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Developing Cost Effective Monitoring for Rainbow Smelt using eDNA

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Project Funding

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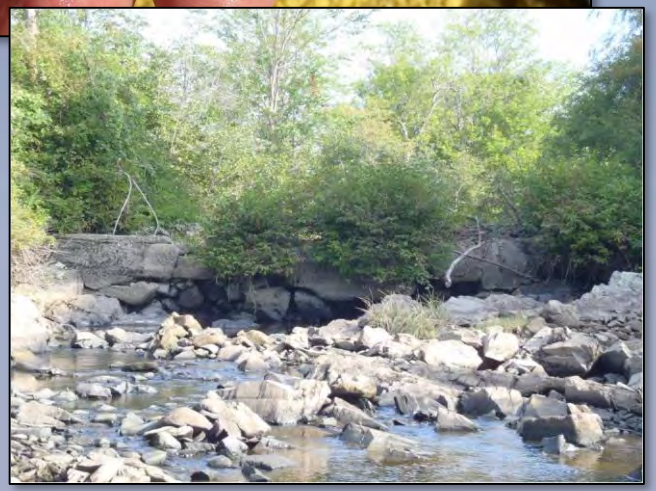
Management Challenges for Rainbow Smelt



- NMFS Species of Concern
- Maine Tier I Species of Greatest Conservation Need
- Declining due to historic alterations to habitat
- ~50% of spawning sites may be impacted by road crossings or dams
- Future climate driven impacts…?

- 2012 Regional Conservation Plan calls for statewide monitoring and restoring access to habitat

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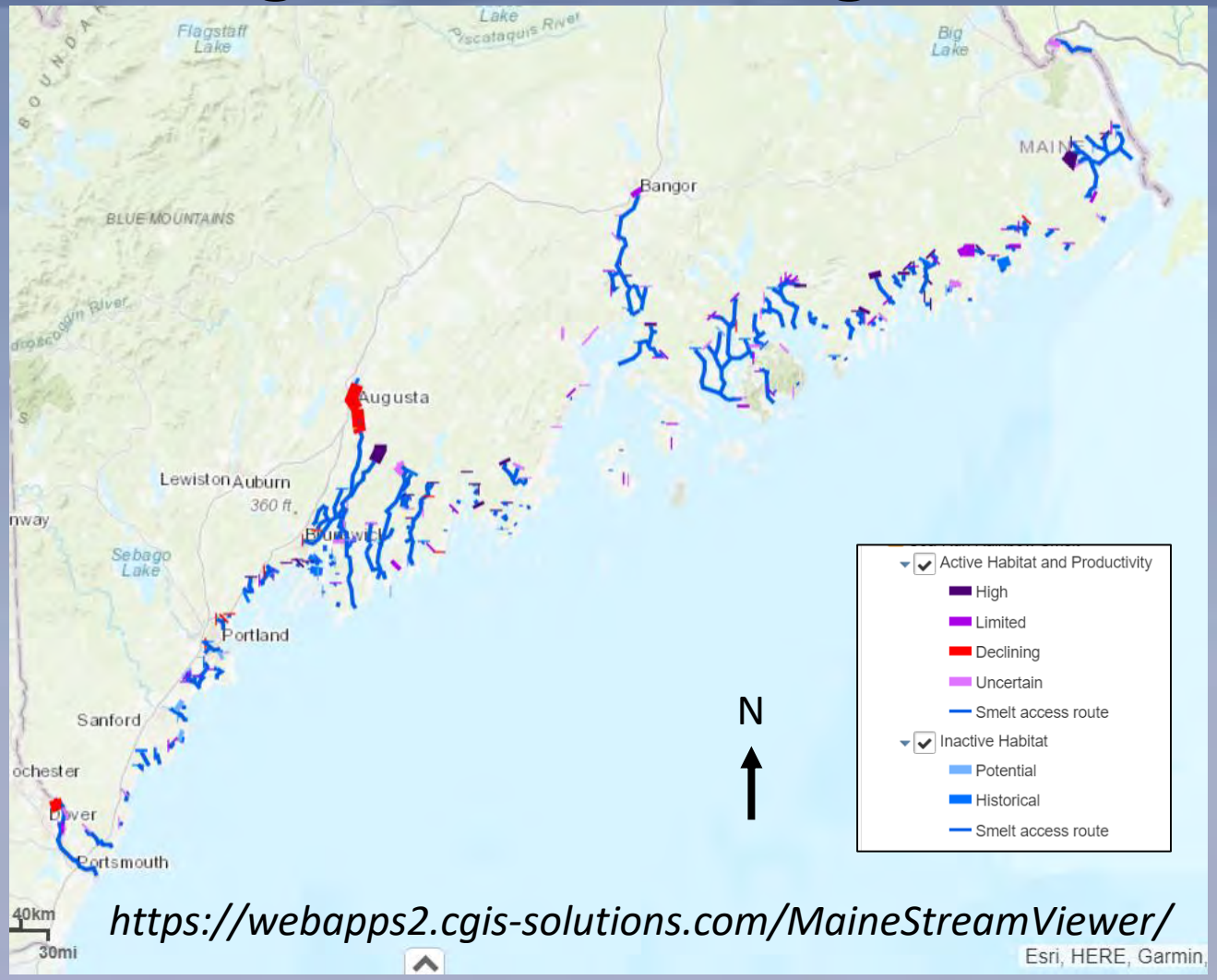

https://webapps2.cgis-solutions.com/MaineStreamViewer/

- 275 historic spawning stream segments mapped by Maine DMR
- Monitoring so many locations is resource intensive
- Lack of current data hinders restoration efforts

