Using environmental DNA in monitoring programs for fish and amphibians

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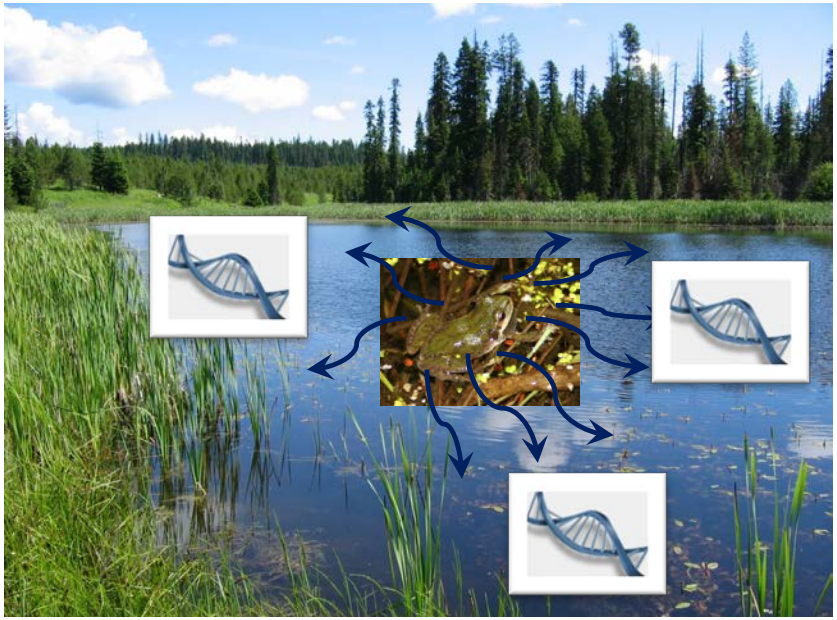
ESTCP

Monitoring aquatic species

- Difficult
- Potentially destructive
- Time-consuming
- Low detection probabilities

