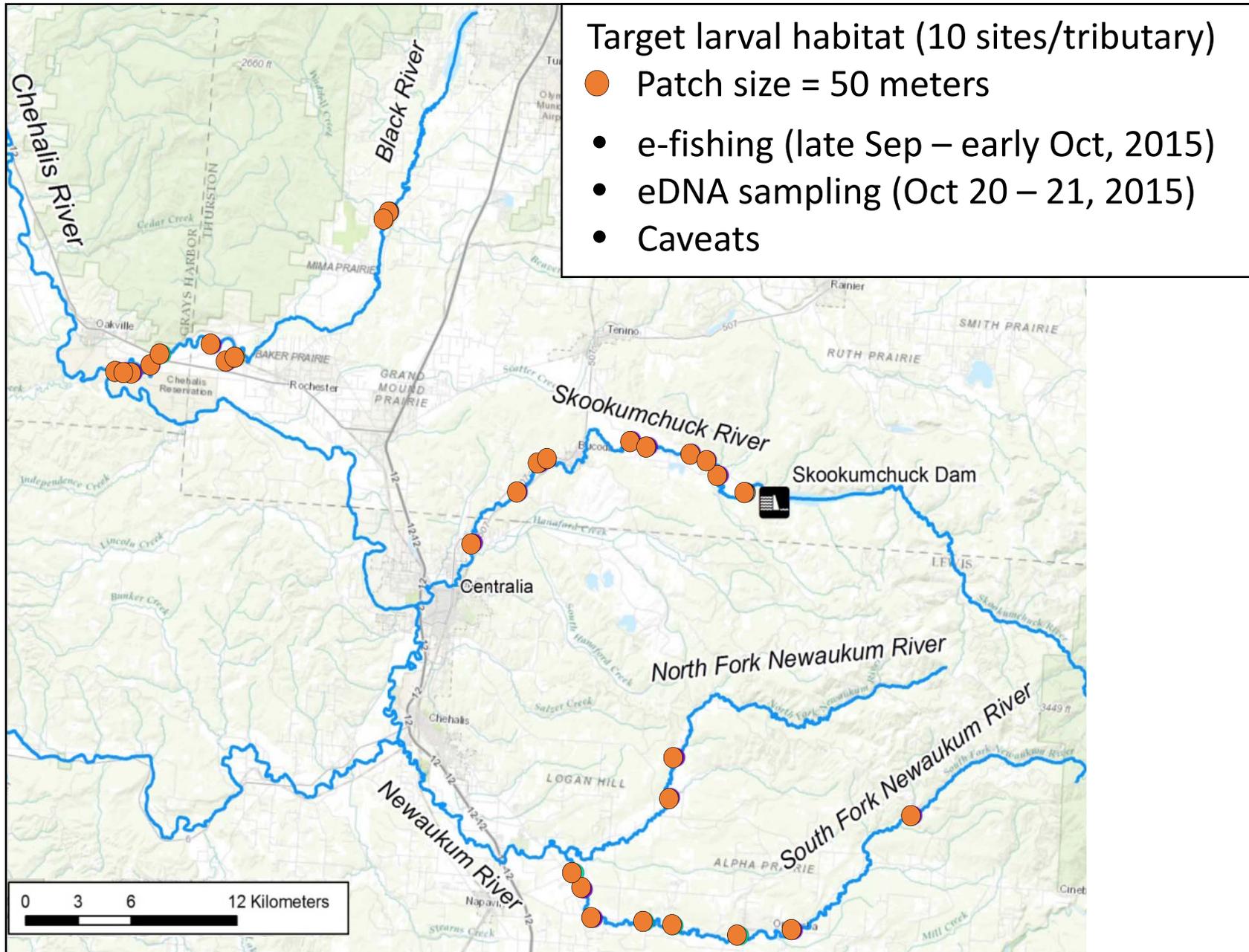
Study 3: Assessing the spatial distribution and occupancy of larval lamprey in Chehalis River tributaries