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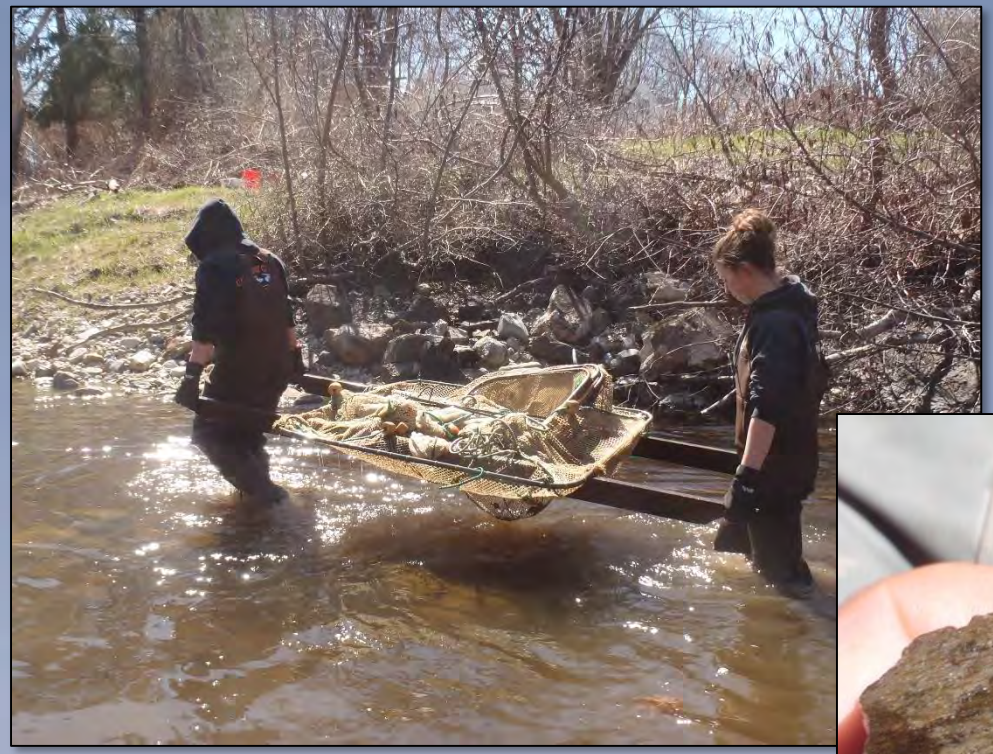
Management Challenges for Rainbow Smelt



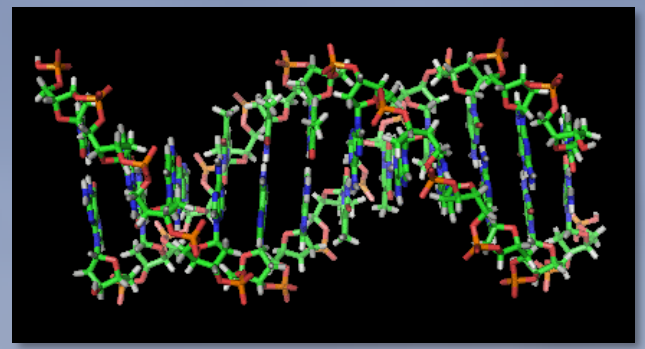
Conventional methods are labor intensive or require special training.

- Trapping
- Trawls
- Creel Surveys
- Egg surveys
- Nighttime observations

eDNA is an Effective and Accessible Tool

<u>Environmental DNA</u> (eDNA): DNA that occurs in an environment as a byproduct of the life processes of living organisms inhabiting that environment or linked environments.

