Development and evaluation of an environmental DNA (eDNA) protocol to monitor wild delta smelt

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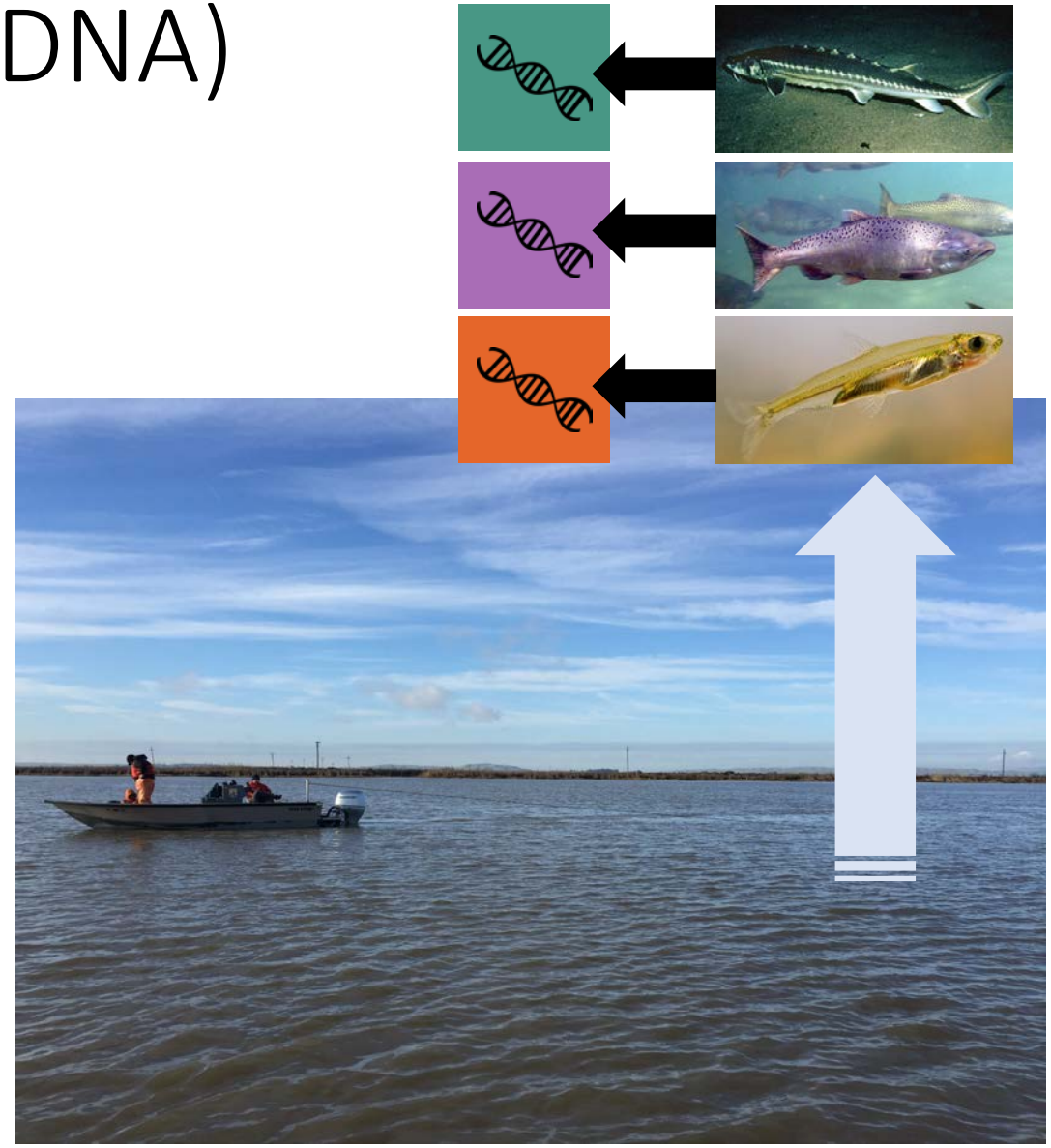
Environmental DNA (eDNA)

- Genetic methods for detecting species in water or soil
- Does not directly sample the organism
- Species-specific and community approaches



Photos: DW Gotshall (green sturgeon), J Katz (Chinook salmon), DWR (Delta smelt)

Environmental DNA (eDNA)

- Genetic methods for detecting species in water or soil
- Does not directly sample the organism
- Species-specific approach:

  <u>Advantages for monitoring</u>

  - Cost per sample: lower
  - Processing time: shorter

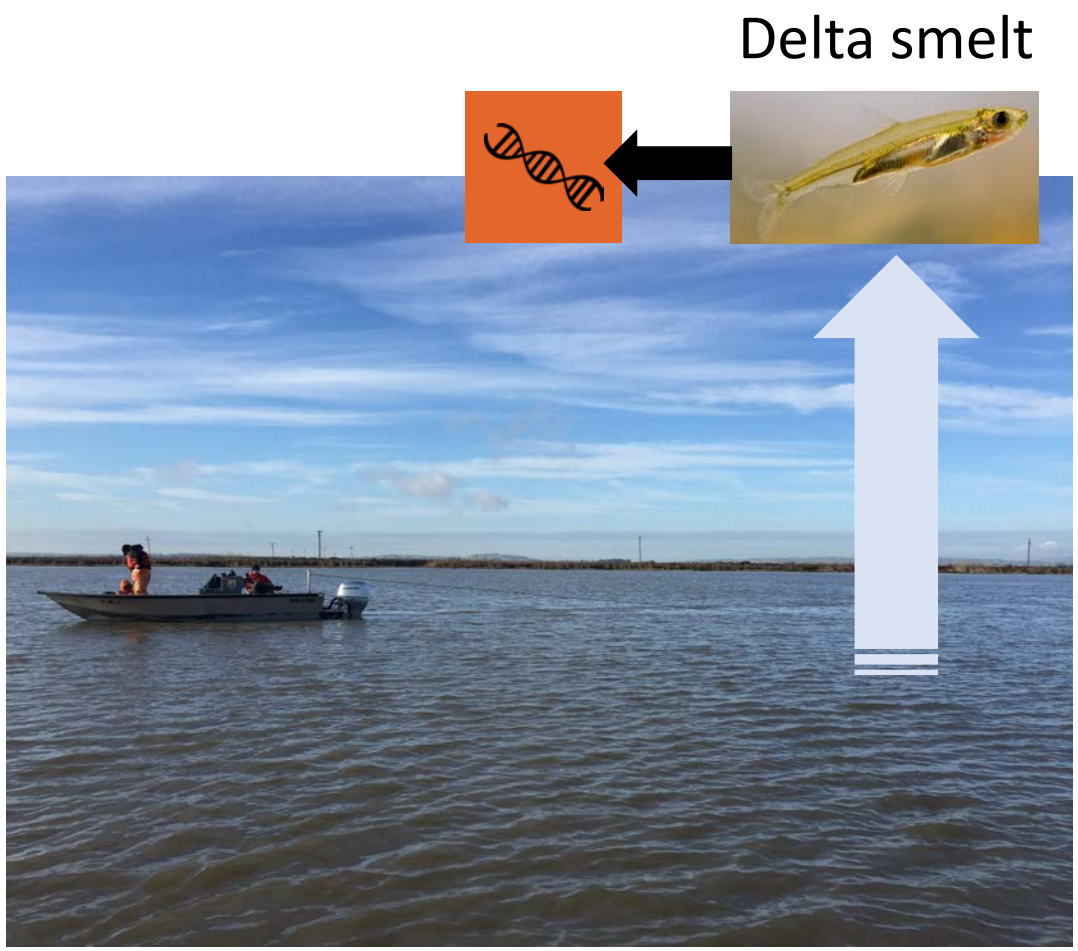


Photo: DWR (Delta smelt)

eDNA: Monitoring application

Surveying rare or cryptic species with traditional methods requires substantial field effort

Surveying Europe's Only Cave-Dwelling Chordate Species (*Proteus anguinus*) Using Environmental DNA

Judit Vörös[1,2]*, Orsolya Márton[3], Benedikt R. Schmidt[4,5], Júlia Tünde Gál[1], Dušan Jelić[6]

Environmental DNA from Seawater Samples Correlate with Trawl Catches of Subarctic, Deepwater Fishes

Philip Francis Thomsen[1]*, Peter Rask Møller[2], Eva Egelyng Sigsgaard[2], Steen Wilhelm Knudsen[2], Ole Ankjær Jørgensen[3,4], Eske Willerslev[1,5,6]*

An eDNA Assay to Monitor a Globally Invasive Fish Species from Flowing Freshwater

Irene Adrian-Kalchhauser[1]*, Patricia Burkhardt-Holm[1,2]

Citations: **1.** Vörös et al. 2017 **2.** Thomsen et al. 2016 **3.** Adrian-Kalchhauser et al. 2016; Photos: A Hyde, N Calovianis, wikipedia

eDNA: Advantages

Photo: USFWS

- Detect rare/cryptic species[1,2,3]
- No morphological identification
- No sampling-related mortality
- Less disturbance of habitat/populations[4]
- Ability to sample sites not accessible by trawl
- Same gear for all life stages
- Large-scale implementation