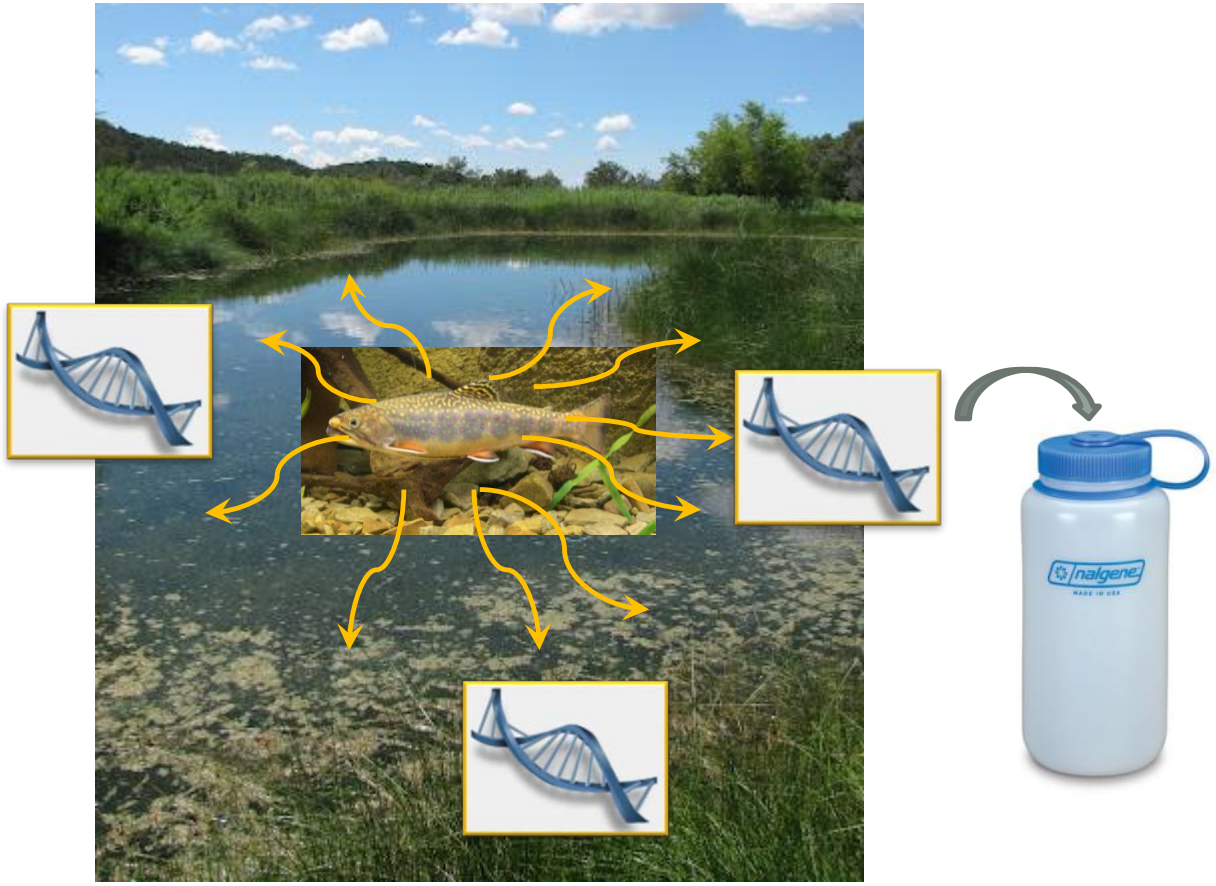


Outline

- Overview of eDNA research
- General eDNA methods
- Factors affecting eDNA detection
- eDNA sampling in the Yakima Basin

DNA in the environment

DNA in the aquatic environment



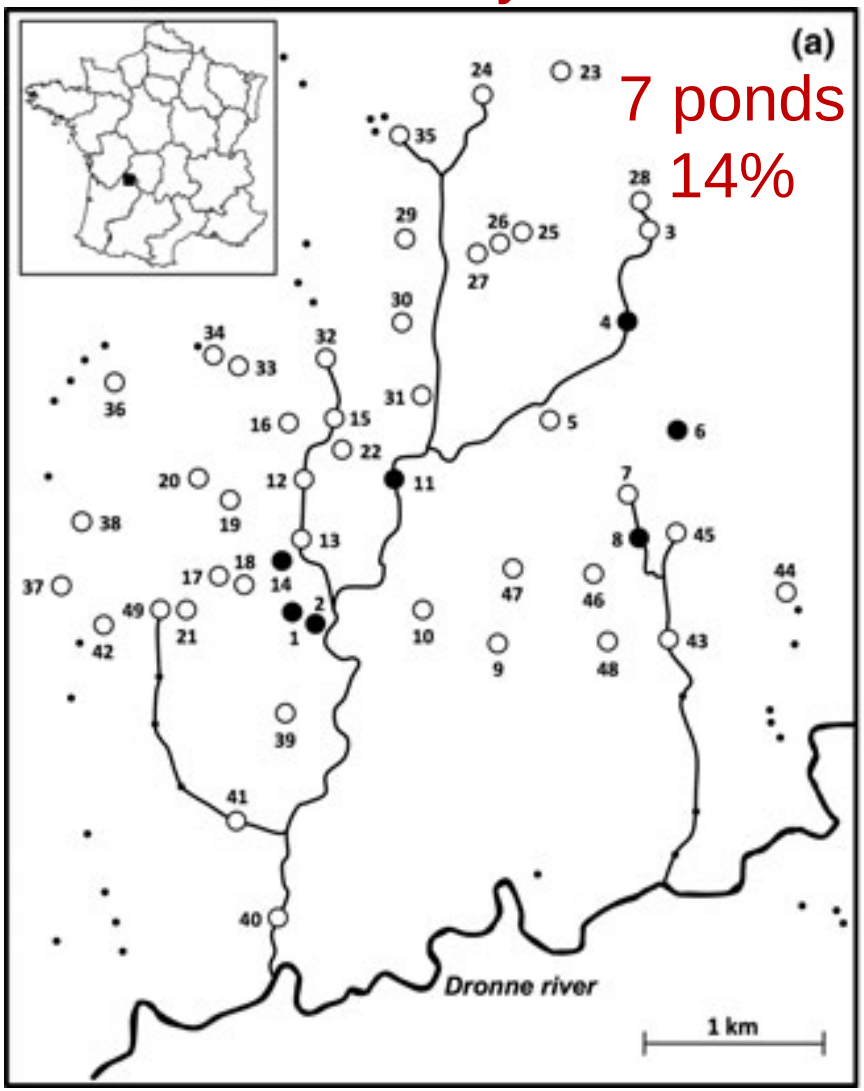
Case studies

- Bullfrogs at ponds (Ficetola et al. 2008)
- Asian carp in canals (Jerde et al. 2011)
- Fish, amphibians, crustacean, aquatic insect in wetlands (Thomsen et al. 2012)
- Otters and fish in rivers (lower detection) (Thomsen et al. 2012)
- Common carp in aquaria, ponds, lagoons (Takahara et al 2012)
- Marine fish and mammals (Thomsen et al. 2012, Foote et al. 2012)