- Less time and labor intensive
- Low risk to smelt populations being monitored
- Does not require special knowledge or equipment
- Highly sensitive, good for rare species



Wikipedia.org

- Presence/Absence information
- Timing and duration of spawning
- Abundance…?
- Biological data collection not possible
- Prioritize locations for conventional monitoring

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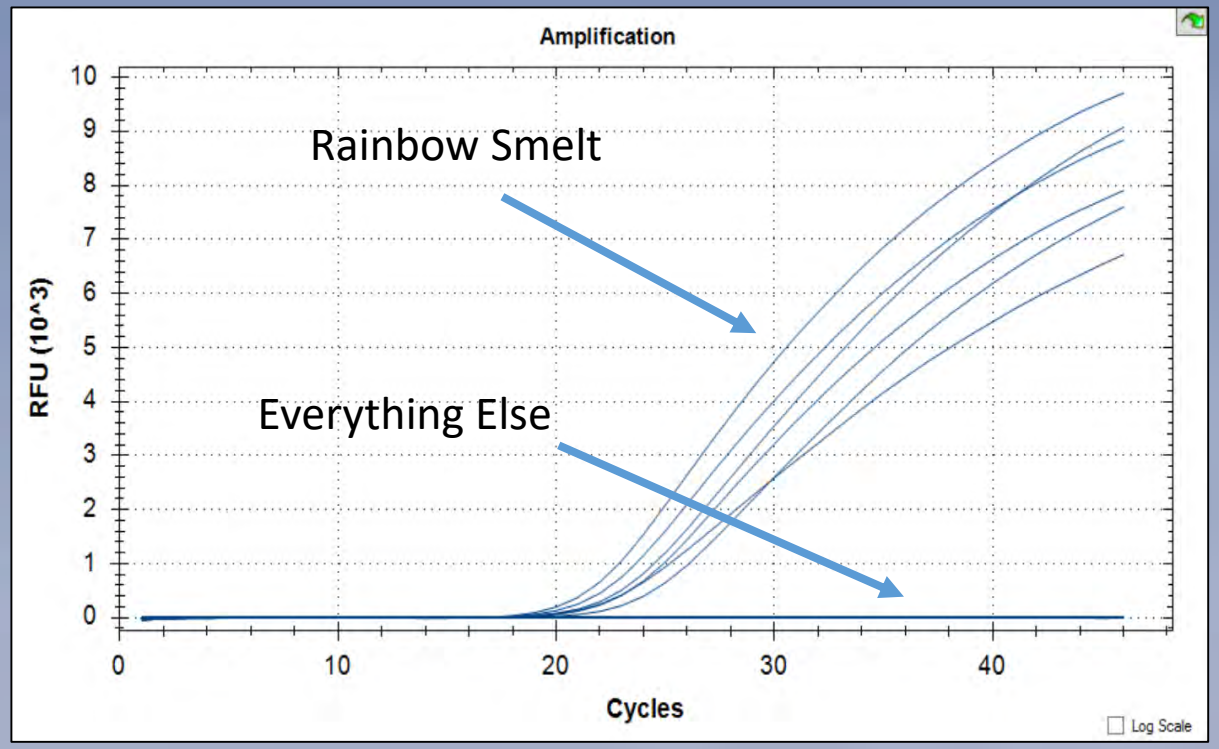
eDNA is an Effective and Accessible Tool

Smelt TaqMan MGB-NFQ qPCR Primer-Probe Set
develop by Kinnison Lab, University of Maine

OSM ND5 Primer-Probe Set

Species	5' Forward 3'	5' Probe 3'	5' Reverse 3'
OSM	CACAACCATCCACCGCTCTCTC	TGGGCCAAGCTATCGCGAGCCA	TTGCTGCTGGGAGGTGAATAGC
ARC	TGCCGTCGTCCACCGATTAGCC	TAGGACAAACTATTGCCAGCCA	TGACTATGGGCAGGTTAGTTGA
ATL	AGCCATTATCCACCGATTAGCC	TAGGACAAACCATTGCCAGCCA	TGACCATAGGTAGGTGAGTGGA
BKT	TGCCATCGTACACCGATTGGCC	TAGGACAAACTATTGCCACCCA	TAACTATAGGGAGGTTAGTTGA
LKT	TGCCGTCGTCCACCGATTAGCC	TAGGACAAACTATTGCCACCCA	TGACTATGGGCAGGTTAGTTGA
RBT	CGCCATCATCCACCGATTGACC	TAGGACAAACCATCGCCAGCCA	TGACTATTAGGCAGGTGAGTTG
BNT	AACCATCATCCACCGATTGGCC	TGGGACAAACCATTGCTAGCCA	TGACCATAGGCAGGTGAGTTGA
LWF	CGCCATTGTCCACCGACTAGCC	TCGGTCAGGCCATTGCCAGCCA	TAATTATGGGCAGATGGGTGGA
CP	ATCAATTATCCATCGGATAATT	TGGGTCAAAAAAATTGCTACCCA	TAATAAGGGGTAGATTAATTGA
NP	ATCAATTATTCATCGCTTAACC	TCGGCCAAAAAAATTGCCACCCA	TAATTATGGGGAGGTTGATGGA
LMB	AGGGGTTTTCCACCGCCTCATG	TTGGCCAAGCAATTGCCAGCCA	AAGCTAAGGGGGTATTGAGGGA
SMB	CATAGTTTTCCACCGCCTTATG	TTGGCCAAGCAATTGCCAGTCA	AAACTAAAGGGGTGTTTAAGGGA
BC	AATAATCACTCACCGCTTCATT	TAGGCCAGTCAATTGCTAGCCA	TAATTAAGGGGGTGTTGAGGGA