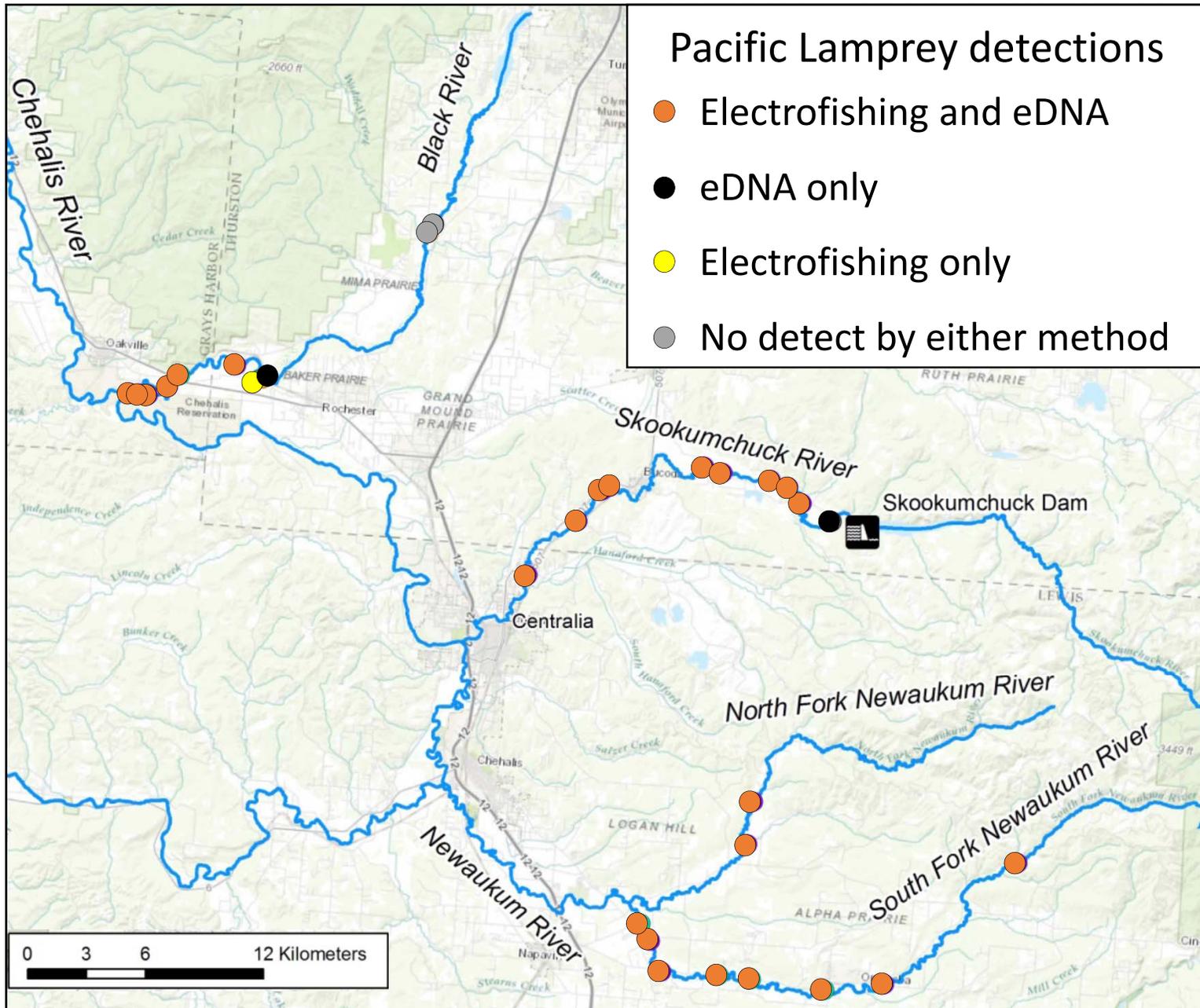
Objectives

- Evaluate performance of eDNA for detecting Pacific Lamprey and *Lampetra* spp compared to electrofishing.
- Determine if eDNA quantity is distributed differently for Pacific Lamprey and *Lampetra* spp within tributaries.
- Apply eDNA to an occupancy modeling framework