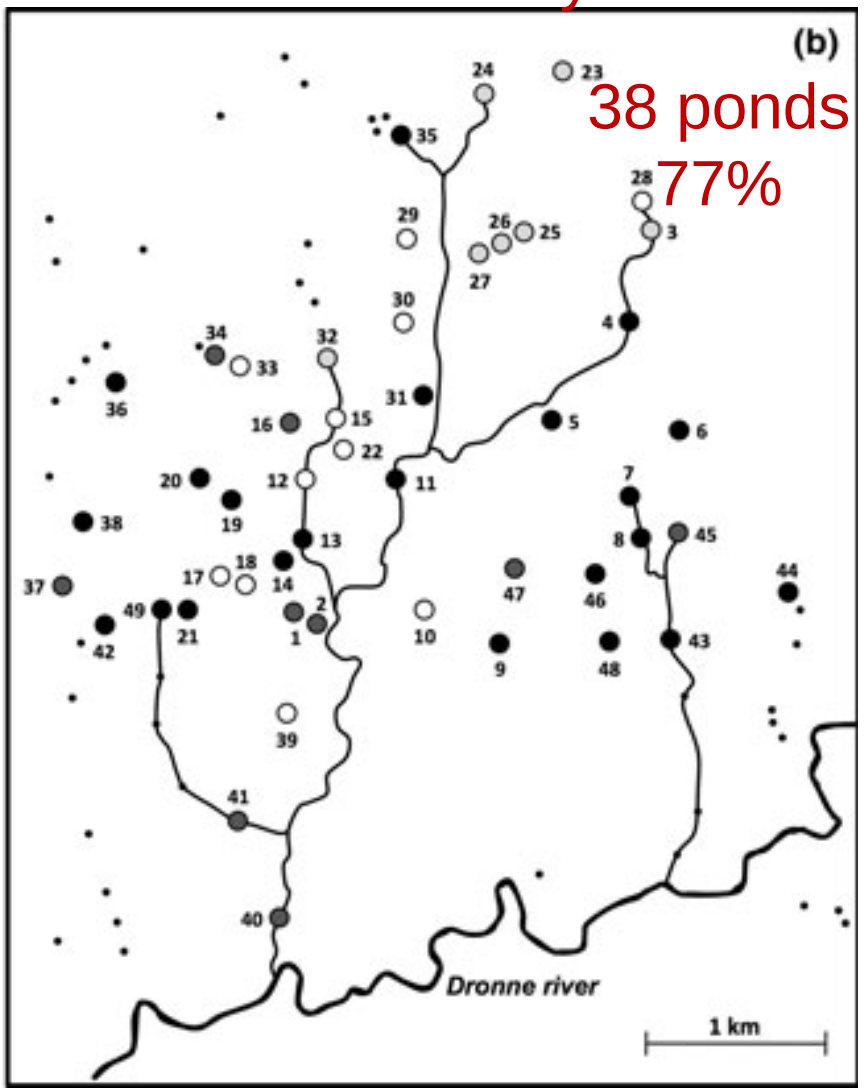


Bullfrog detection (Dejean et al. 2012)

