Environmental DNA Applications for Fisheries Conservation and Management

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FOR WILDLIFE AND FISH CONSERVATION

Columbia Gorge Fisheries and Watershed Science Conference
April 18th, 2017

Environmental DNA

DNA released from an organism into the surrounding environment

Environmental DNA

A powerful presence/absence tool

A somewhat useful tool for abundance

A poor tool for age/size structure, genetic diversity, hybridization

Environmental DNA: Basic Research

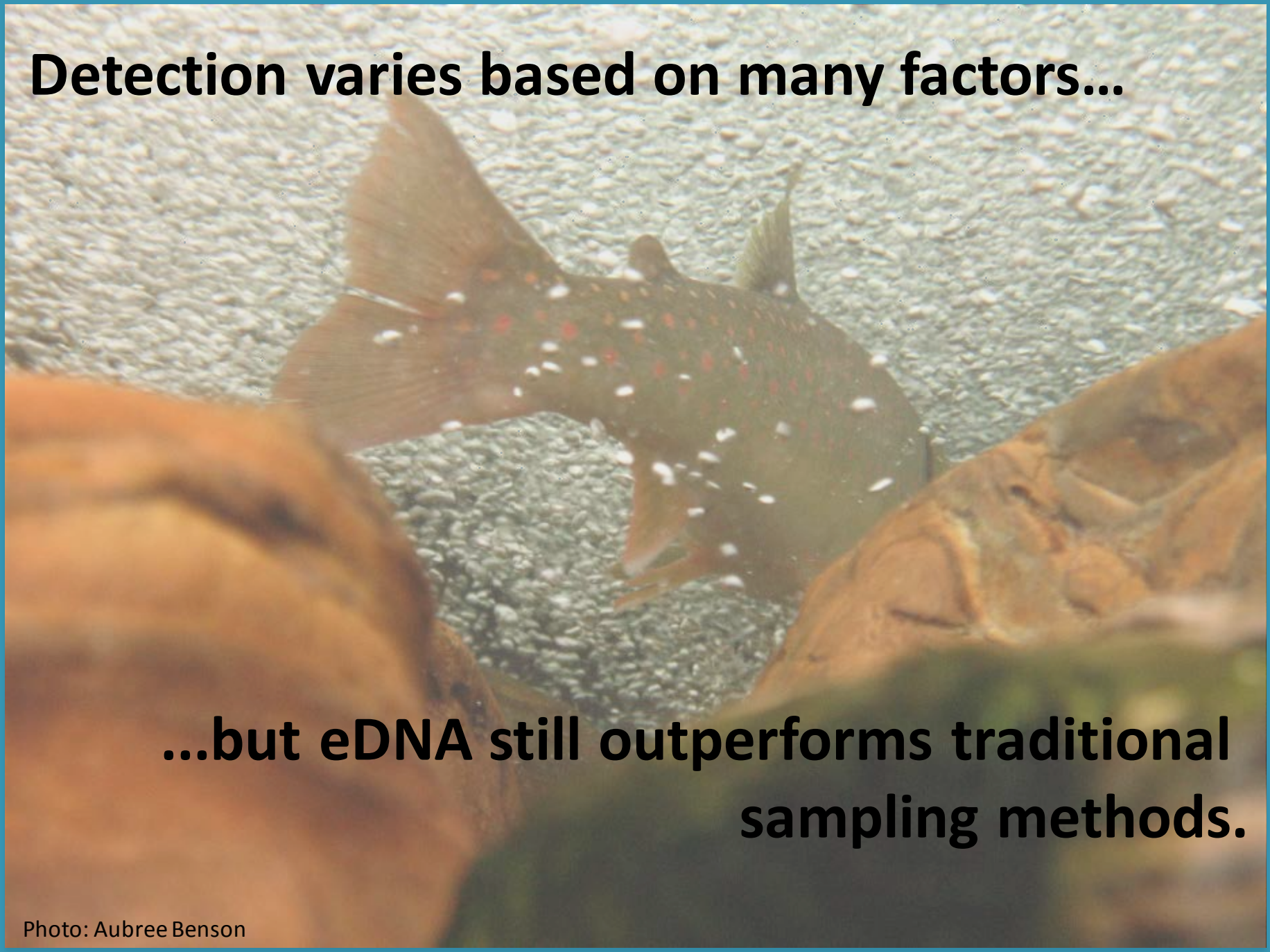
How long does eDNA persist in the environment?

How close do you need to be to an animal to detect it?

How does eDNA detection vary between systems?

How common are false positives and false negatives?

Photo: Aubree Benson

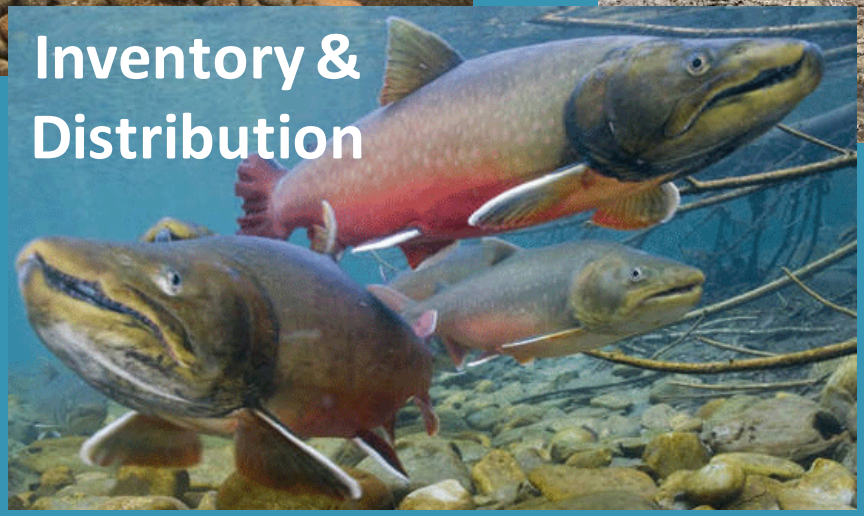

Detection varies based on many factors…
…but eDNA still outperforms traditional sampling methods.
Photo: Aubree Benson

Environmental DNA: Applied Research

How can eDNA be used to inform fisheries conservation and management?

Photo: Aubree Benson

Environmental DNA Applications for Fisheries Conservation and Management



eDNA for Monitoring Species Reintroduction Efforts

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Reintroduction of Pacific Lamprey in the Wenatchee River

Reintroduction of Pacific Lamprey in the Wenatchee River

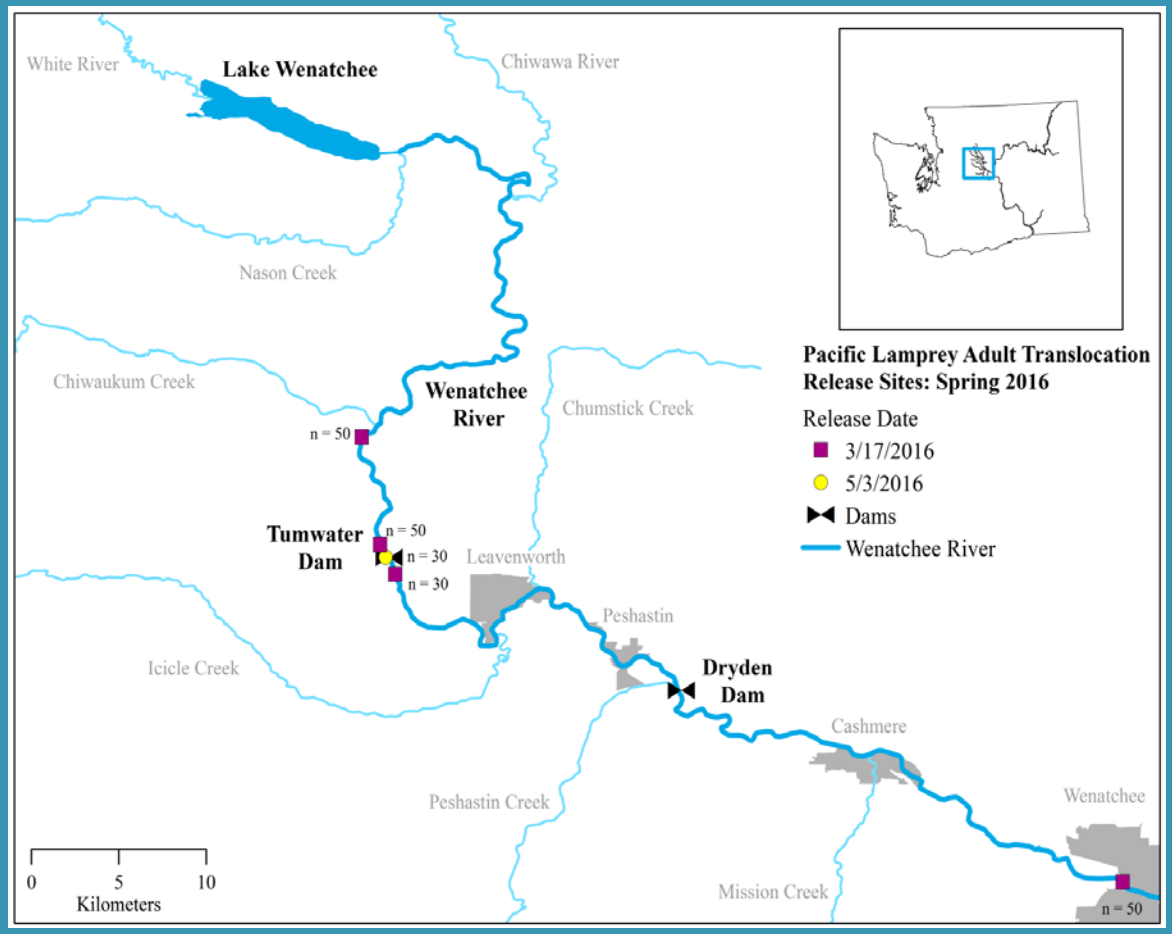
2009 electrofishing surveys by US Fish and Wildlife Service to determine distribution