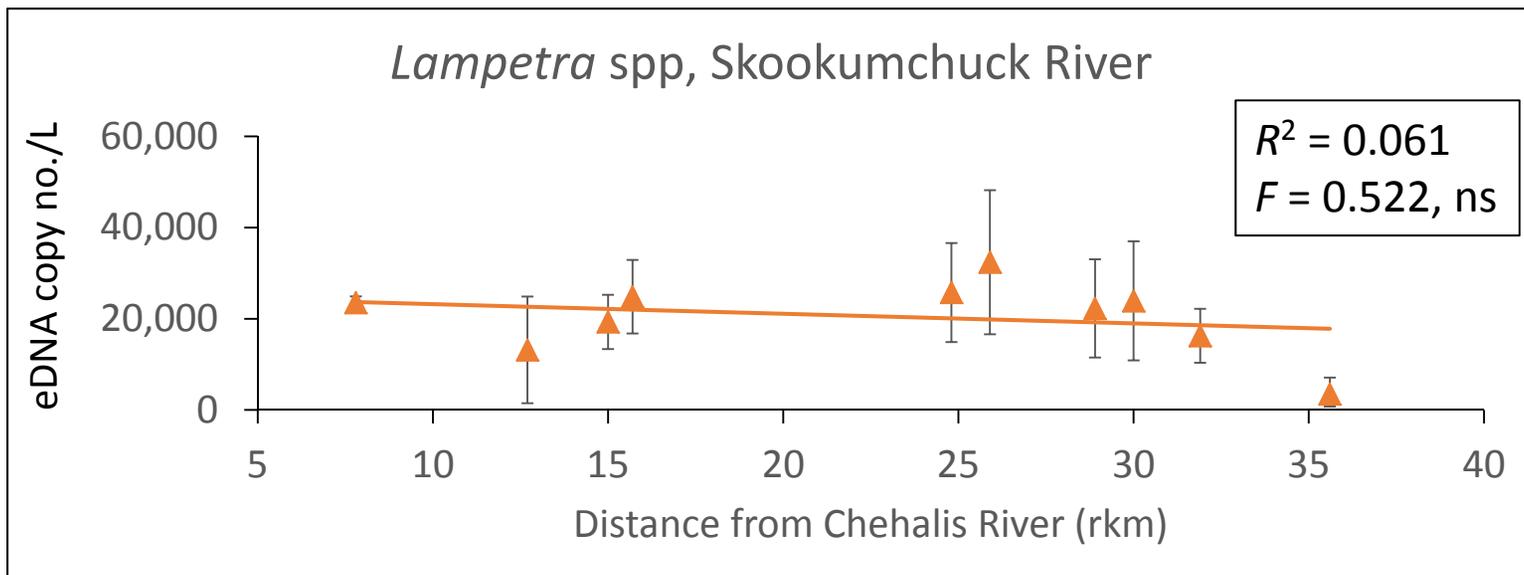
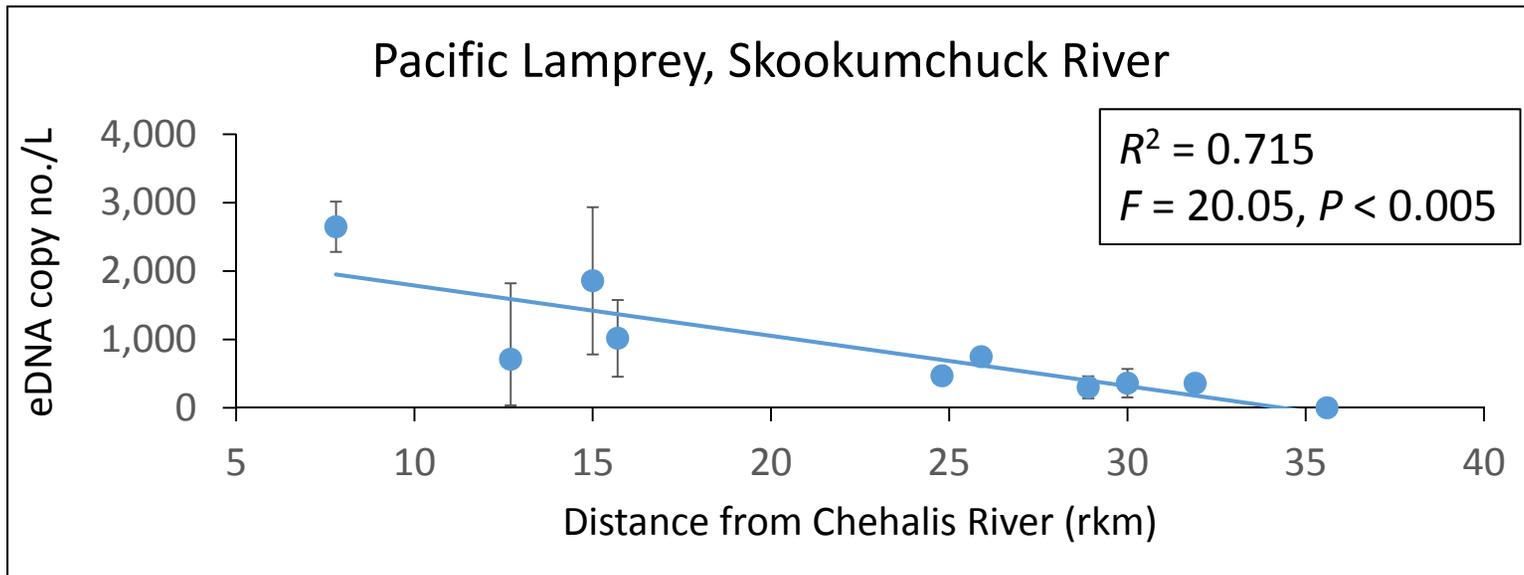
2015 sampling (Black, Skookumchuck, Newaukum)