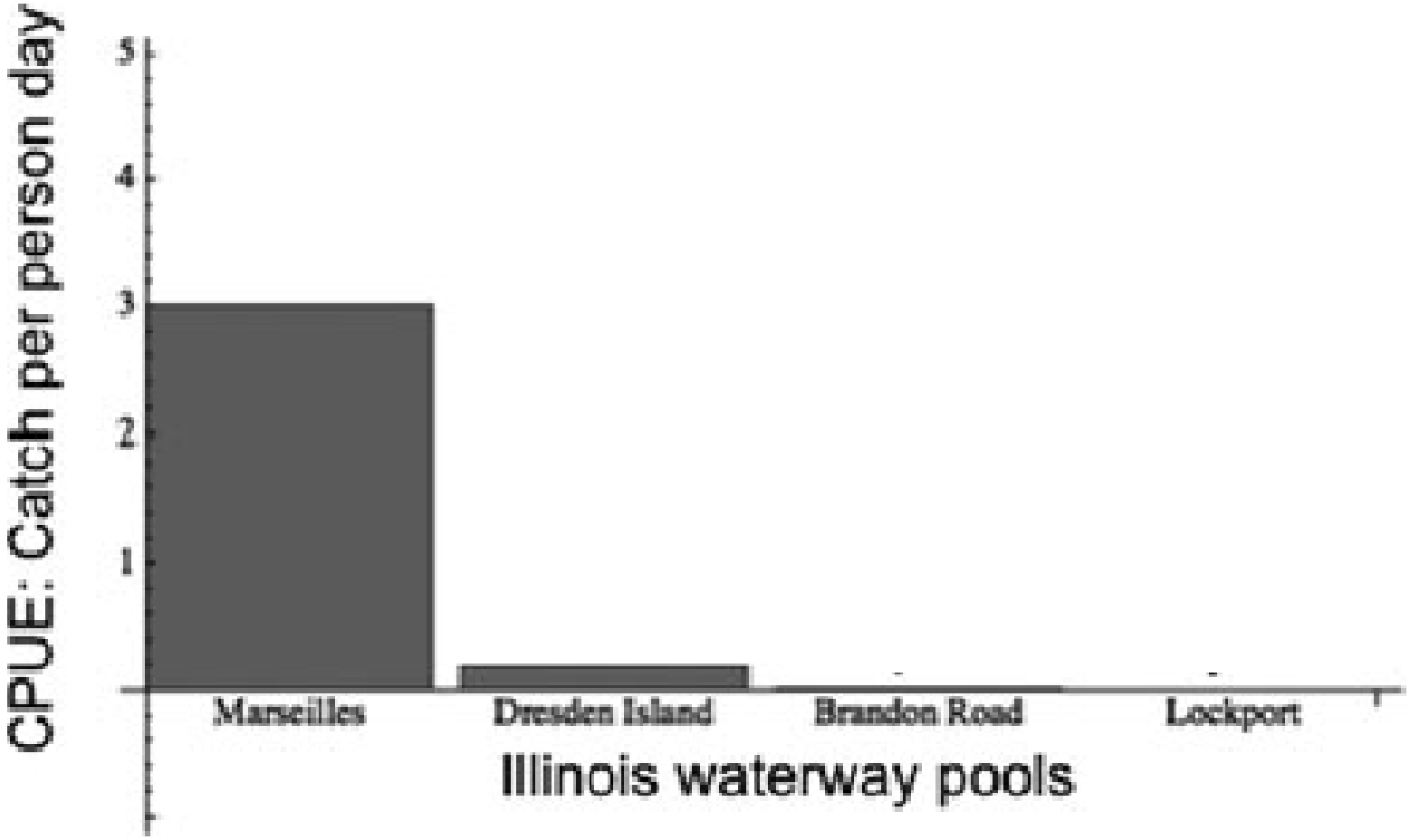
Field surveys



eDNA surveys



eDNA efficiency (Jerde et al. 2011)