1. Vörös et al. 2017 **2.** Thomsen et al. 2016 **3.** Adrian-Kalchhauser et al. 2016 **4.** Thomsen et al. 2012

eDNA: Fish detection

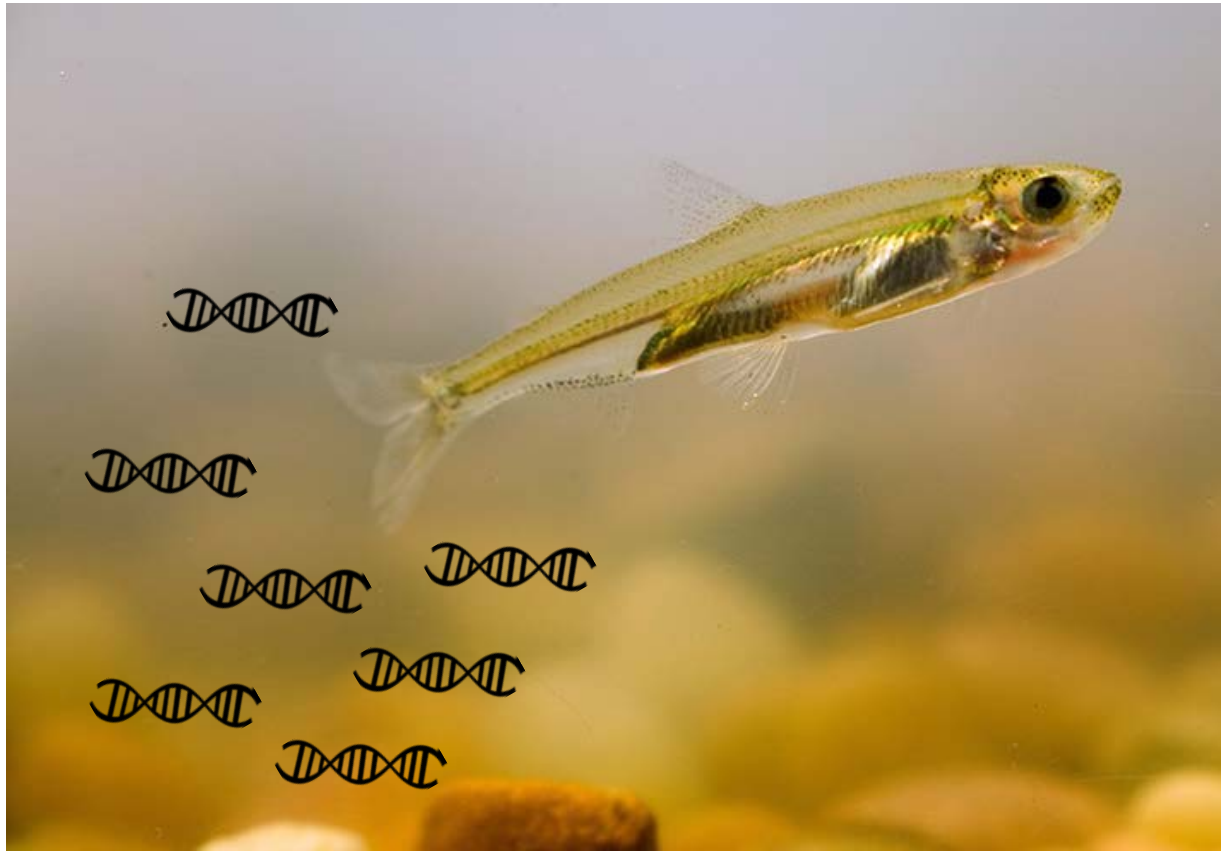


Photo: DWR

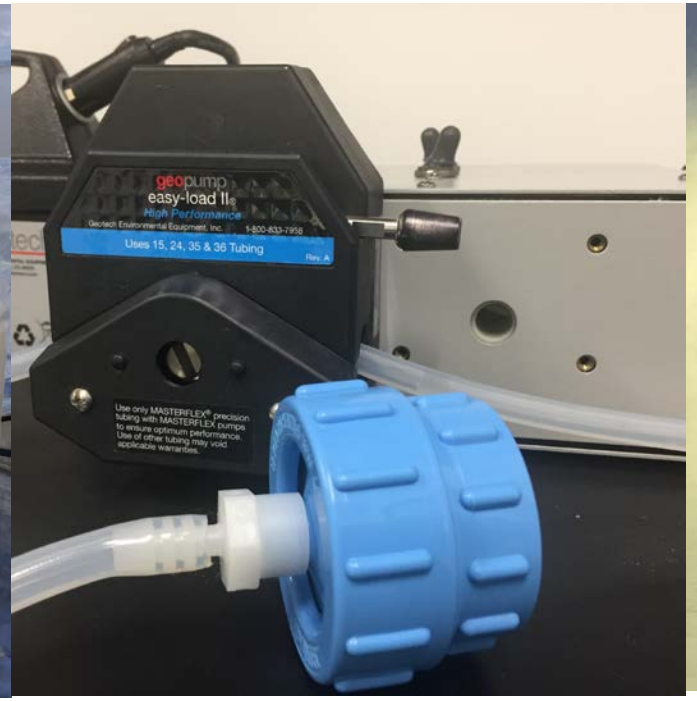
- Fish shed: mucus, waste, skin, scales
  - Cellular
  - Extracellular
- Particulates filtered from water
- Total DNA extracted from sample
- Delta smelt eDNA detected using quantitative PCR (qPCR) assay[5]

5. Baerwald et al. 2011

Field sampling

Collect water → Filter → Extract DNA from filter

3 x 1L per tow



eDNA + negative controls

What can go wrong?

- Low detection rate / no detection
  - Optimize assay for sensitivity
  - Understand impact of environmental factors (e.g. variable flows, turbidity)
- Contamination
  - Manage contamination in the field (right) and cross-contamination between samples[6]

Field sampling for fish (top) and eDNA (left) in the San Francisco Estuary with USFWS

6. Brandl et al. 2014

Delta Smelt detection using eDNA: Protocol considerations

- Detection method: species specific
  - Delta smelt qPCR assay[5] ✓
- Detection protocol (risk of false negatives)
  - Current project
- Contamination (risk of false positives)
  - Current project


Field sampling with USFWS

5. Baerwald et al. 2011

Detection using eDNA: Protocol considerations

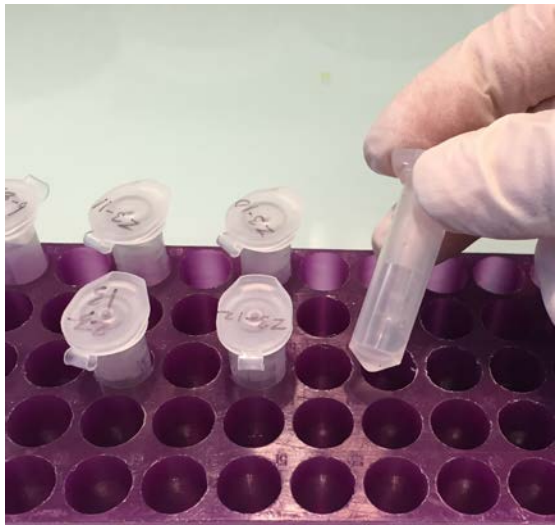
- Detection method: species specific
- Detection protocol (risk of false negatives)
- Contamination (risk of false positives)
  - Identify steps most likely to cause contamination
  - Field methods, equipment
  - Infrastructure: clean lab
  - Negative controls