Pacific Lamprey: electrofishing vs. eDNA



Is eDNA quantity distributed differently for Pacific Lamprey and *Lampetra* spp within tributaries?



Lessons learned – summary

- Combined temporal and spatial sampling
 - Allowed colonization to be tracked upstream over time.
 - Detections increased over time
- Single detections are interpreted with caution
 - replicated results provide confidence
- Seasonal differences in eDNA detection
 - Higher in spring/summer; lower in fall/winter
 - Stream flow
 - Life history events
- eDNA accurately identifies species distributions
- eDNA performs comparably to electrofishing for identifying occupancy
- eDNA concentrations may inform on relative abundance/biomass
 - Further studies required

Acknowledgements

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NPS

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USFWS

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Carrie Cook-Tabor

Judith Barkstedt



Pacific Lamprey assay primer and probe sites are conserved among:

- Vancouver Lamprey (*E. macrostomus*)
 - Miller Lake Lamprey (*E. minimus*)
 - Klamath Lamprey (*E. similis*)
 - Pit-Klamath Brook Lamprey (*E. lethophagus*)
 - forward primer has one mismatch with Pit-Klamath Brook Lamprey
-
- Lampetra spp assay primer and probe sites are conserved among:
 - *L. ayresii*, *L. richardsoni*, *L. pacifica*, and *L. hubbsi*, although the assay may have limited or no detectability of *Lampetra spp* in certain geographic locations.
 - North Fork Siuslaw River, OR, Hunter Creek, CA, McGarvey Creek, CA, Kelsey Creek, CA, and Mark West Creek, CA
 - Boguski et al. (2012) suggested the *Lampetra* spp in Siuslaw River, Kelsey Creek, and Mark West Creek could represent cryptic species.