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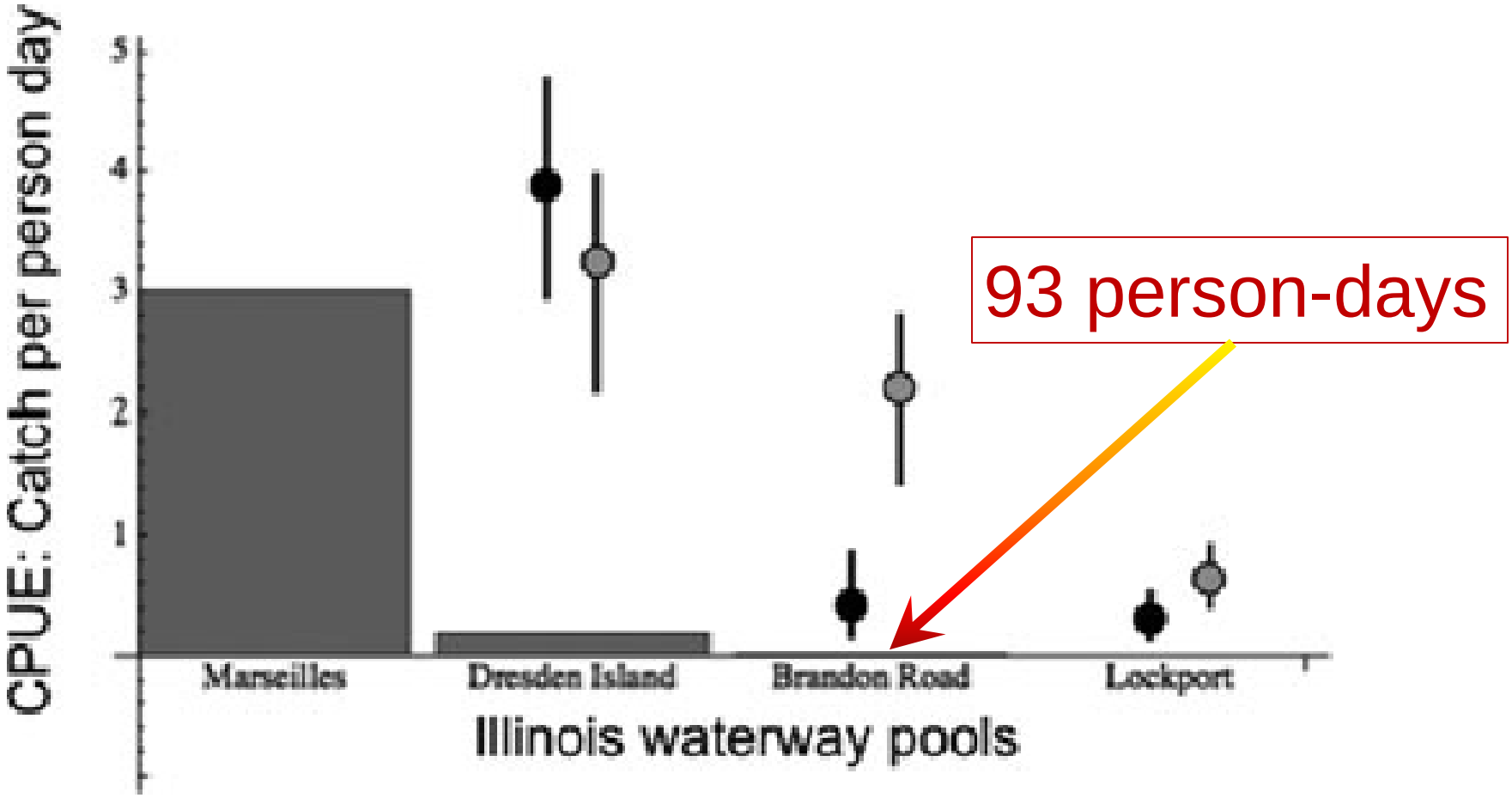

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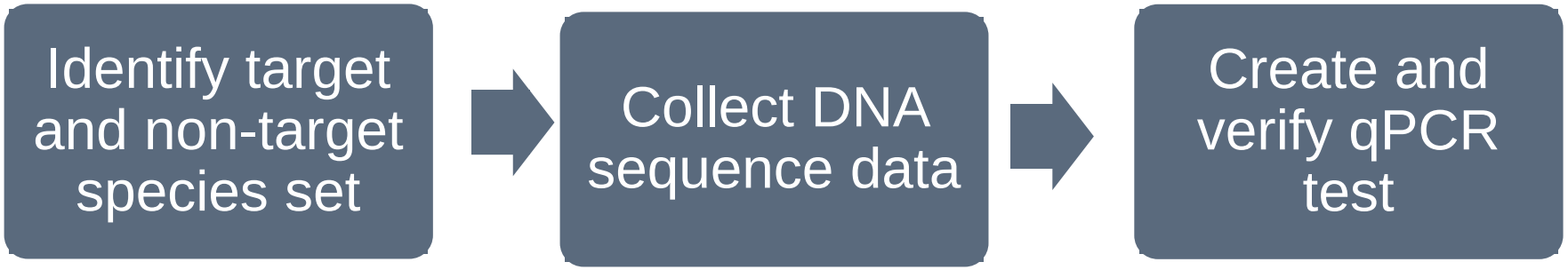
eDNA Methods – Test Development

eDNA protocol development:



eDNA Methods - Sampling

4 replicates: 1 L in streams, 250 mL in wetlands

eDNA Methods - Sampling

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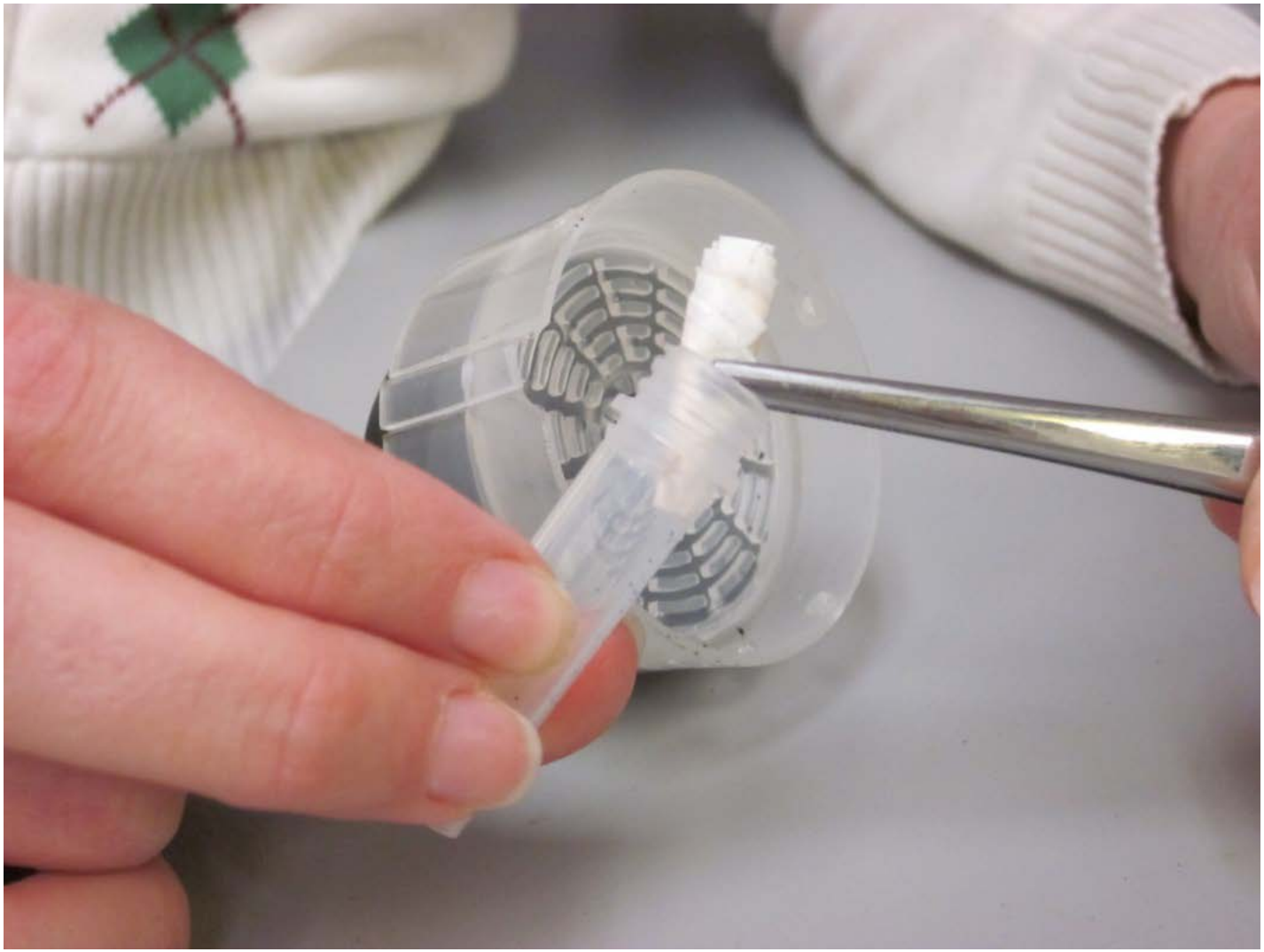
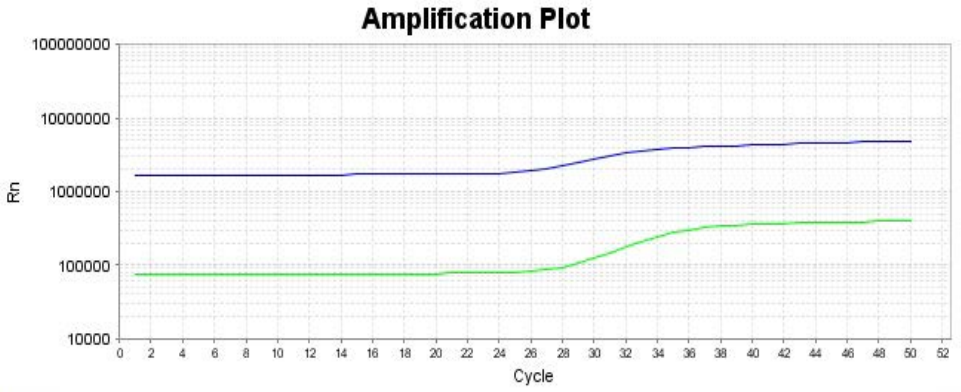


eDNA Methods - Analyses

- DNeasy/Qiashredder
- Quantitative PCR



- Occupancy modeling
  - UV exposure
  - Conductivity
  - Water temperature
  - pH
  - Volume