Field sampling with USFWS

Protocol development

More control

More realistic



DNA dilutions

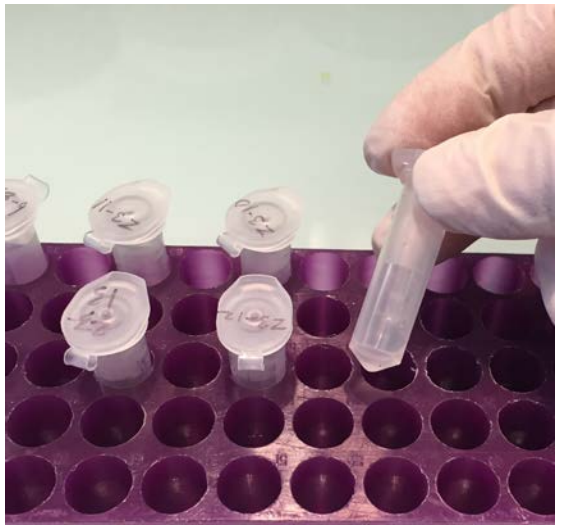
Tank experiments

Field experiments

Field sampling

Protocol development

More control



DNA dilutions

Tank experiments

- Serial DNA dilutions *<u>2016-2017</u>*
  - Consistent detection at delta smelt DNA concentration of 0.1 pg/µl
- Tank experiments at Fish Conservation and Culture Lab (FCCL) *<u>Upcoming</u>*
  - eDNA shed rate
  - eDNA decay rate

Protocol development

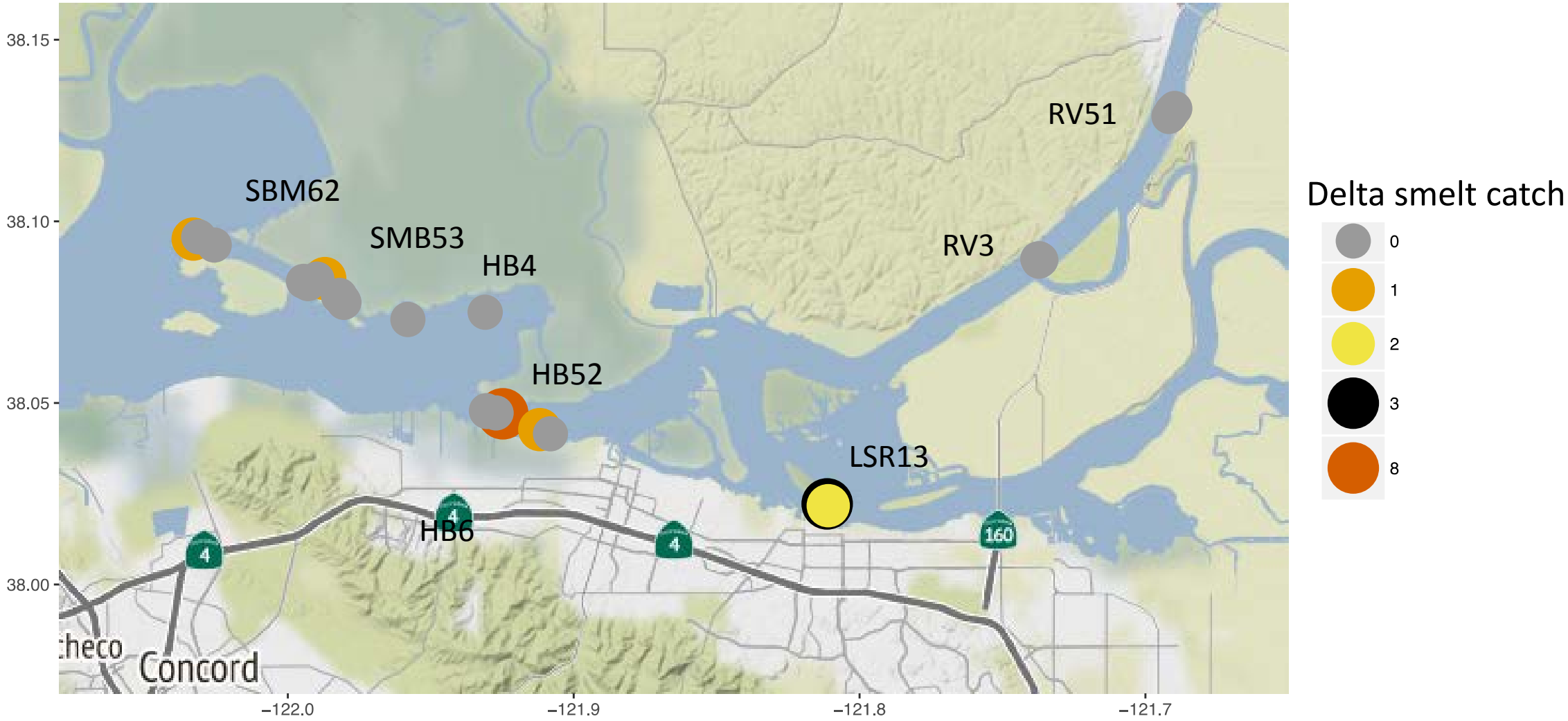
- Field Experiment: *May 2017*
  - How far away is eDNA detectable?
  - How long is eDNA detectable?
- Field Sampling: *Jan-Feb 2017*
  - Concurrent with USFWS Enhanced Delta Smelt Monitoring (EDSM)