No Pacific lamprey observed above Tumwater Dam

In 2016 Yakima Nation Fisheries Program began translocations

What can eDNA sampling tell us about fish movement post-translocation in a large river system?

Lamprey Reintroduction by the Numbers

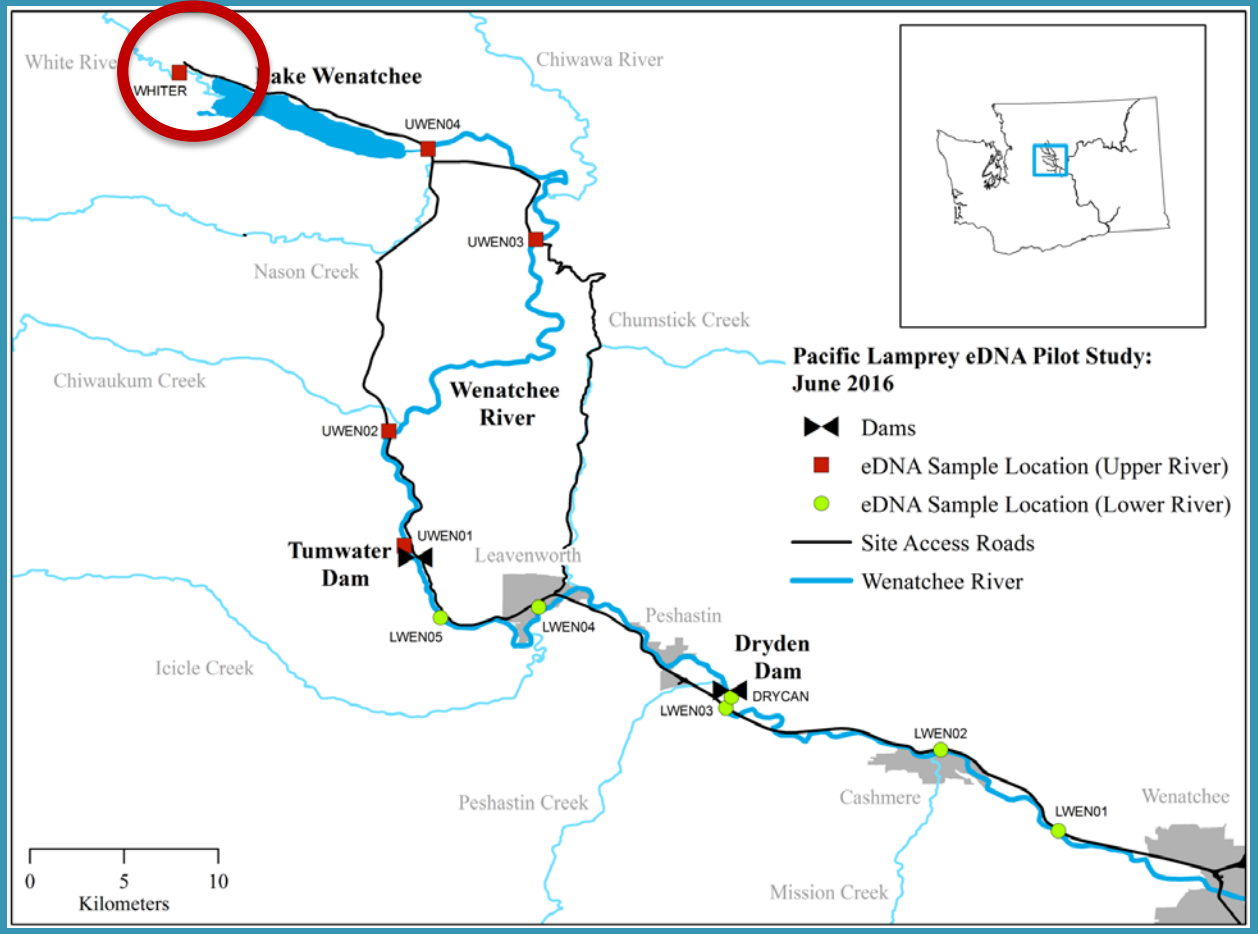


March 17th, 2016: 180 PIT tagged fish in “lower” and “upper” River

May 3rd, 2016 : 30 additional PIT tagged fish released in “upper” River

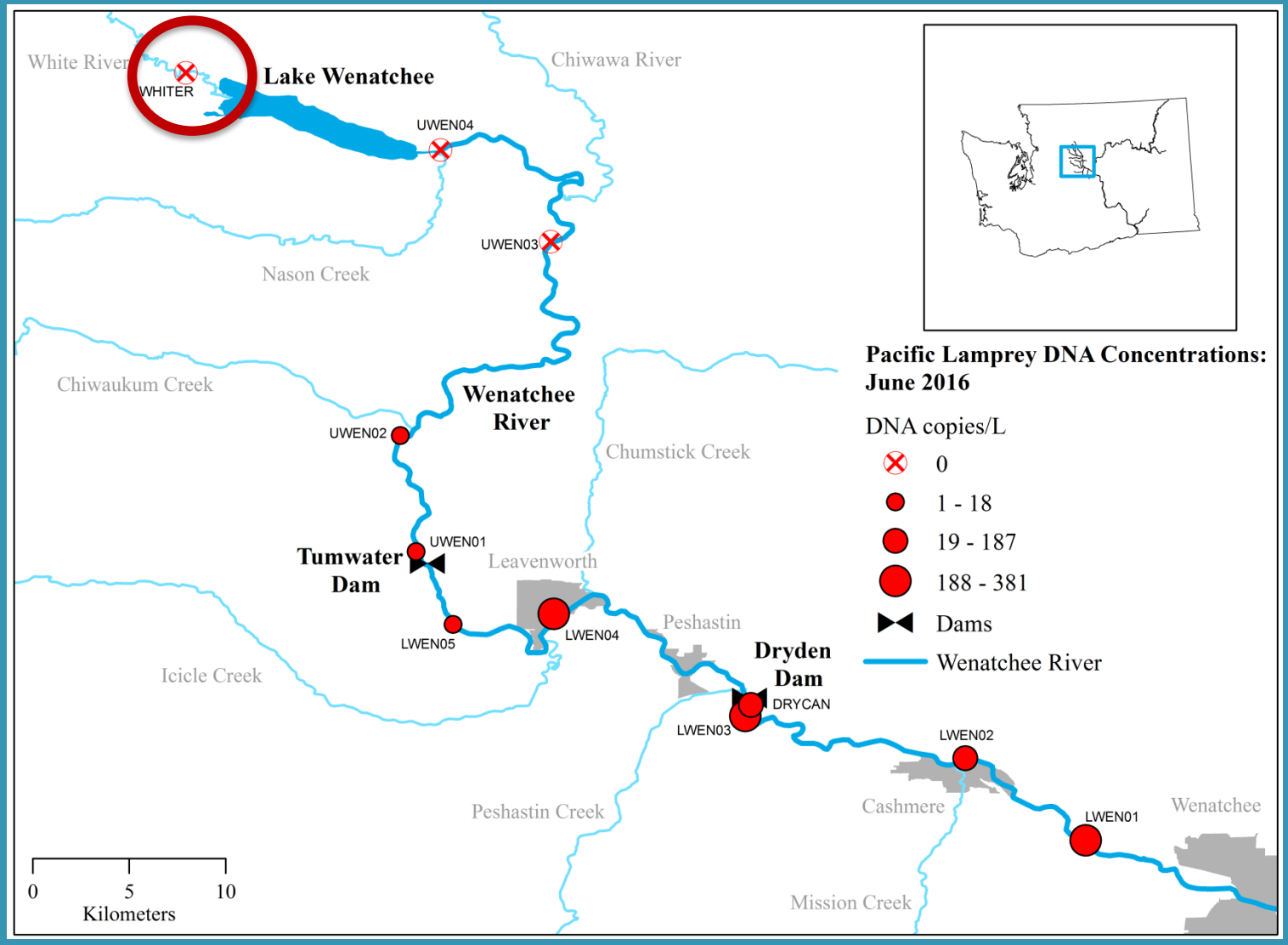
June 7th 2016 : Single PIT tagged adult detected at White River

eDNA Sampling Post-Reintroduction



Samples collected June 13th – 21st, 2016 (pre-spawning)
Locations based on ease of access (road crossings)
Analyzed for presence and quantity of Pacific lamprey DNA