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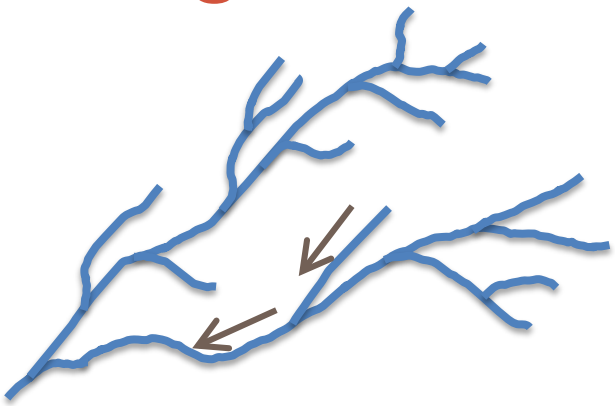
Processes affecting eDNA detection

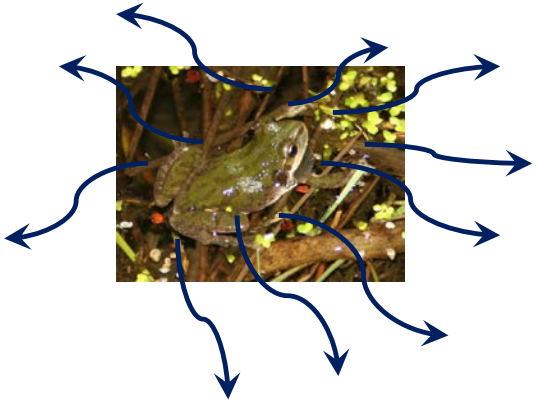


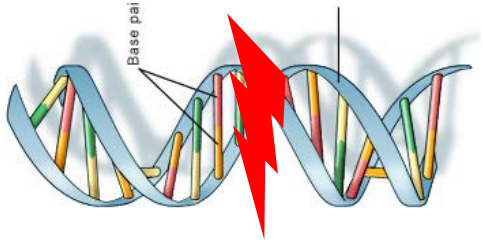
Diffusion/Transport

Production

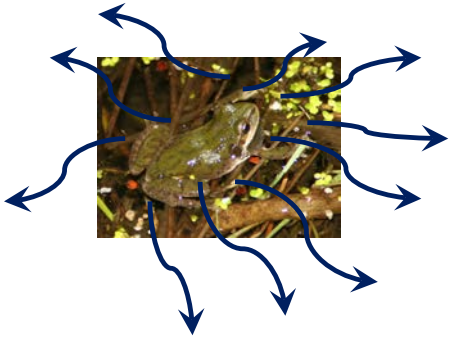