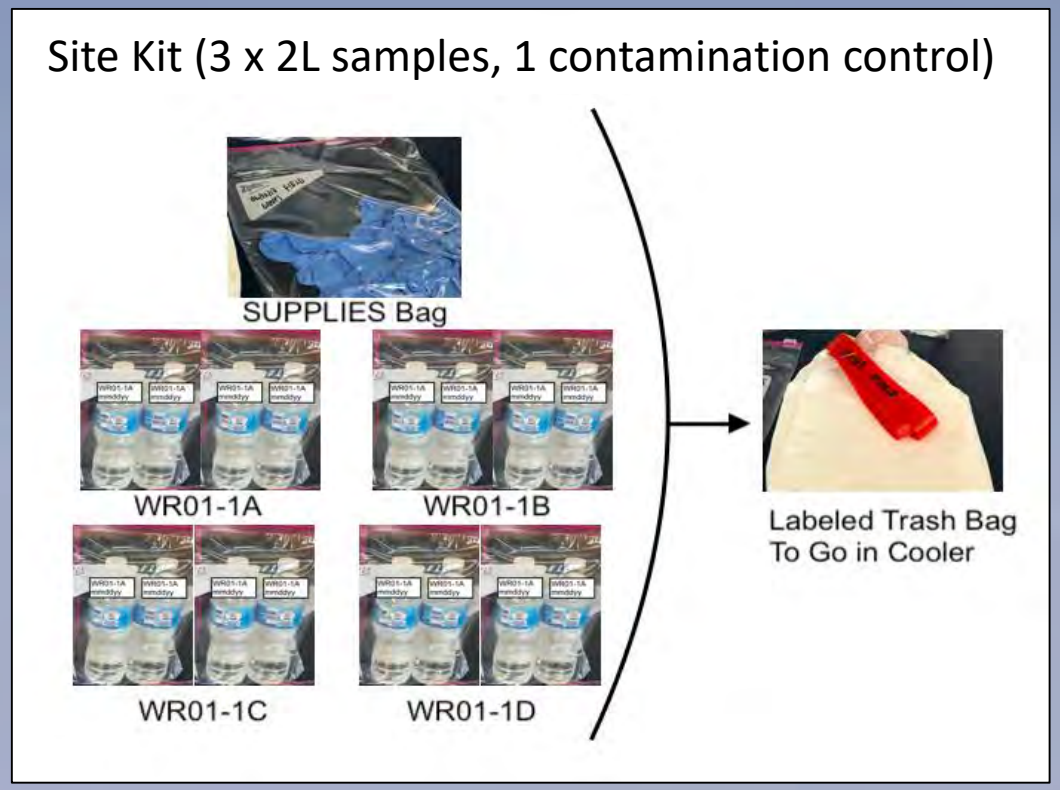


+ Initially Field Validated by Testing Positive in Archived Floods Pond Water

eDNA is an Effective and Accessible Tool

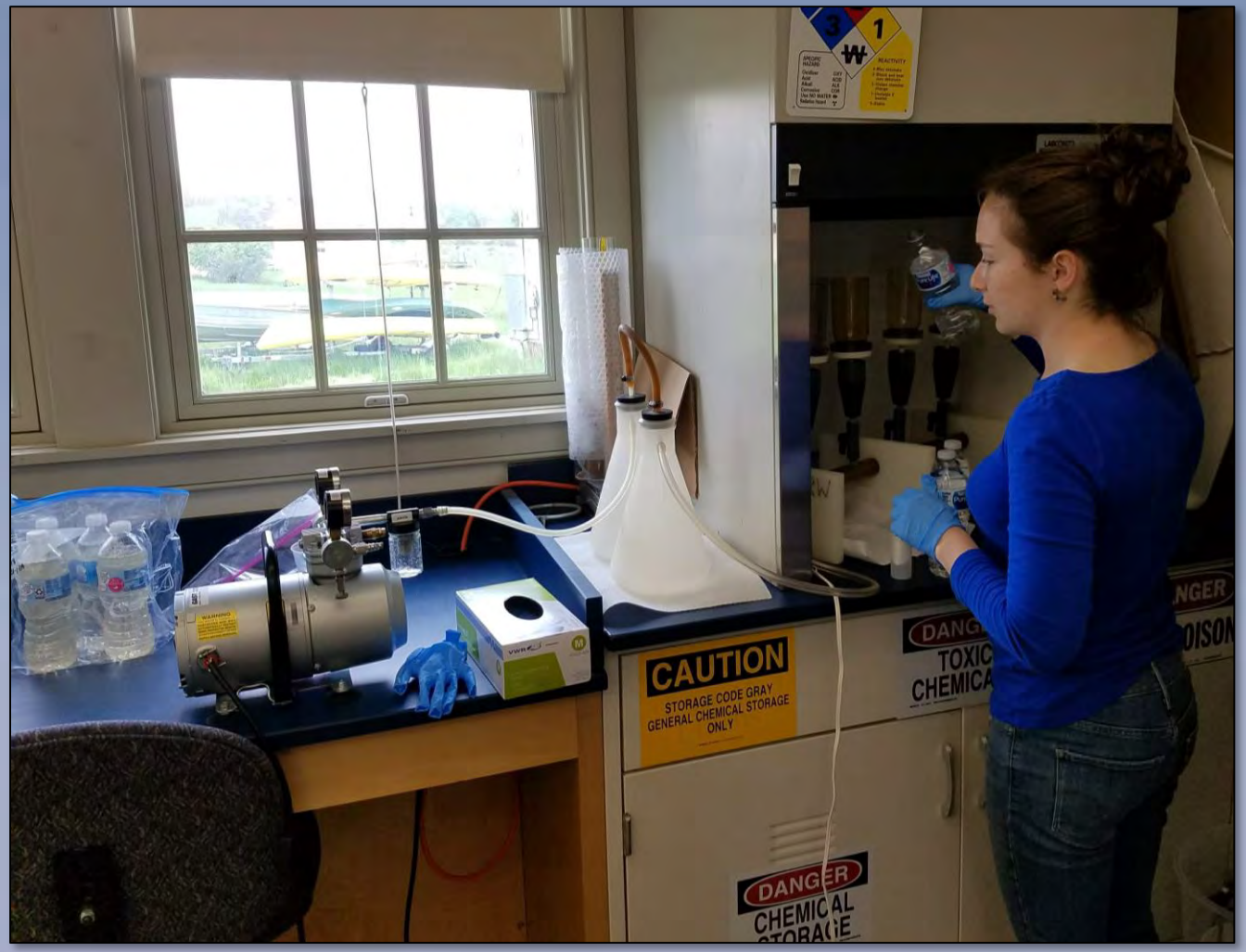
eDNA surveys could in principle be conducted by almost anyone, without risk of harm to protected species, without concern for legal harvest seasons, and without special licenses or permits.

eDNA Sample Collection



- Sample kits are inexpensive.
  - water bottles
  - sealable bags
  - gloves
  - paper towels
  - cooler and ice
- Samples are frozen before shipping to lab.

eDNA is an Effective and Accessible Tool



Detailed protocols have been developed.

- EPA approved mini-QAPP
- UMaine sampling protocols and filtering protocols

Filtration in-house saves shipping and lab costs, but contamination control is a major consideration.

Monitoring in partnership with qualified lab.