Lampetra spp eDNA assay

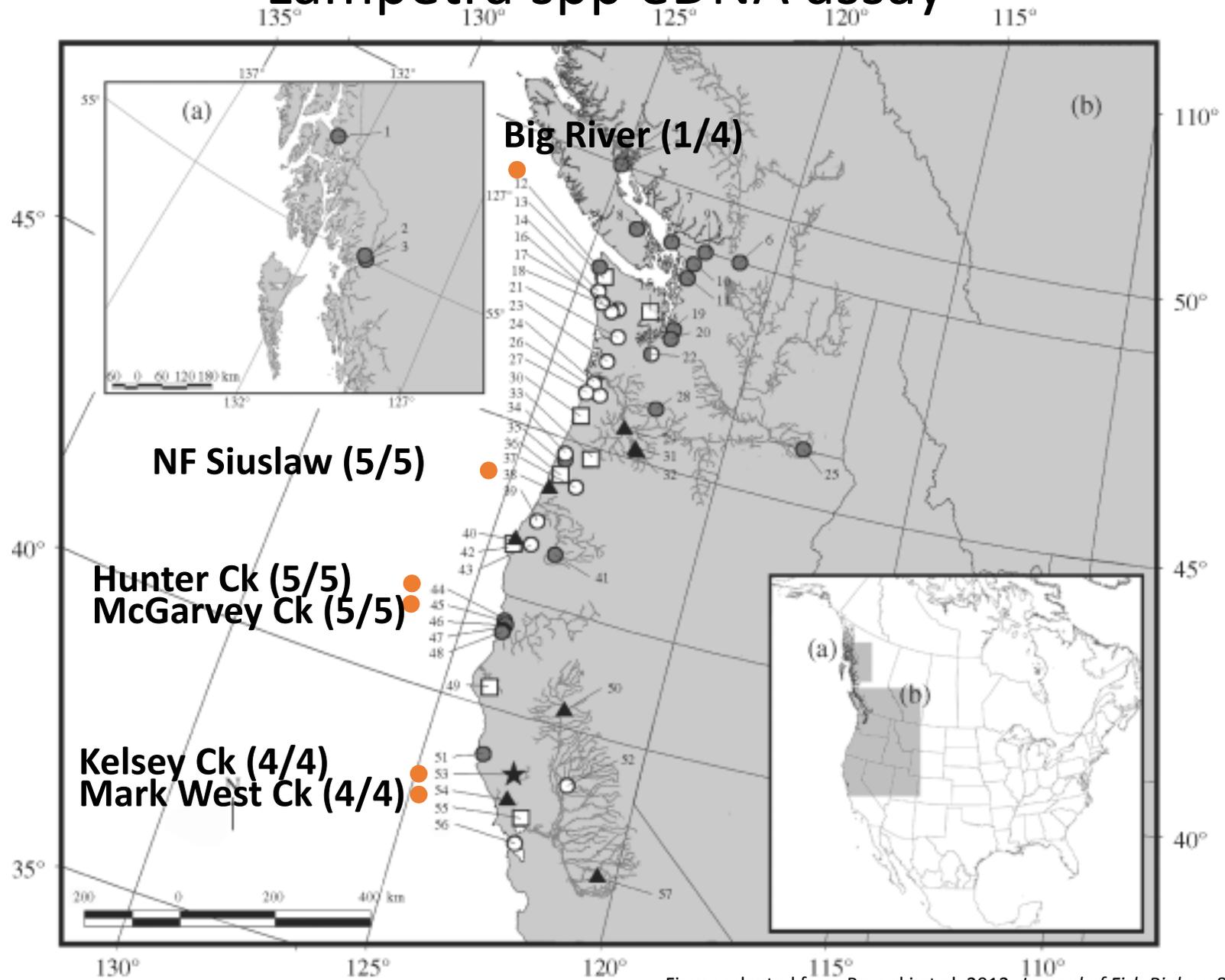