Results: eDNA Lamprey Detections



Conclusions and Sampling Recommendations

Sampling was effective in a large river system

Provided a non-invasive method to monitor translocated fish

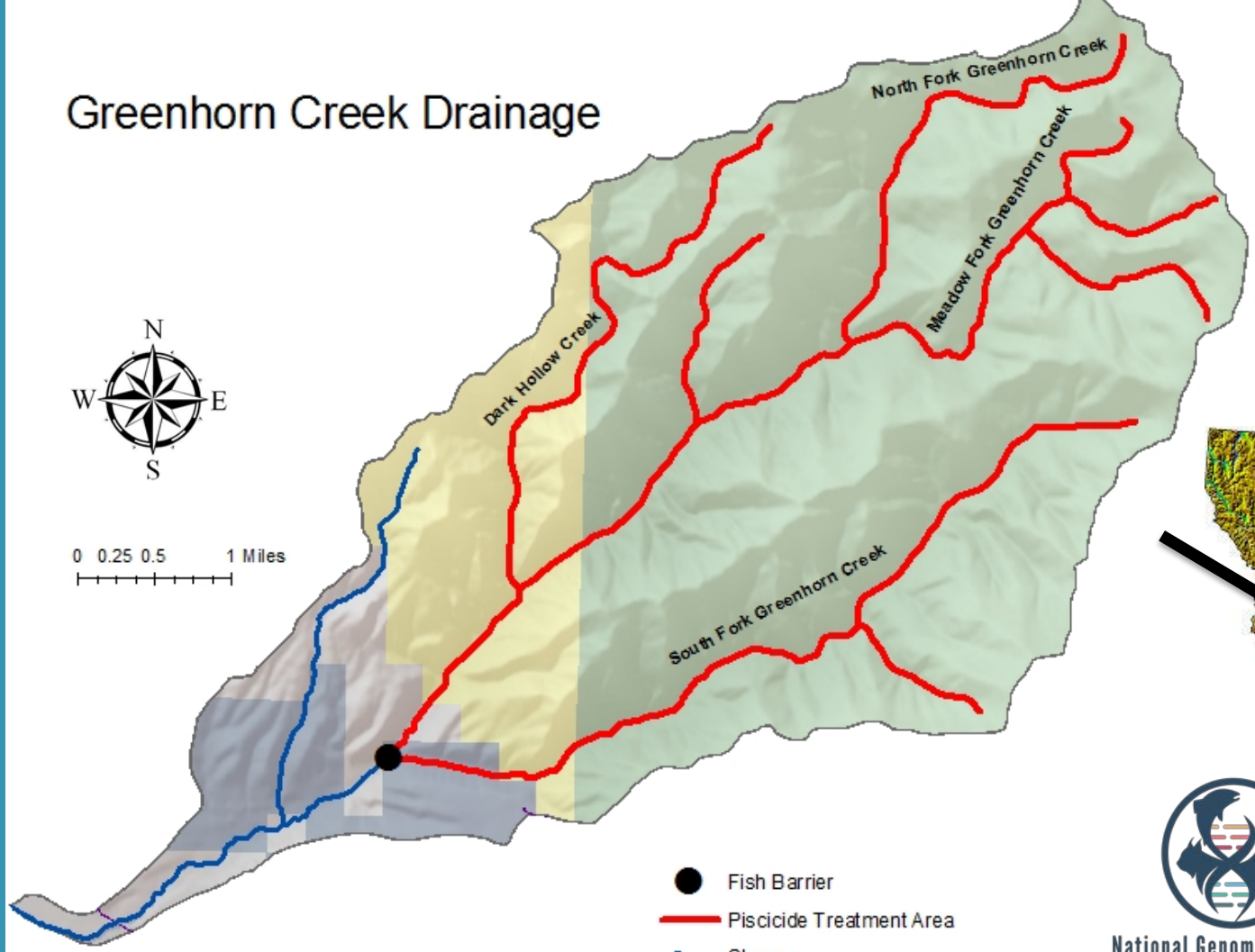
Sampling at sentinel sites through time could indicate timing of migration

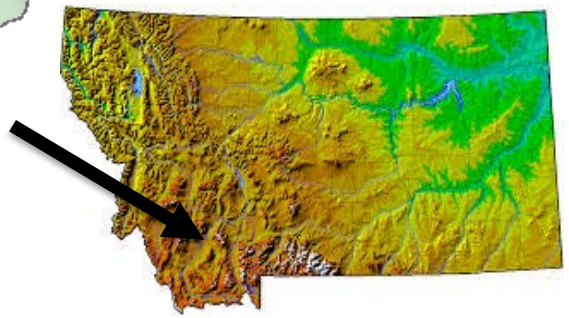
Sampling at tighter spatial intervals identify upper extent of occupied habitat

eDNA for Evaluating Eradication Efforts

A case study in Greenhorn Creek, MT

Greenhorn Creek Drainage





Fish Barrier
Piscicide Treatment Area
Stream
Roads
Drainage

Public Land Ownership

OWNER

Montana State Lands
US Bureau of Land Management
US Forest Service

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FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

Montana Fish, Wildlife & Parks

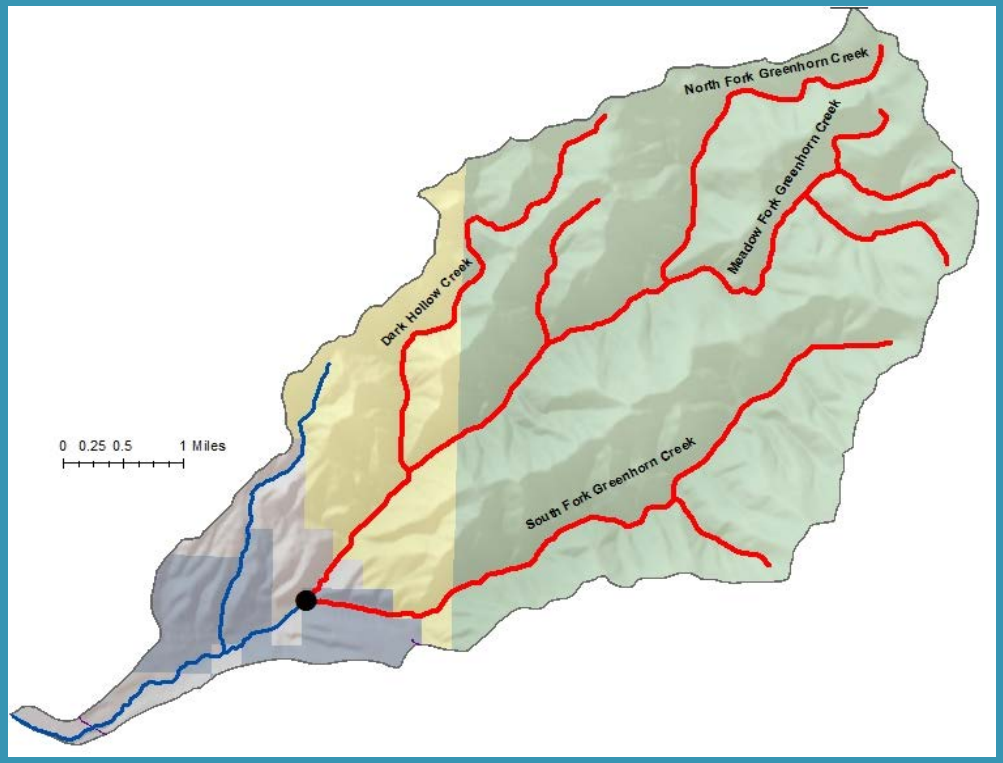
TURNER ENTERPRISES, INC.