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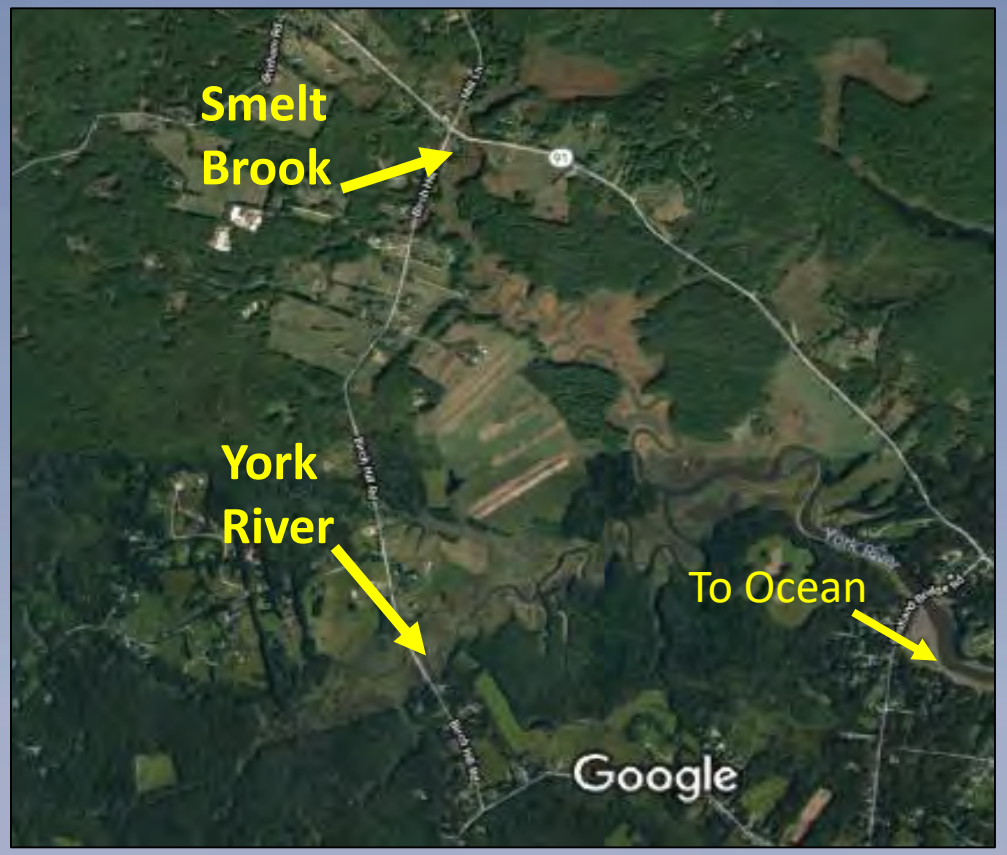
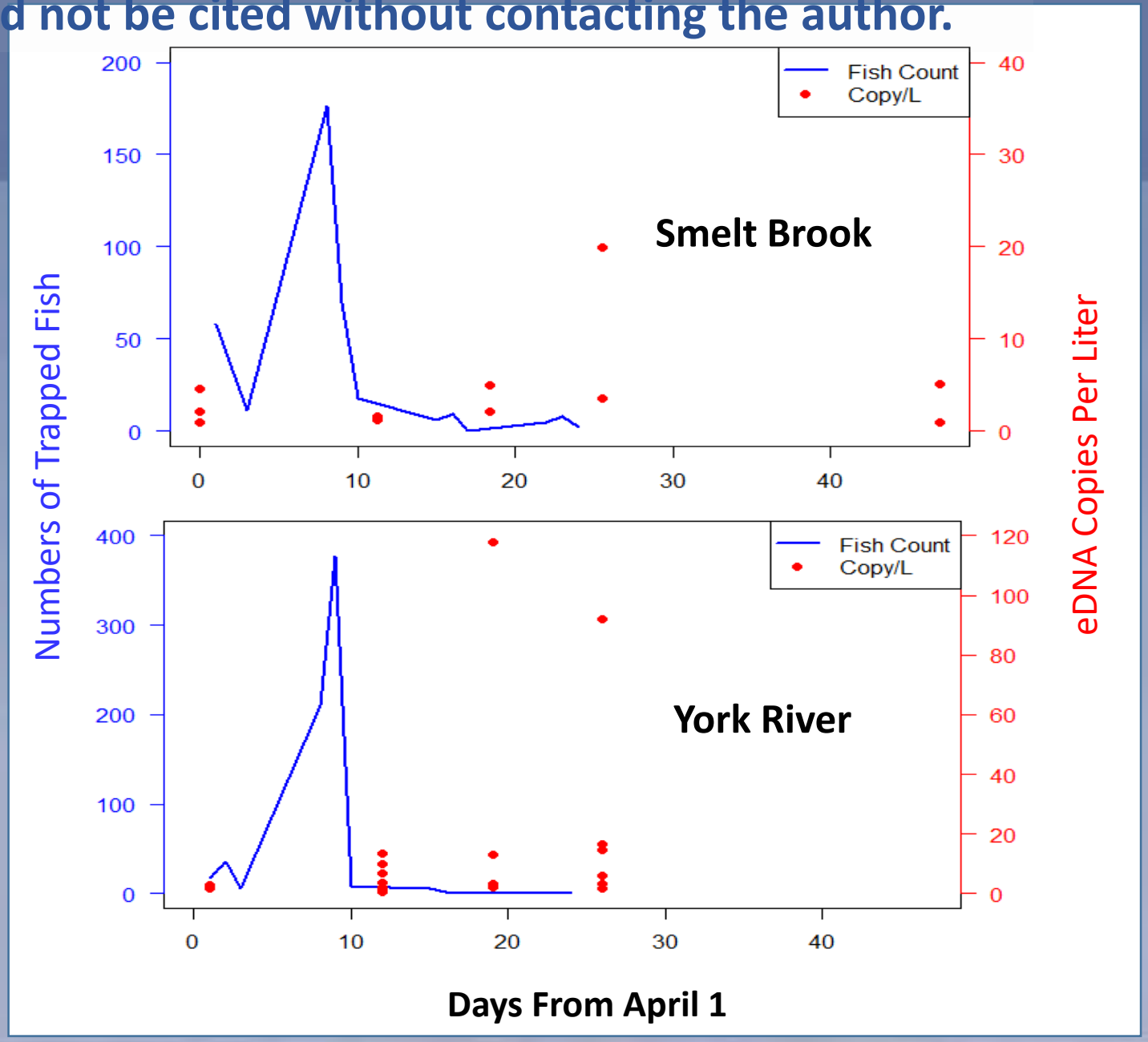
Smelt eDNA Pilot Study