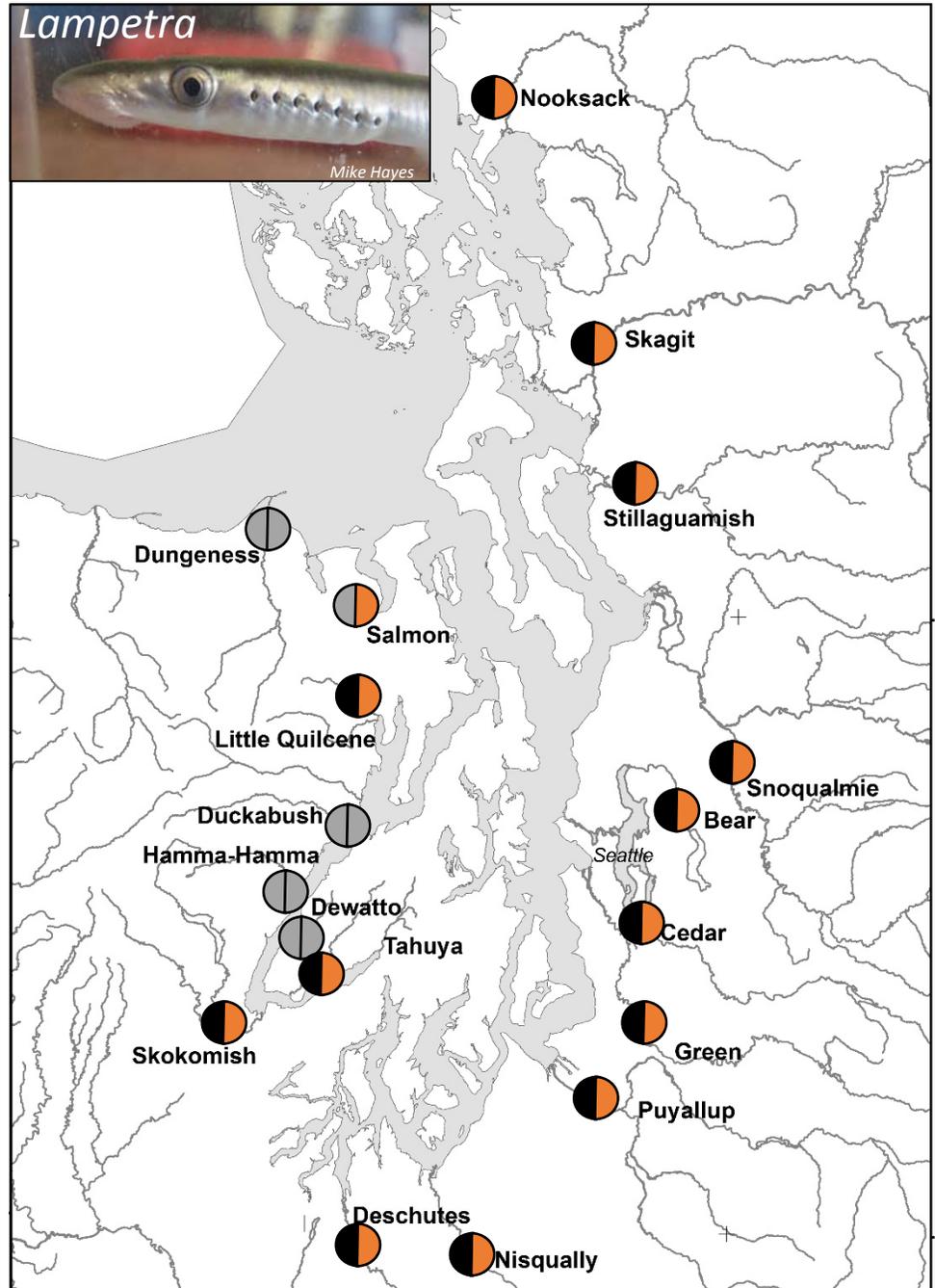