More realistic →

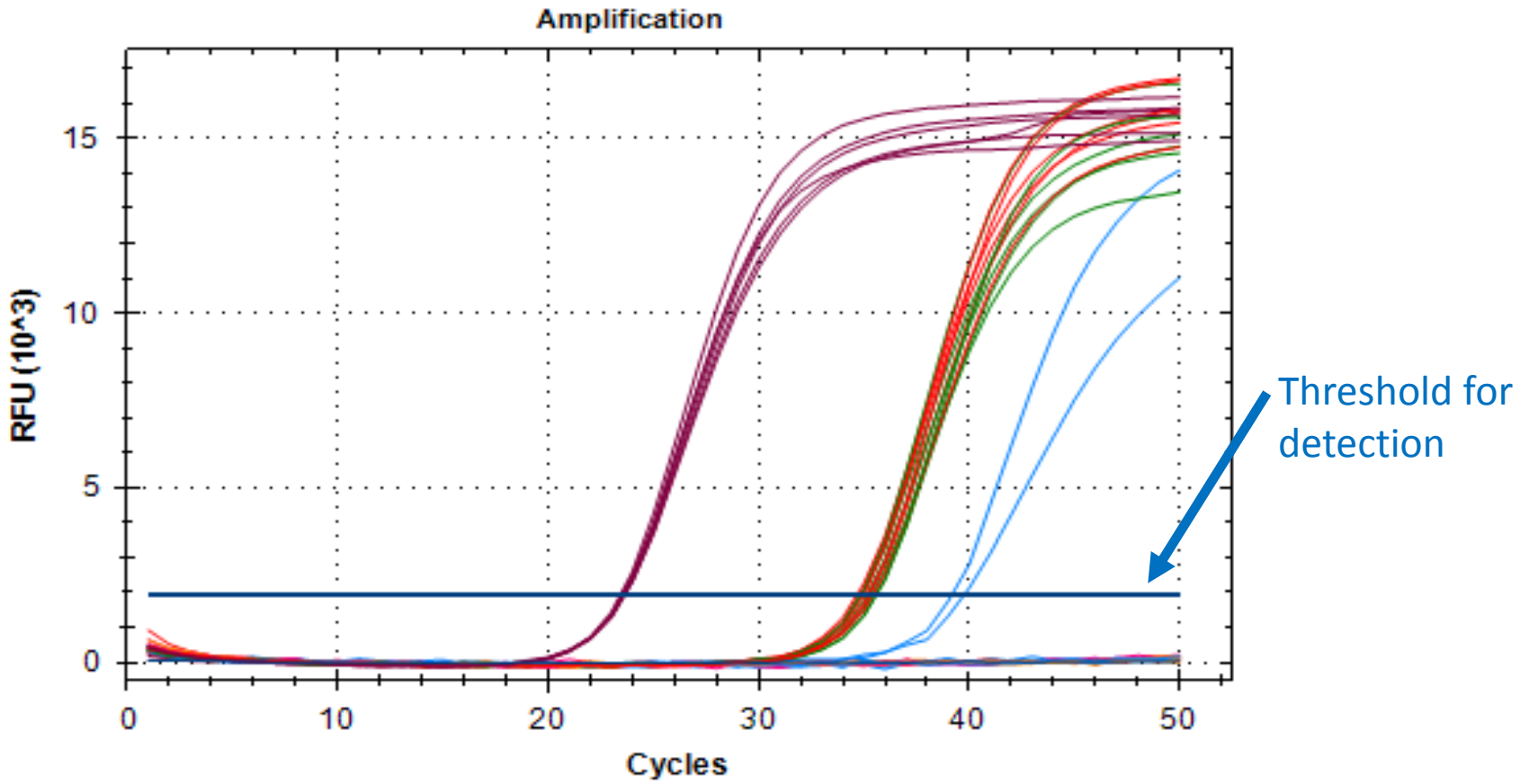
Field experiments

Field sampling

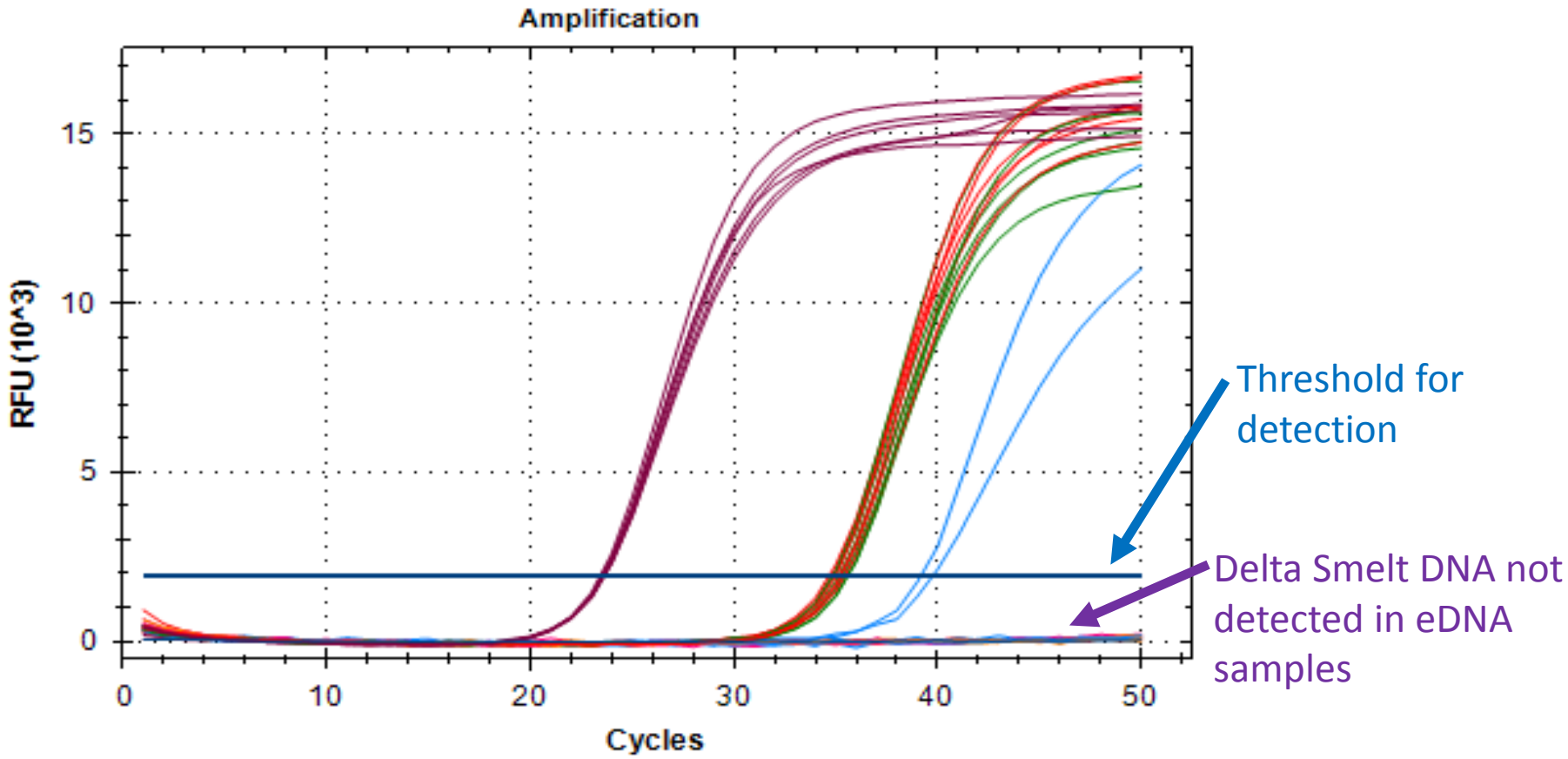
Field sampling with EDSM (USFWS)