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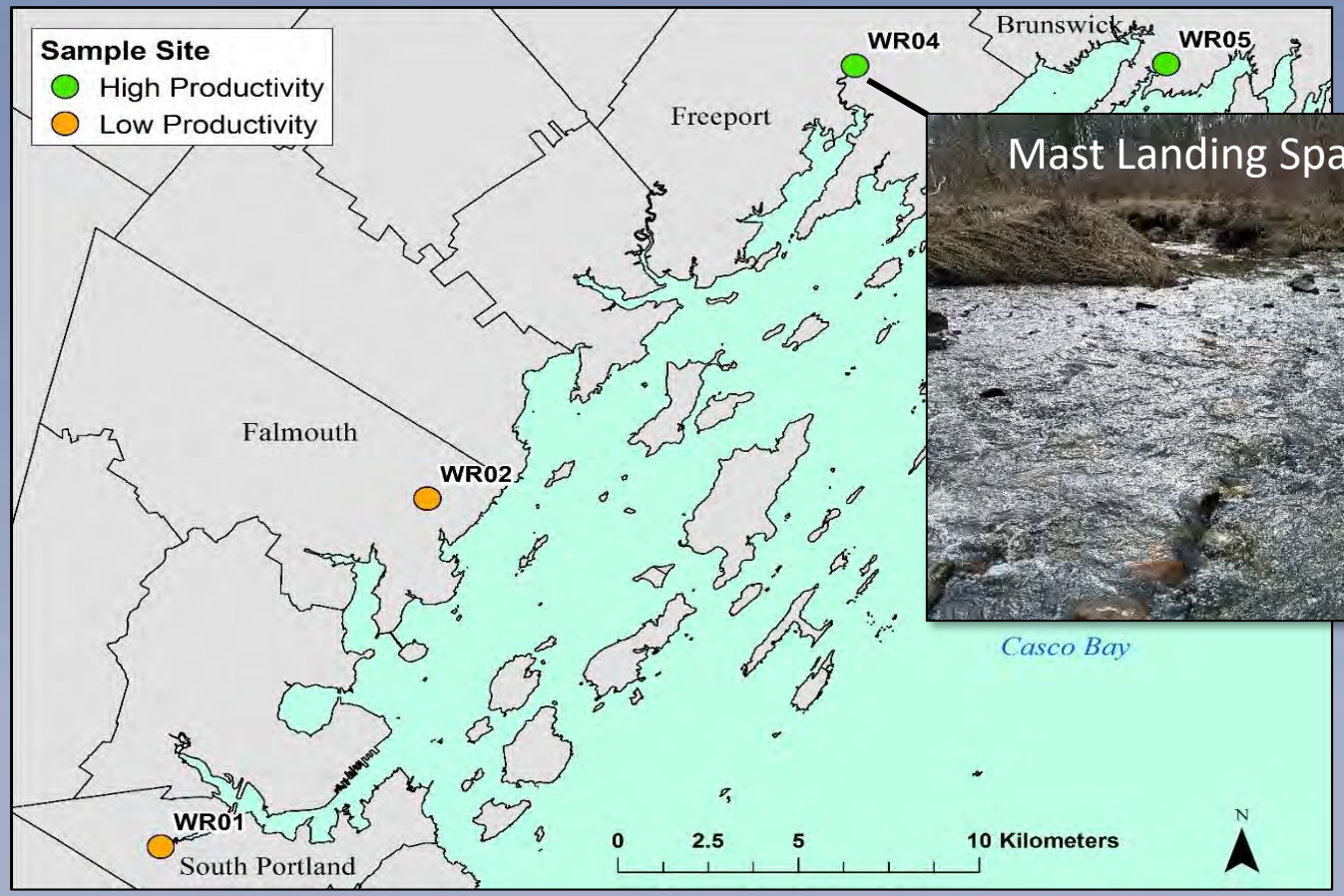
2018 Casco Bay Study



- Sampling March 29 to May 9
- Downstream from spawning areas
- 2 liter samples collected at three locations (A, B, C)
- 177 samples total

Casco Bay study sites at:

- Long Creek (WR01)
- Mussel Cove Creek (WR02)
- Mast Landing (WR04)
- Miller Creek (WR05)