Figure adapted from Boguski et al. 2012, *Journal of Fish Biology* 81:1891-1914

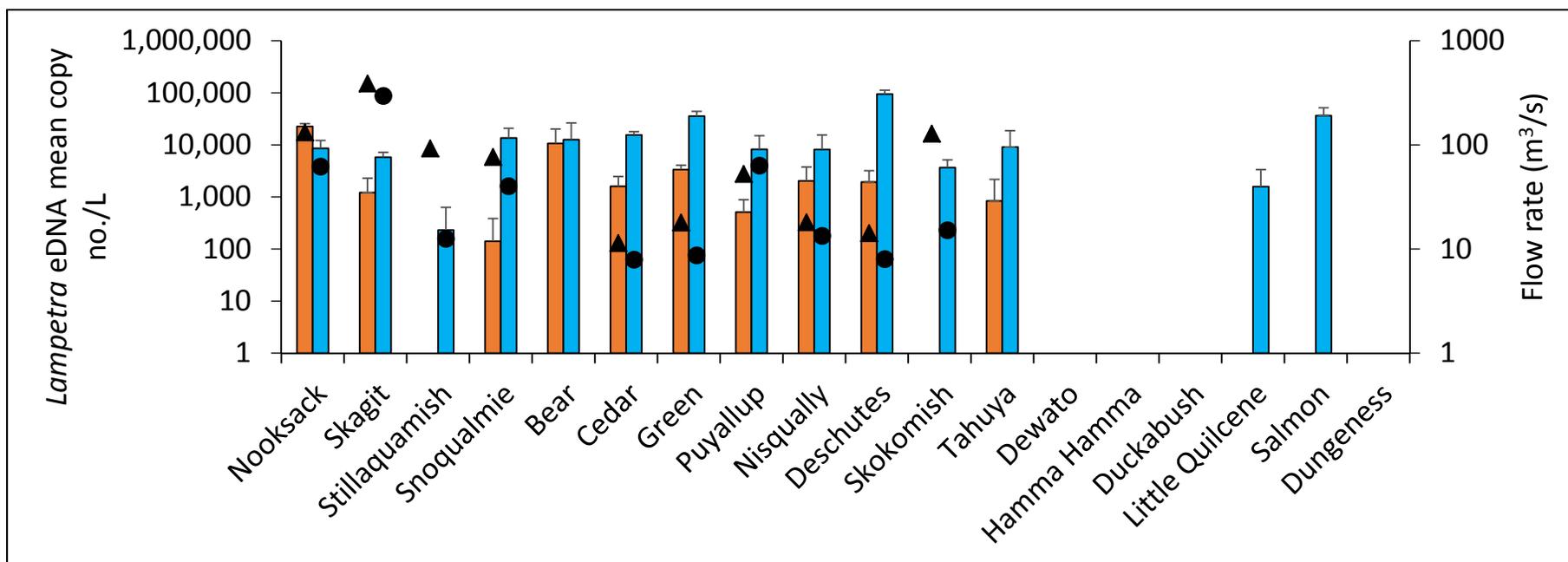
Lampetra distribution



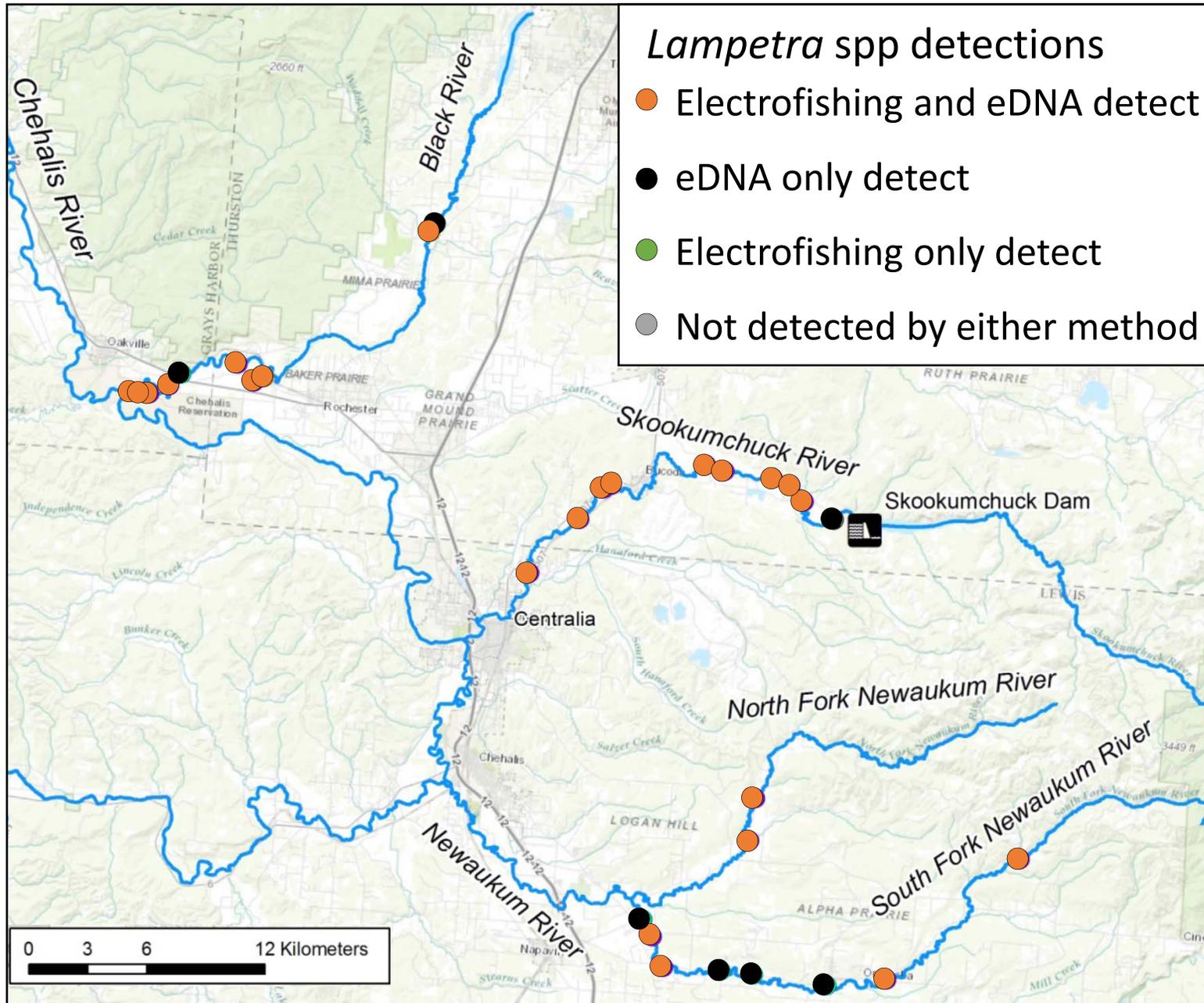
- *Lampetra* known occurrence
- eDNA detected
- Not present or eDNA not detected