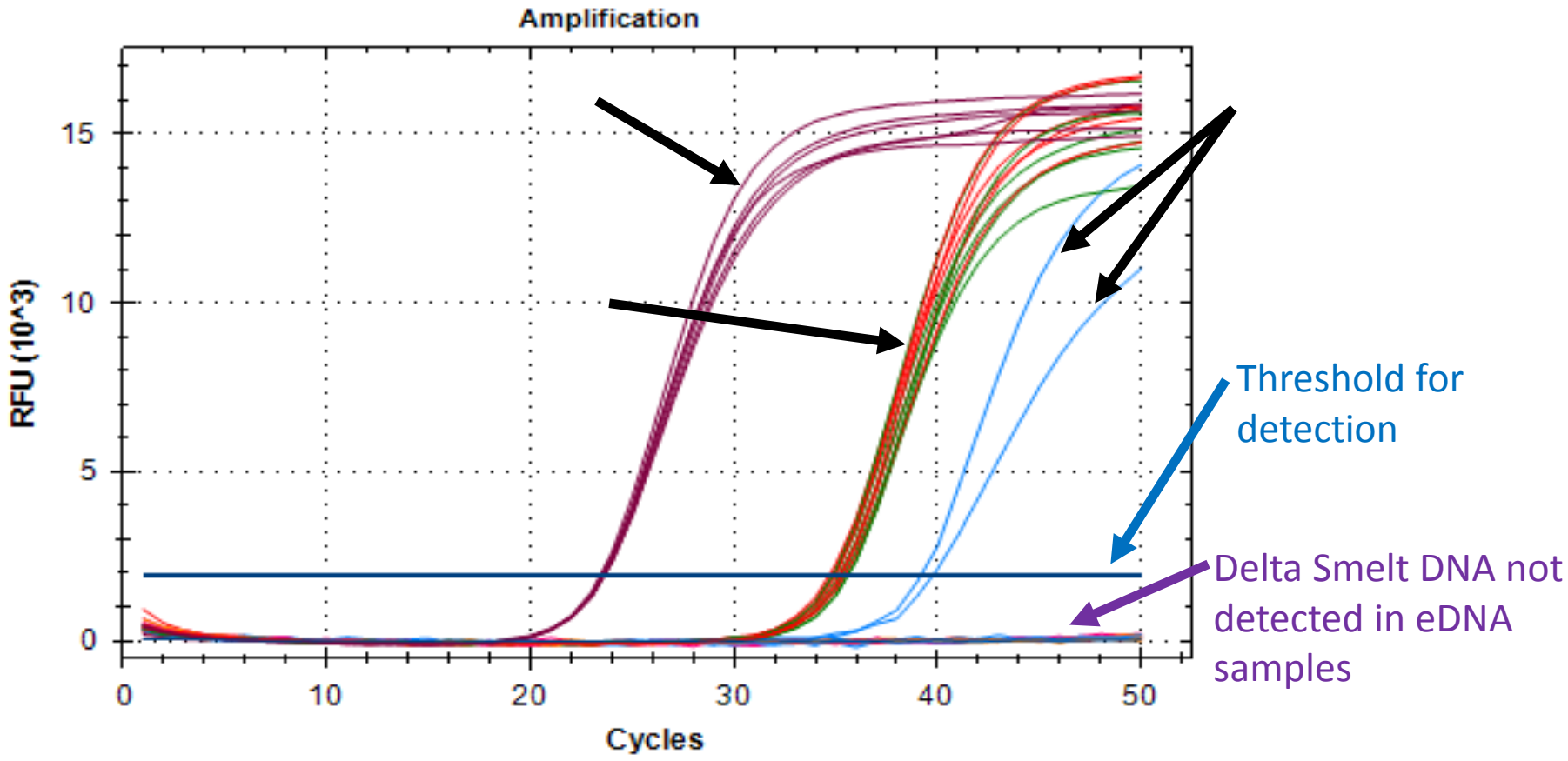
eDNA detection



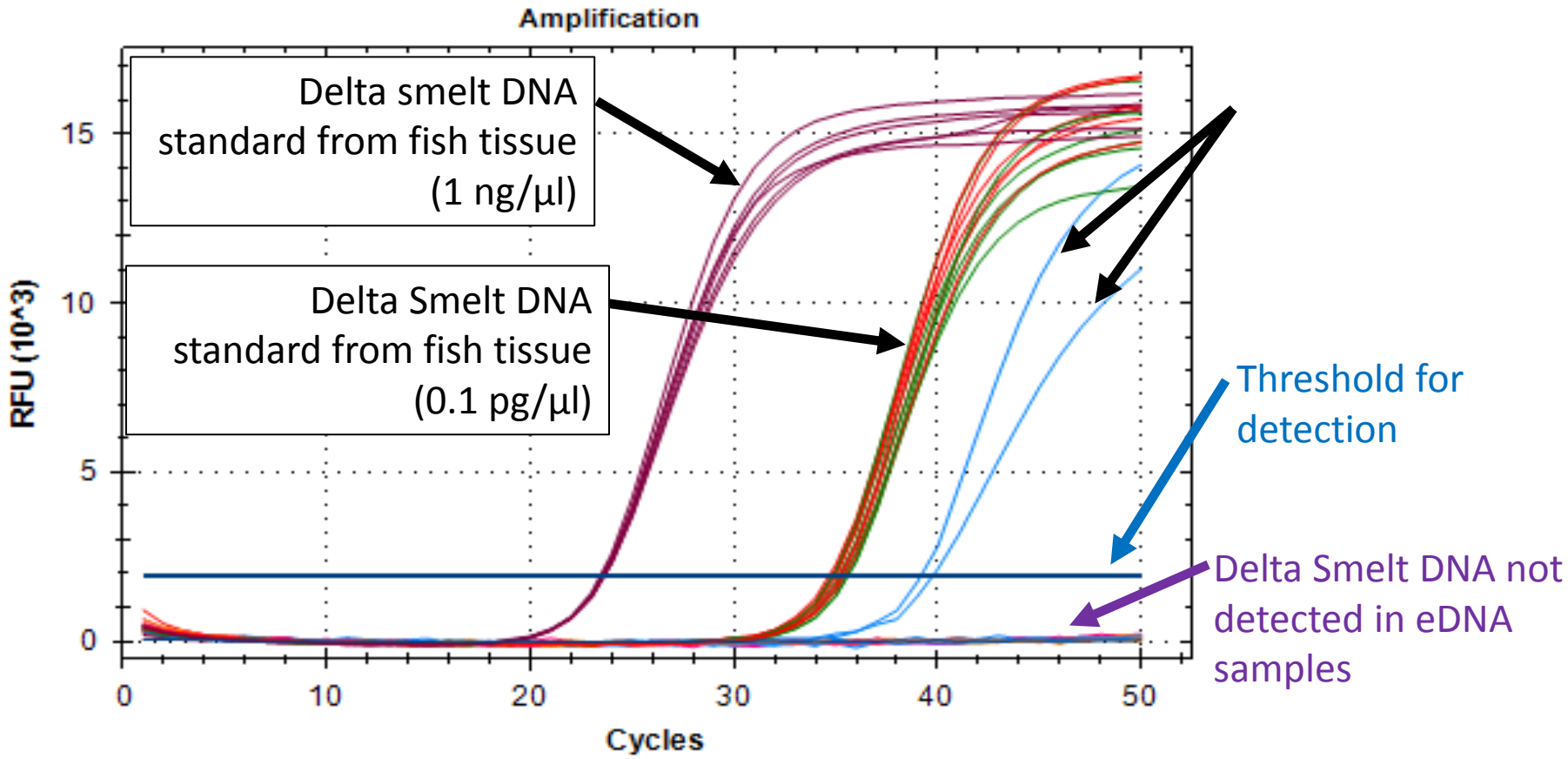
eDNA detection



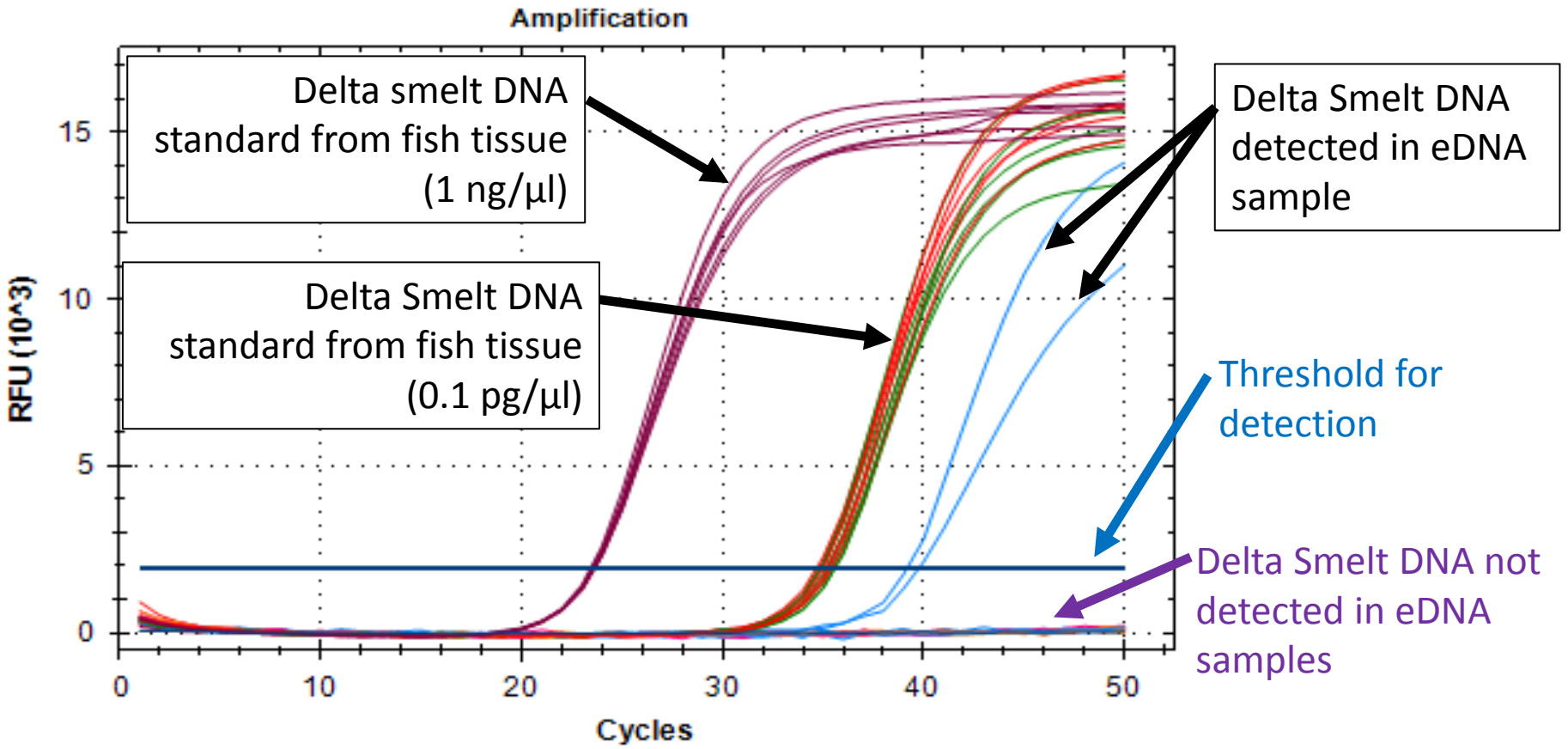
eDNA detection



eDNA detection

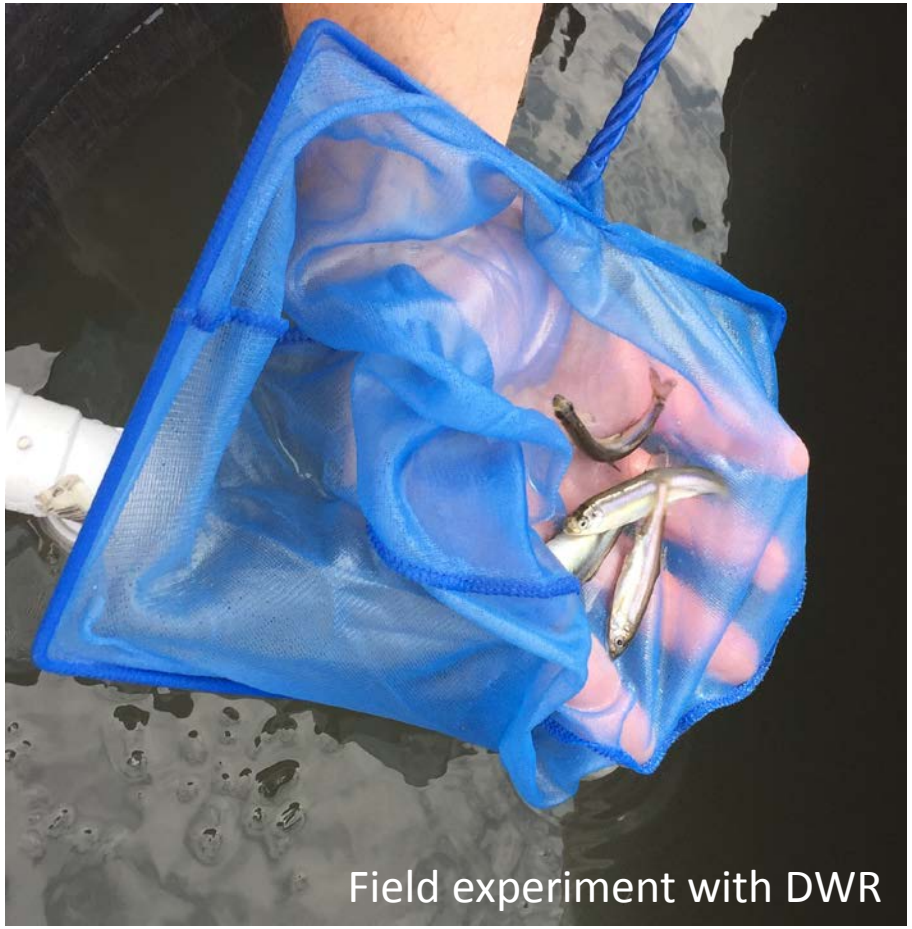


eDNA detection



Summary

- Species-specific approach
- Significant advantages for monitoring of Delta smelt
- Maximize detection, minimize contamination
- Experiments and field sampling
- Challenges and limitations
- Promising preliminary data



Field experiment with DWR

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Field sampling with USFWS

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