Background on Upper Greenhorn Basin

Treated with rotenone in 2013 and 2014

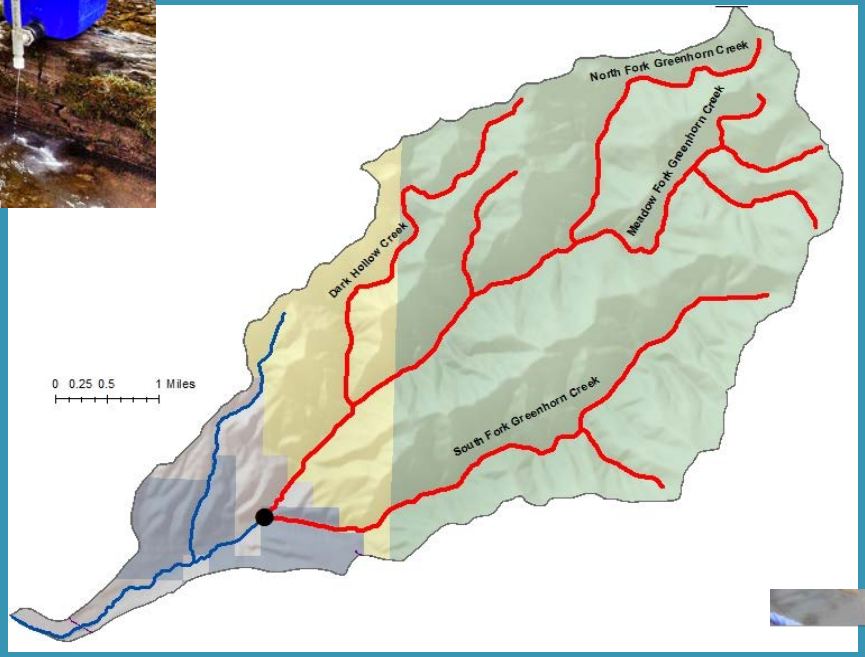
Targets: brook trout and rainbow- cutthroat hybrids

Pure cutthroat present in Dark Hallow
(Upper 1.4 miles not treated)



Intensive electrofishing planned for July & August 2015

Piscicide treatments are expensive; time and labor intensive



Can eDNA sampling save time and money through more effective evaluations?

Methods for Evaluating Piscicide Treatment in the Greenhorn Basin, MT

Sampled entire treated area July 12th- 15th 2015

Collected eDNA samples at 250m intervals, 122 samples total

Analyzed all for brook trout, westslope (excluded Dark Hallow)

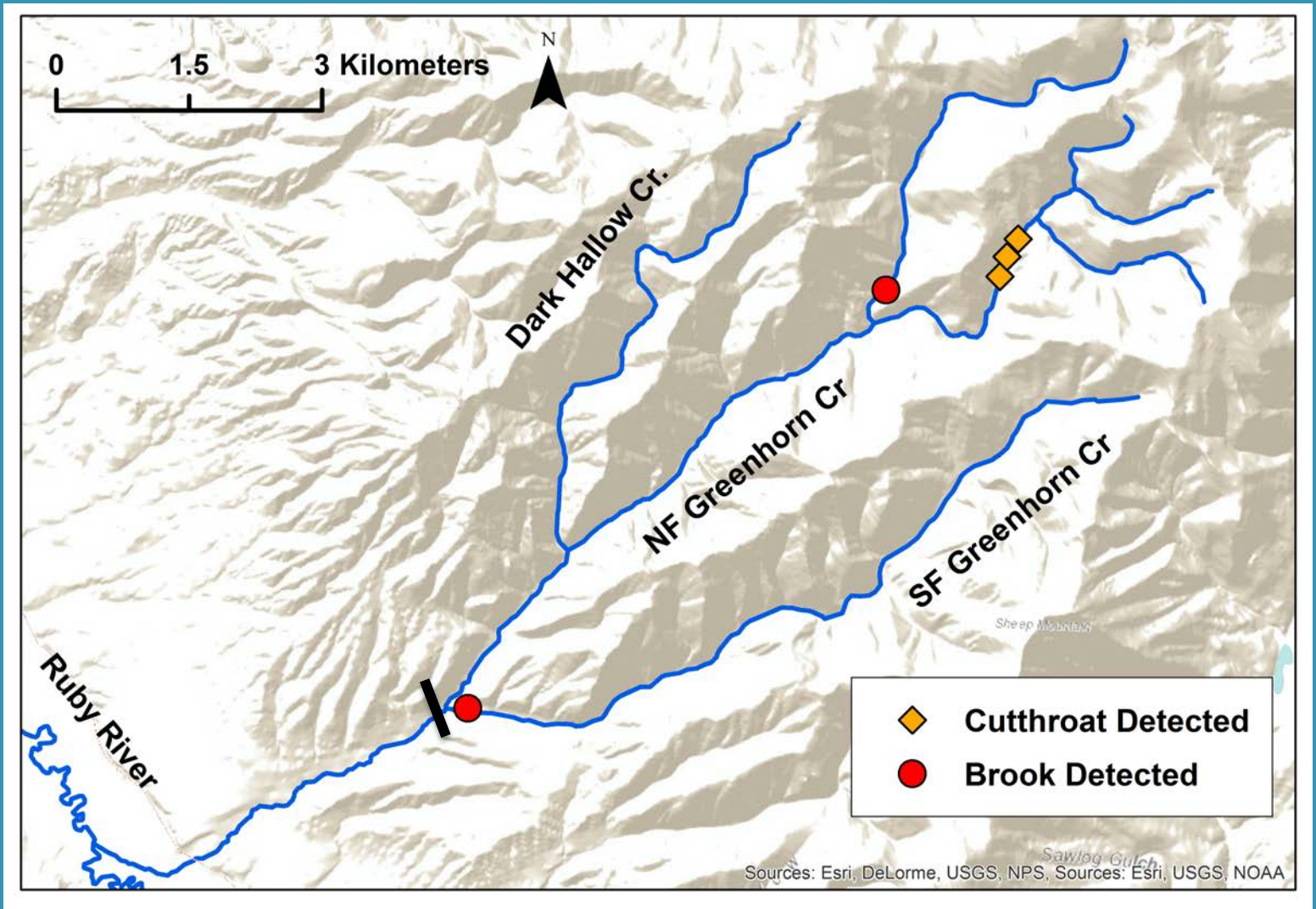
Continuously electrofished entire basin following eDNA sampling

Results: Fish Detections Post-Treatment

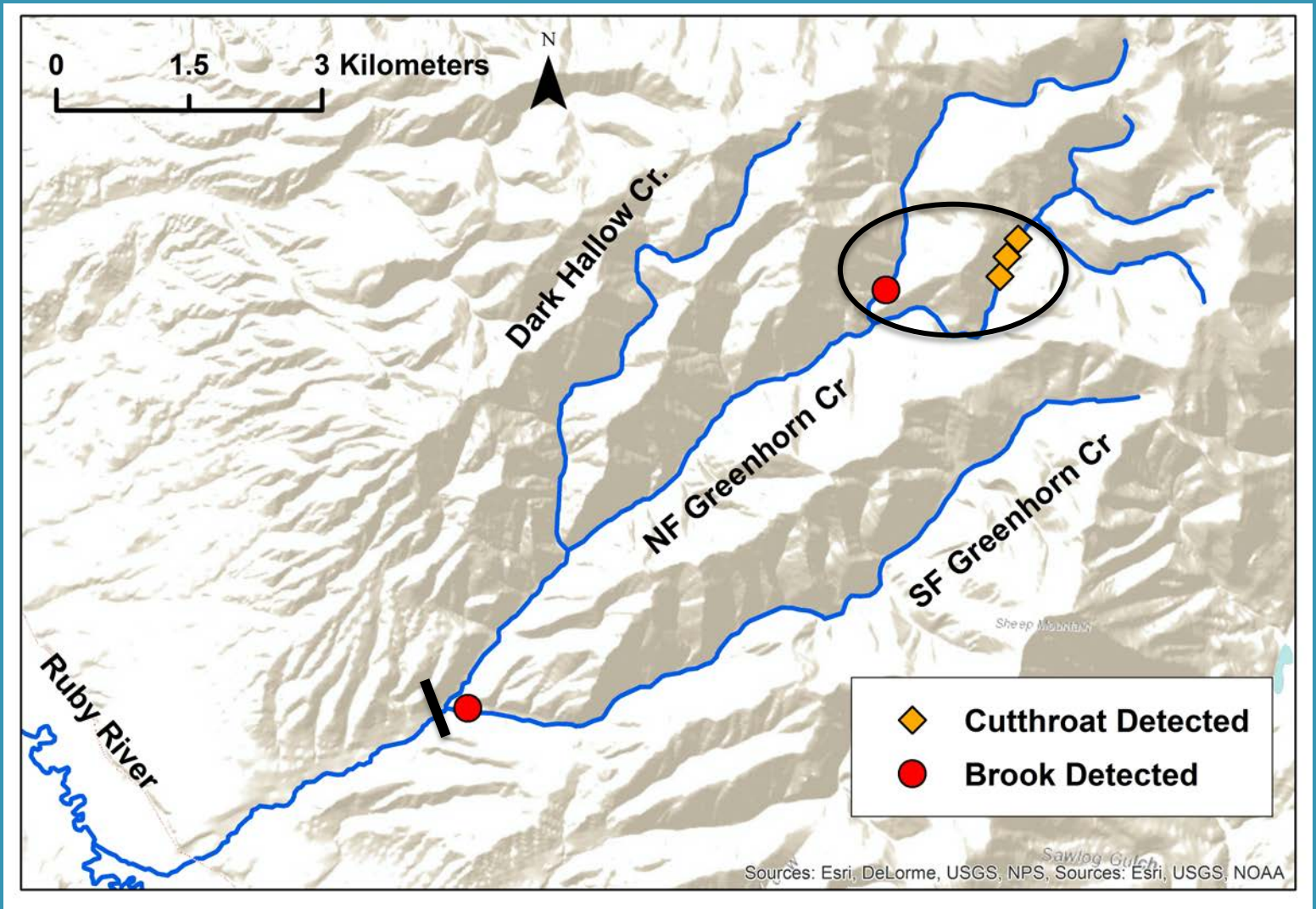
Electrofishing recovered two fish (one of each target)