- Agreement between eDNA and fish traps for 17/18 locations
- *Lampetra* eDNA detected in one additional stream

Seasonal difference in eDNA abundance



Lampetra spp: electrofishing vs. eDNA

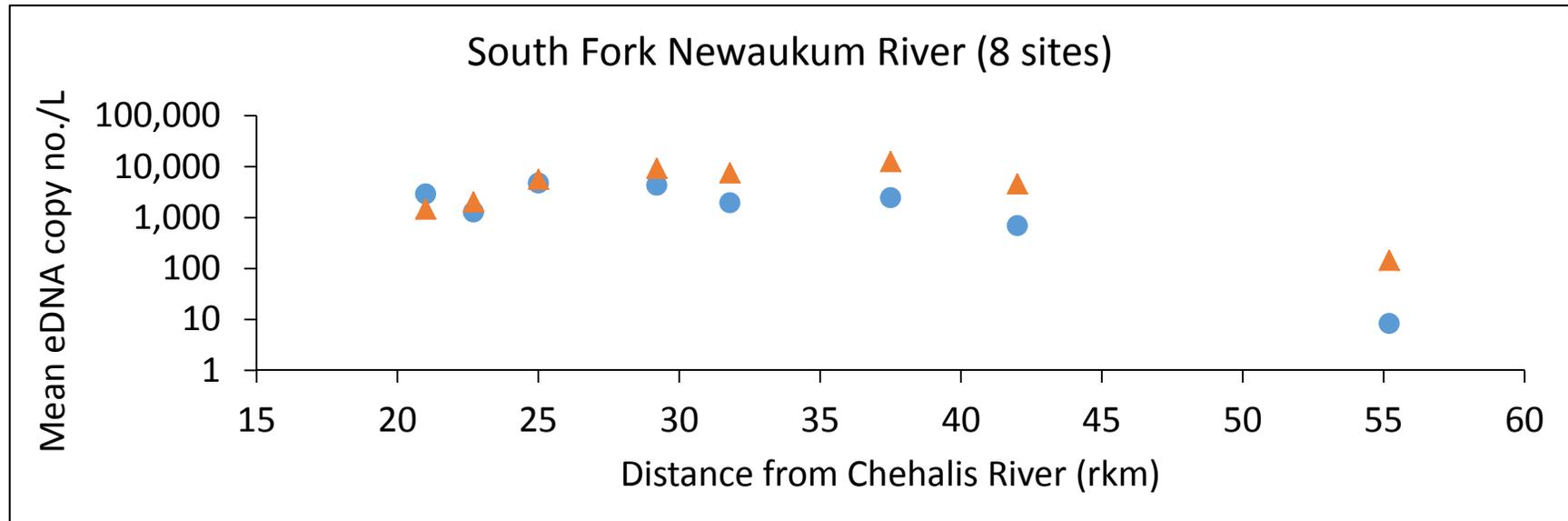


Distribution of Pacific Lamprey and *Lampetra* spp eDNA

➤ What do eDNA concentrations tell us?

Linear regression: eDNA concentration on distance

- H_0 : slope is not different from zero



● Pacific Lamprey

$R^2 = 0.436$

$F = 4.63, P = 0.075$ (DF = 1, 6)

▲ *Lampetra* spp

$R^2 = 0.007$

$F = 0.04, ns$ (DF = 1, 6)