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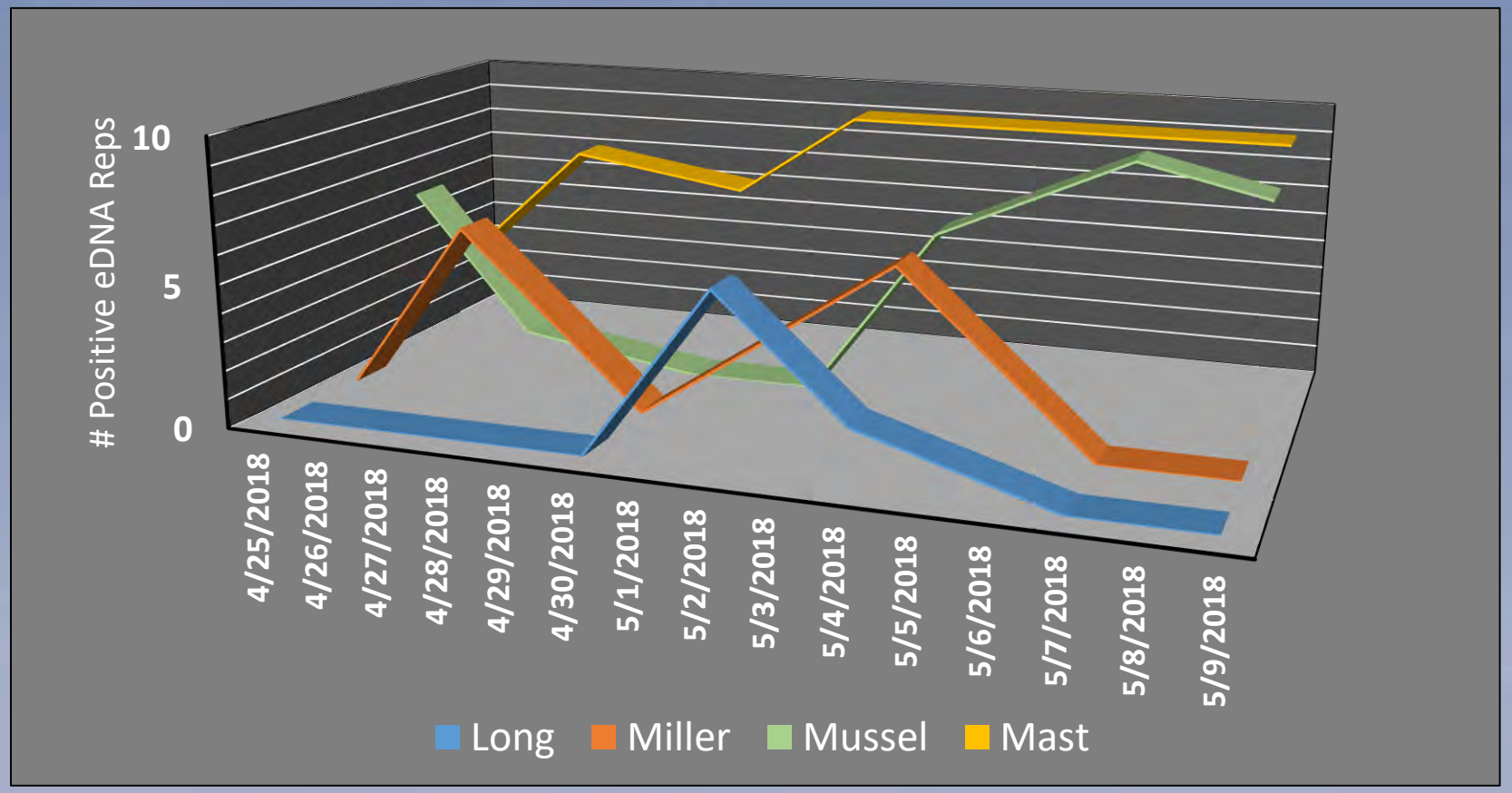
2018 Casco Bay Study



- Unlike pilot study, initial lab detection was poor
- Environmental inhibitors reduced amplification
- PCR inhibition clean-up increased reliability
- eDNA is able to detect rainbow smelt through time and across a range of abundances

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Next Steps

- Calibrate for environmental conditions (flow, inhibition, breakdown rates)
- Further study of eDNA dynamics (sampling for eggs vs. adults)
- Develop application of techniques for managers and restoration planners
- Explore possibility of engaging citizen scientists in surveys

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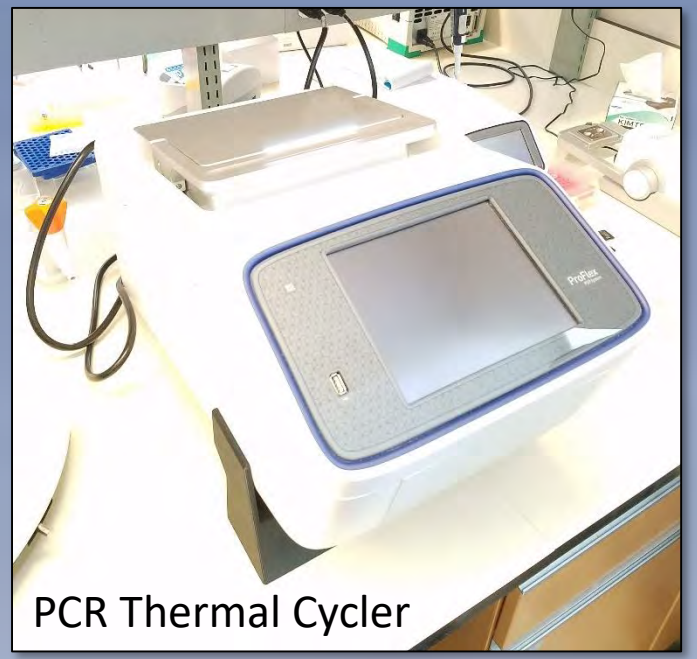
Thank You!

Project Partners

Claire Gottesegen	Wells NERR
Michelle Furbeck	Wells NERR
Dr. Michael Kinnison	University of Maine
Vaughn Holmes	University of Maine
Mary Astumian	University of Maine
Matt Craig	Casco Bay Estuary Partnership
Claire Enterline	Maine Department of Marine Resources

US Environmental Protection Agency
Maine Outdoor Heritage Fund


PCR Thermal Cycler