eDNA samples were run blind; detected both species in multiple locations

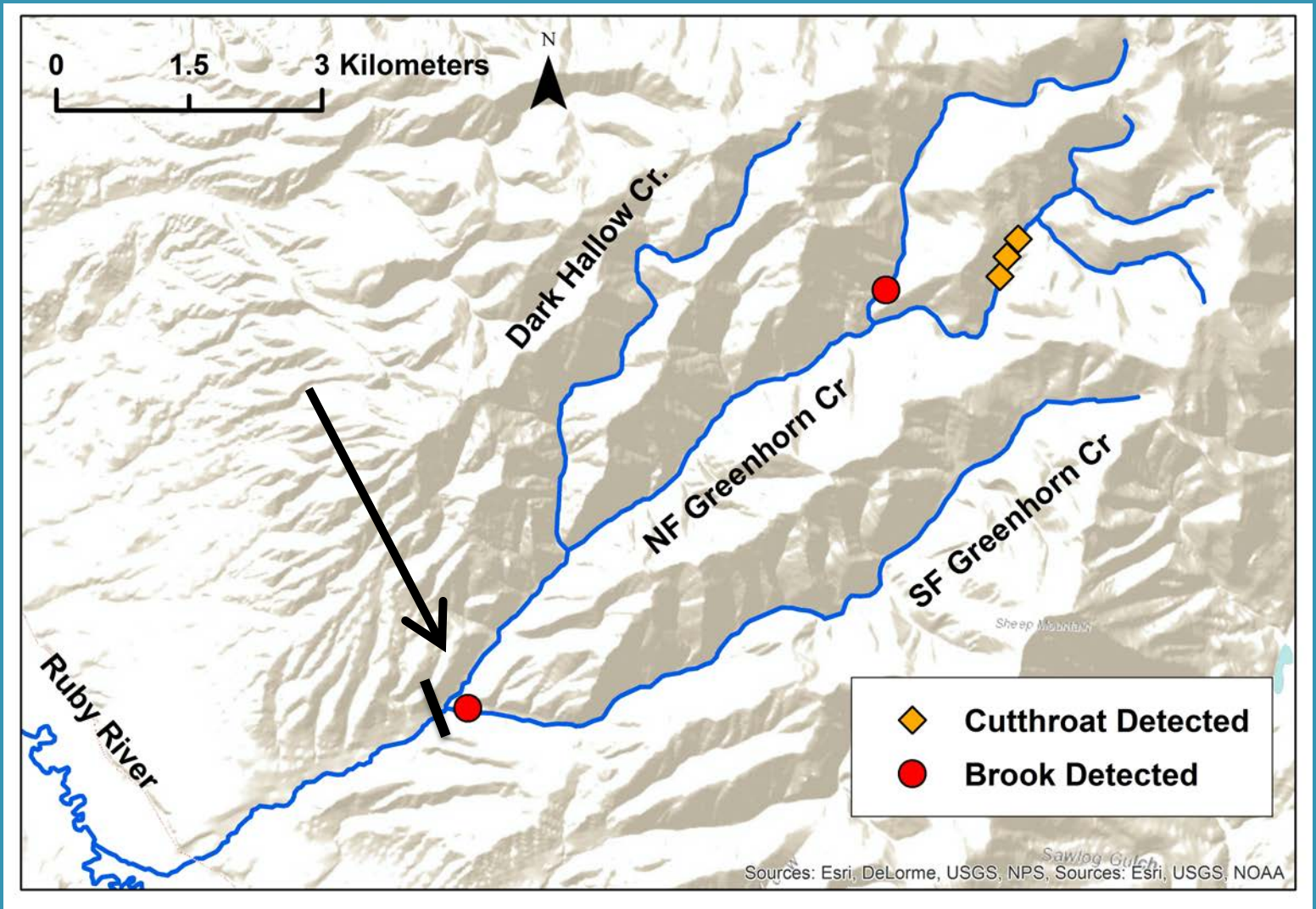
Locations of eDNA Detections



North Fork and Meadow Fork detections consistent with electrofishing



South Fork detection had a low level of DNA, no fish recovered



Validation of Results

Google Earth image showing barrier in Greenhorn Creek

Conclusions and Sampling Recommendations

eDNA sampling is highly efficient and sensitive for assessing eradication efforts

eDNA is highly sensitive to contamination

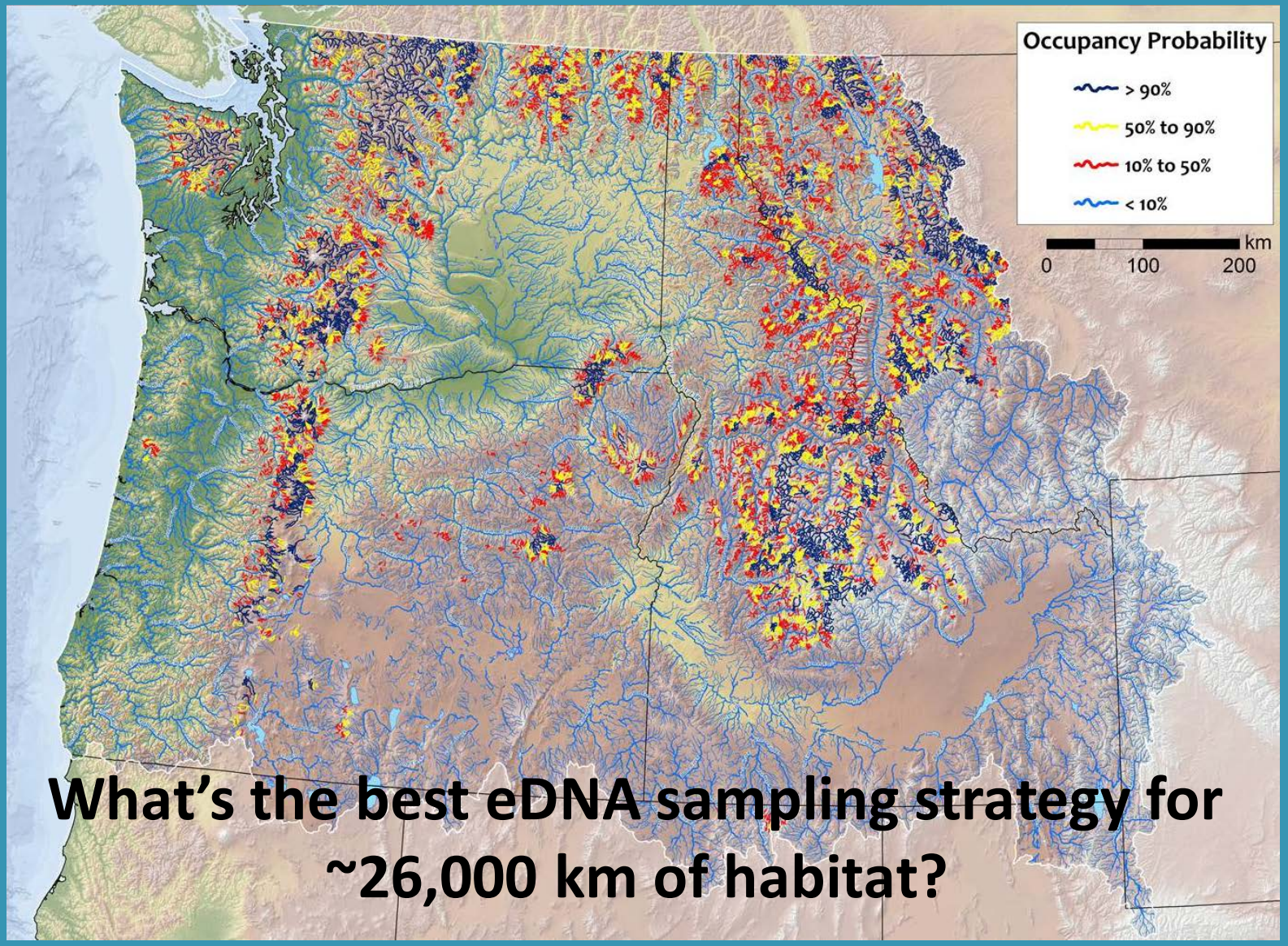
Unexpected results must be interpreted in context

Additional sampling should be used to validate results

eDNA for Inventory and Distribution

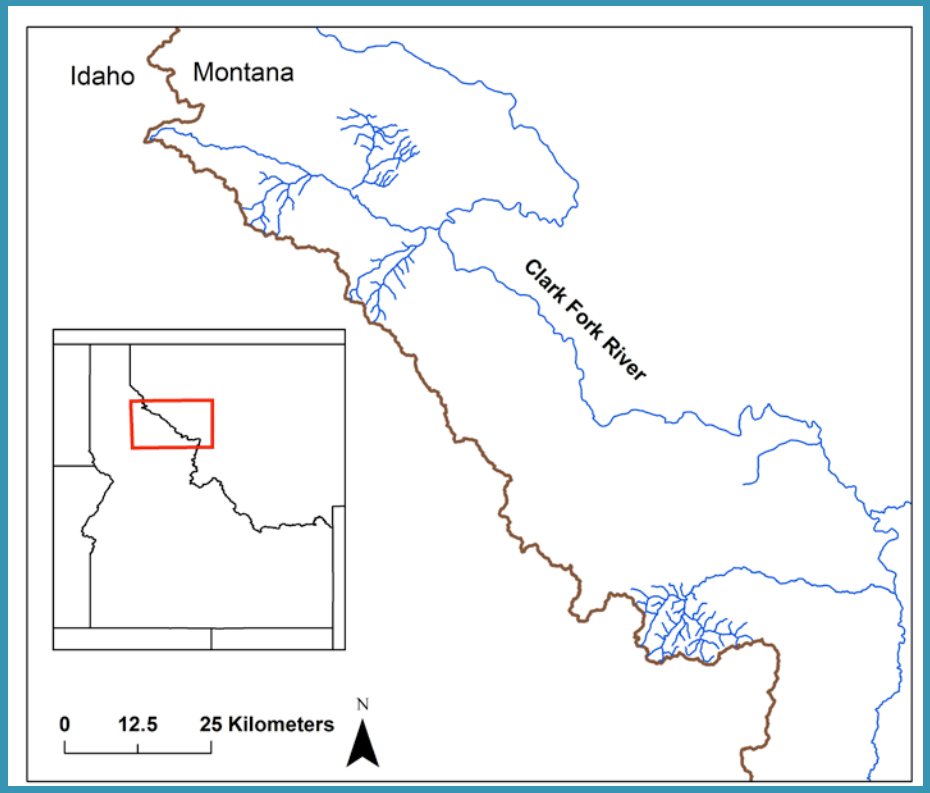
Assessing Bull Trout Occupancy in the Columbia River Basin

Climate Shields Model: Identifying Suitable Bull Trout Habitat



What's the best eDNA sampling strategy for ~26,000 km of habitat?

Pilot Study: eDNA vs. Electrofishing for Detection of Bull Trout Populations



5 drainages in southwestern Montana
76 eDNA samples with 1.5 km spacing
47 sites with paired electrofishing data (1999-2014)

Results: eDNA vs. Electrofishing

McKelvey et al. 2016

Electrofishing	eDNA: Absent	eDNA: Present
Absent	24	
Present		

Total= 47 sites with paired data

Results: eDNA vs. Electrofishing

McKelvey et al. 2016

Electrofishing	eDNA: Absent	eDNA: Present
Absent	24	
Present	0	

Total= 47 sites with paired data

Results: eDNA vs. Electrofishing

McKelvey et al. 2016

Electrofishing	eDNA: Absent	eDNA: Present
Absent	24	
Present	0	16

Total= 47 sites with paired data

Results: eDNA vs. Electrofishing

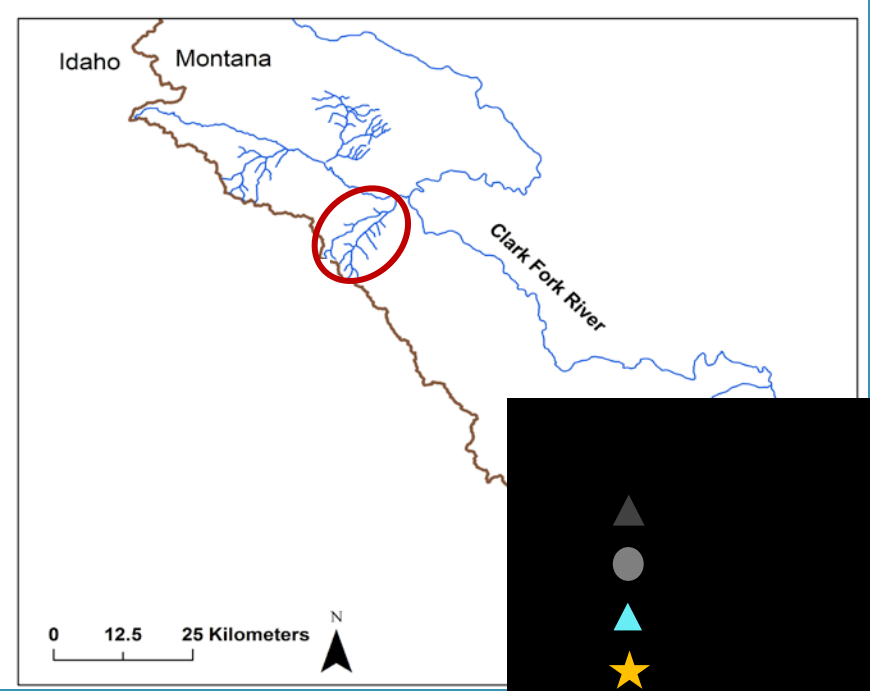
McKelvey et al. 2016

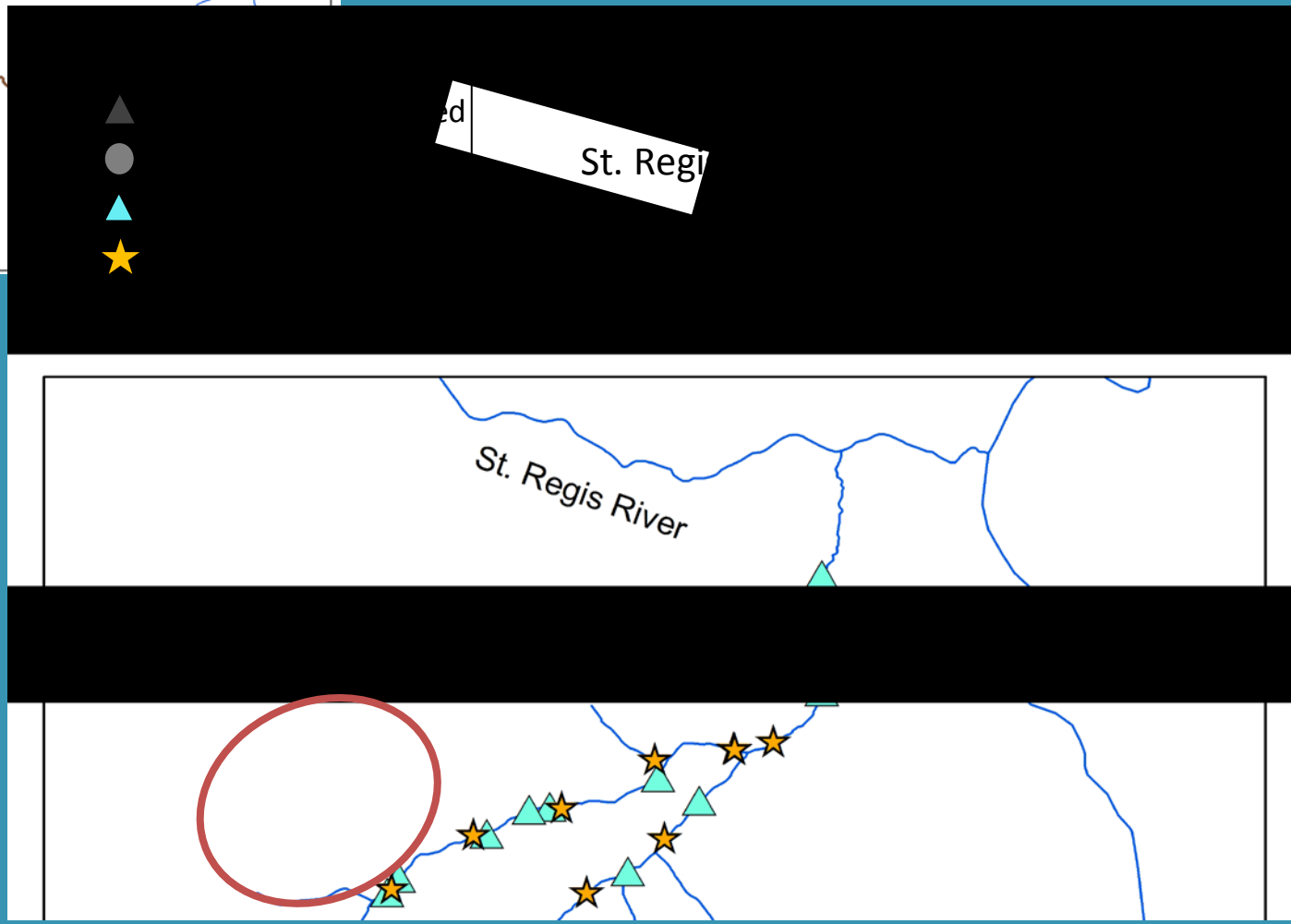
Electrofishing	eDNA: Absent	eDNA: Present
Absent	24	7
Present	0	16

Total= 47 sites with paired data

Little Joe Drainage

Upper extent of occupied habitat

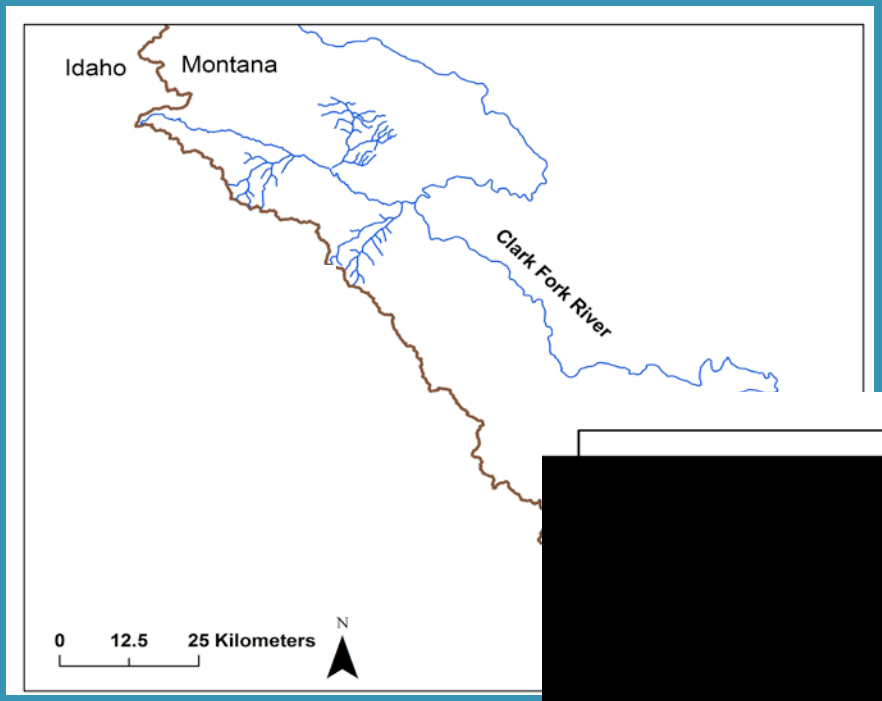


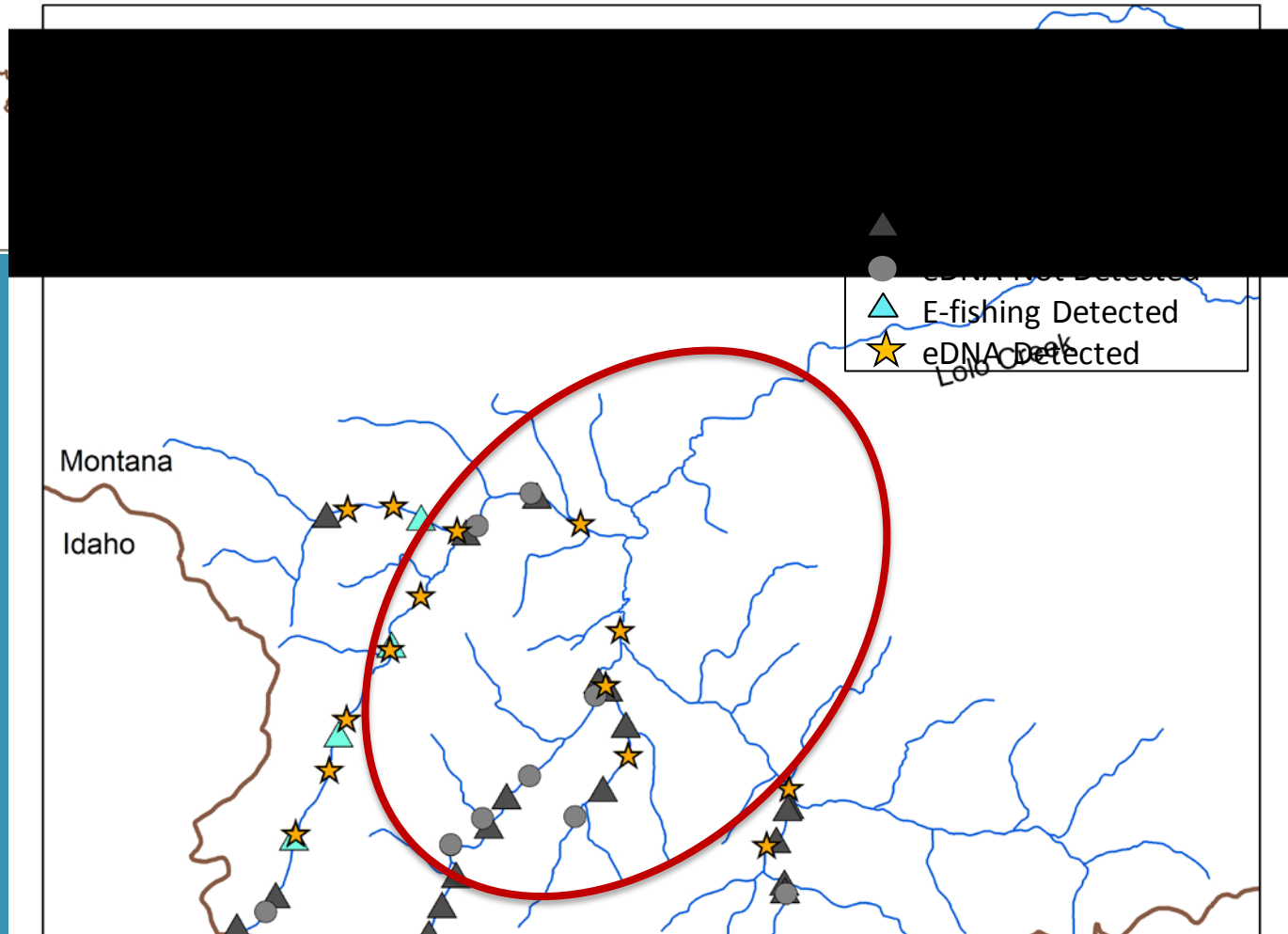


McKelvey et al. 2016

Lolo Creek Basin:

Discovery of unknown populations





McKelvey et al. 2016

Conclusions and Sampling Recommendations

Faster and more sensitive than electrofishing

1km intervals good for population level detection

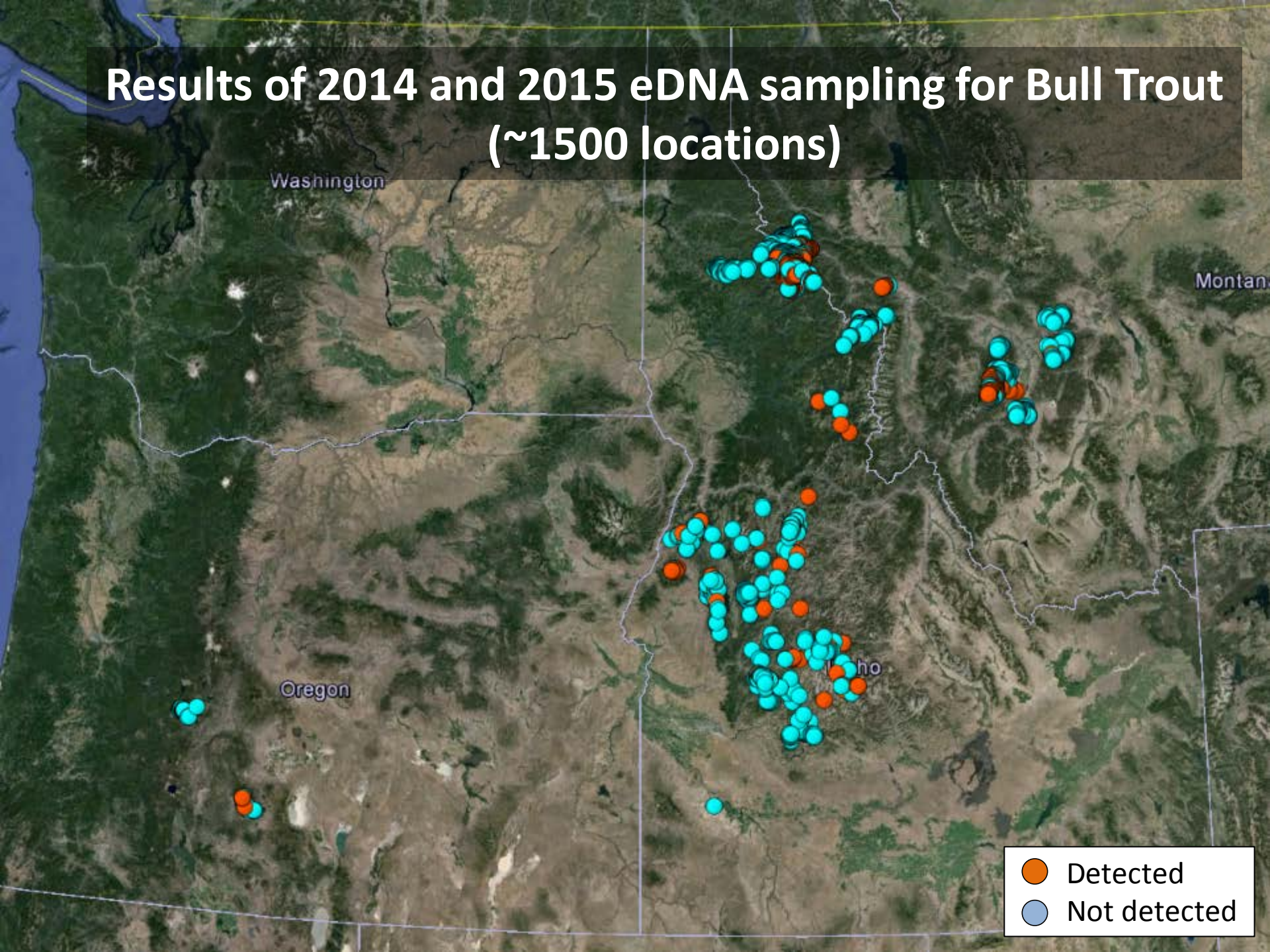
Sampling at fixed intervals helps delineate length of occupied habitat

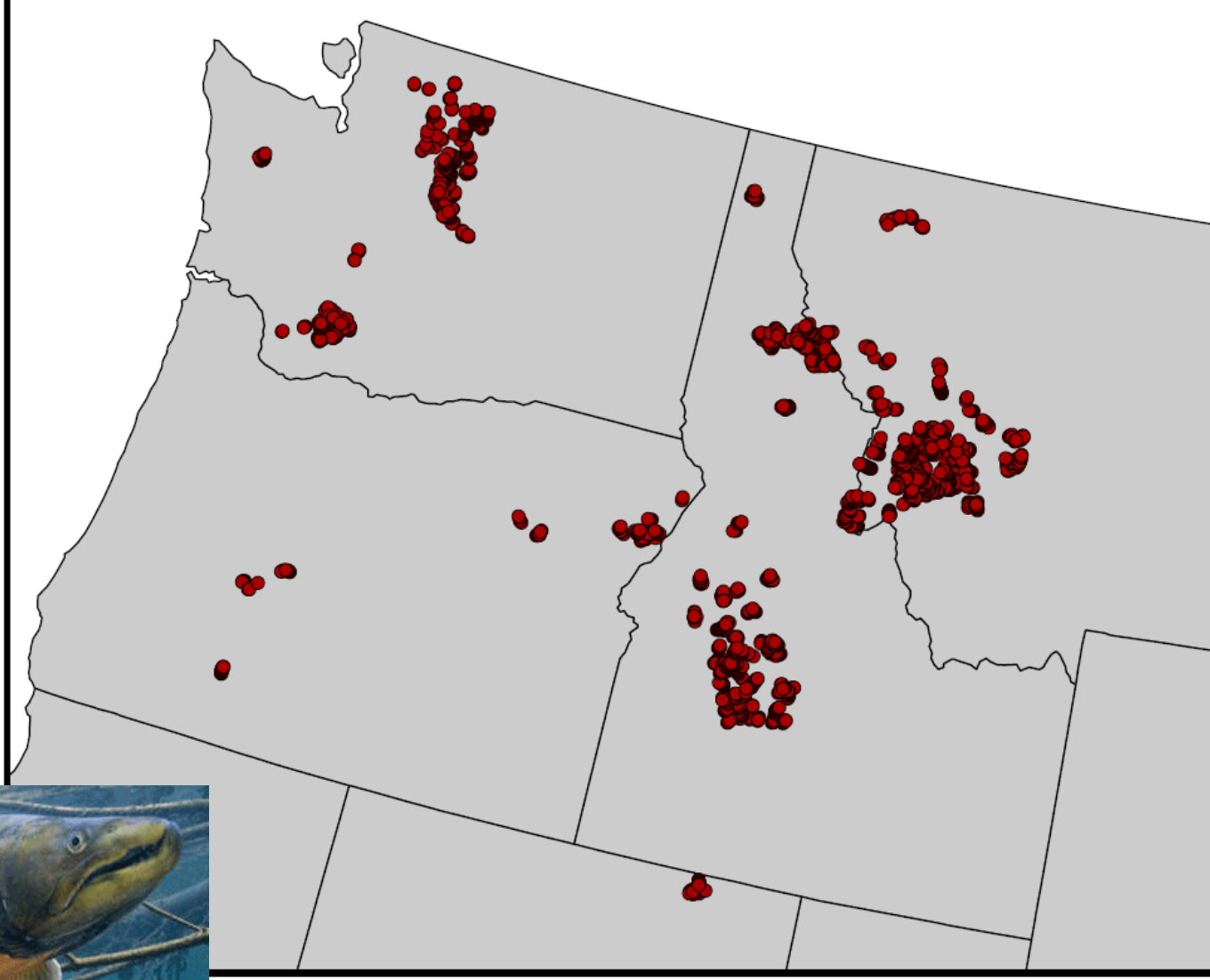
Bull Trout Inventory in the Columbia River Basin

Federal, State, Tribal and Non-profit Collaborative Effort

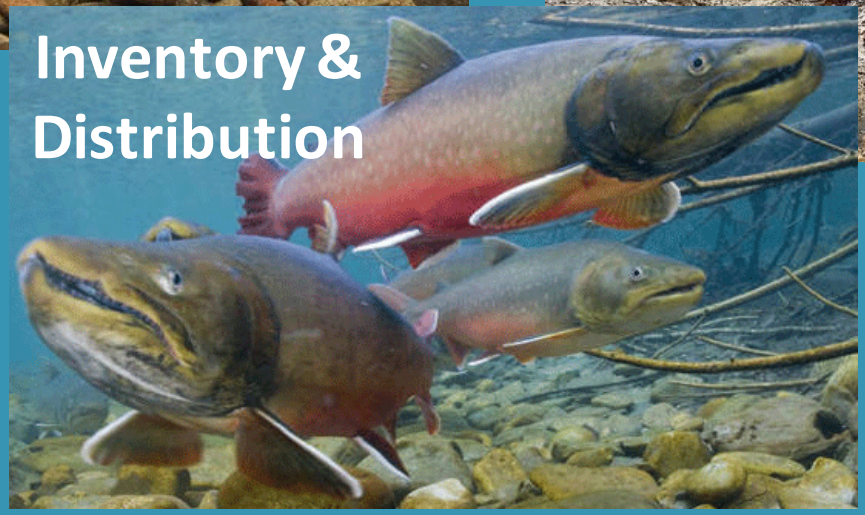
14 National Forests
3 USFS Regions

Results of 2014 and 2015 eDNA sampling for Bull Trout (~1500 locations)





> 3,500 locations sampled since 2014



Spread and emergence of invasive species
Community composition
Monitoring seasonal movements
And many more…

Questions?

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