Detection

Degradation

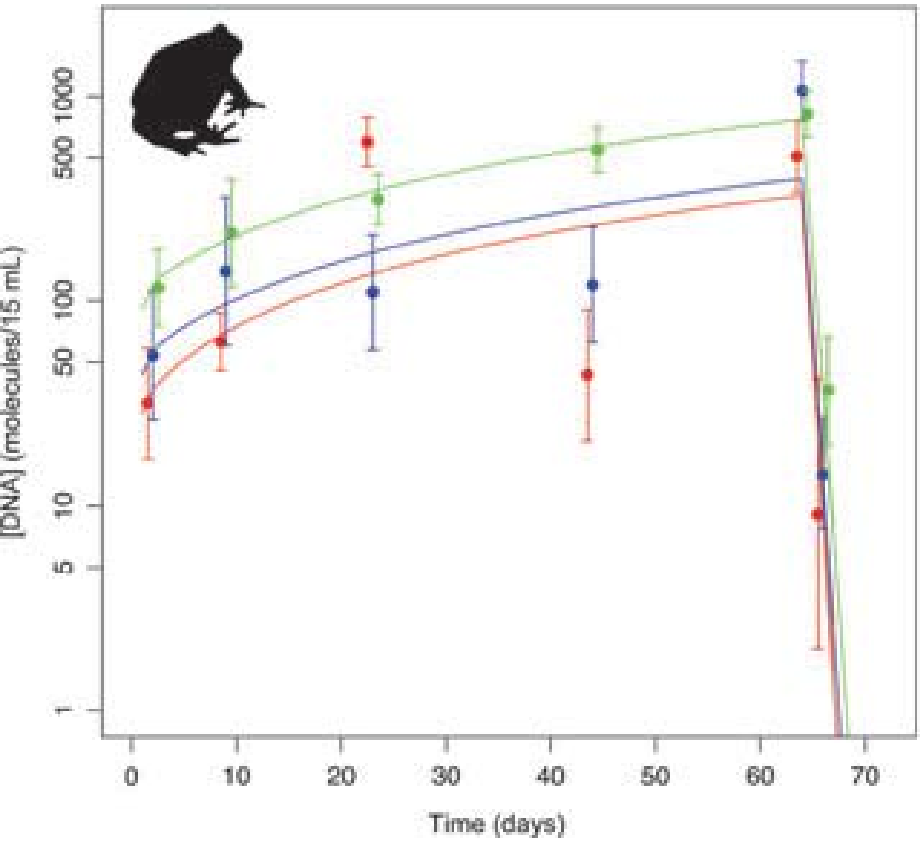


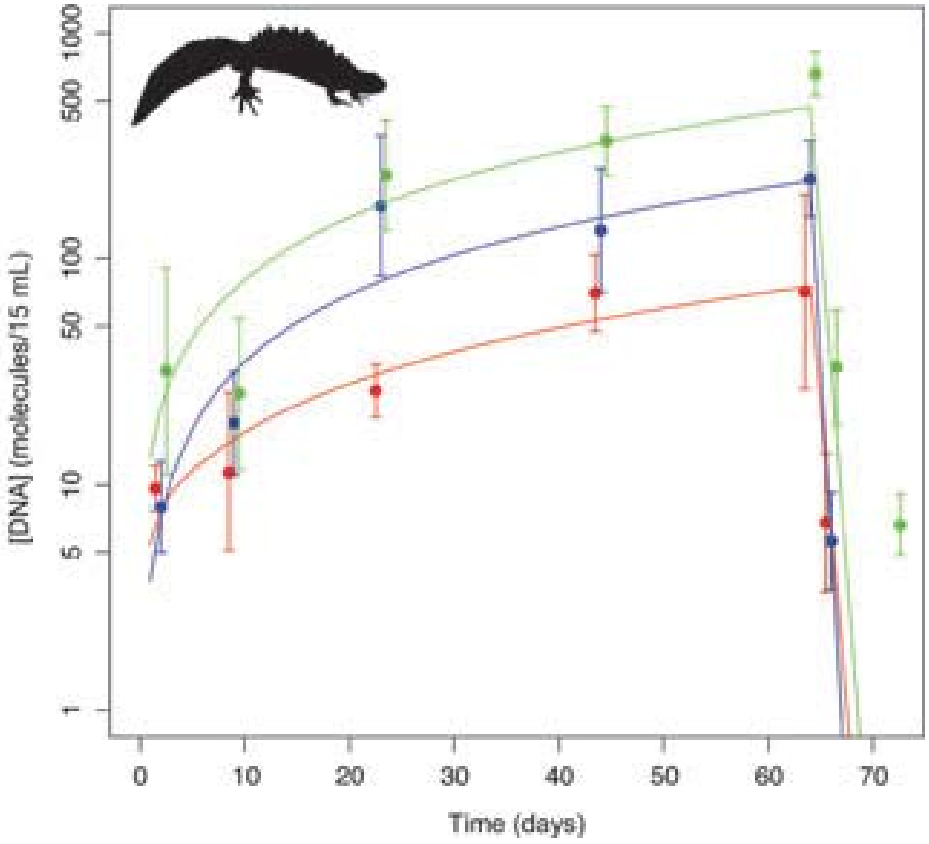


Production



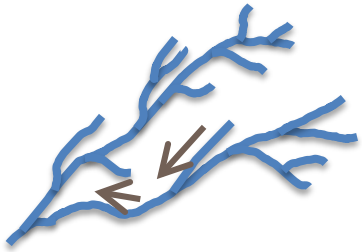
- Could be affected by:
  - Metabolism, stress, water chemistry, population density…

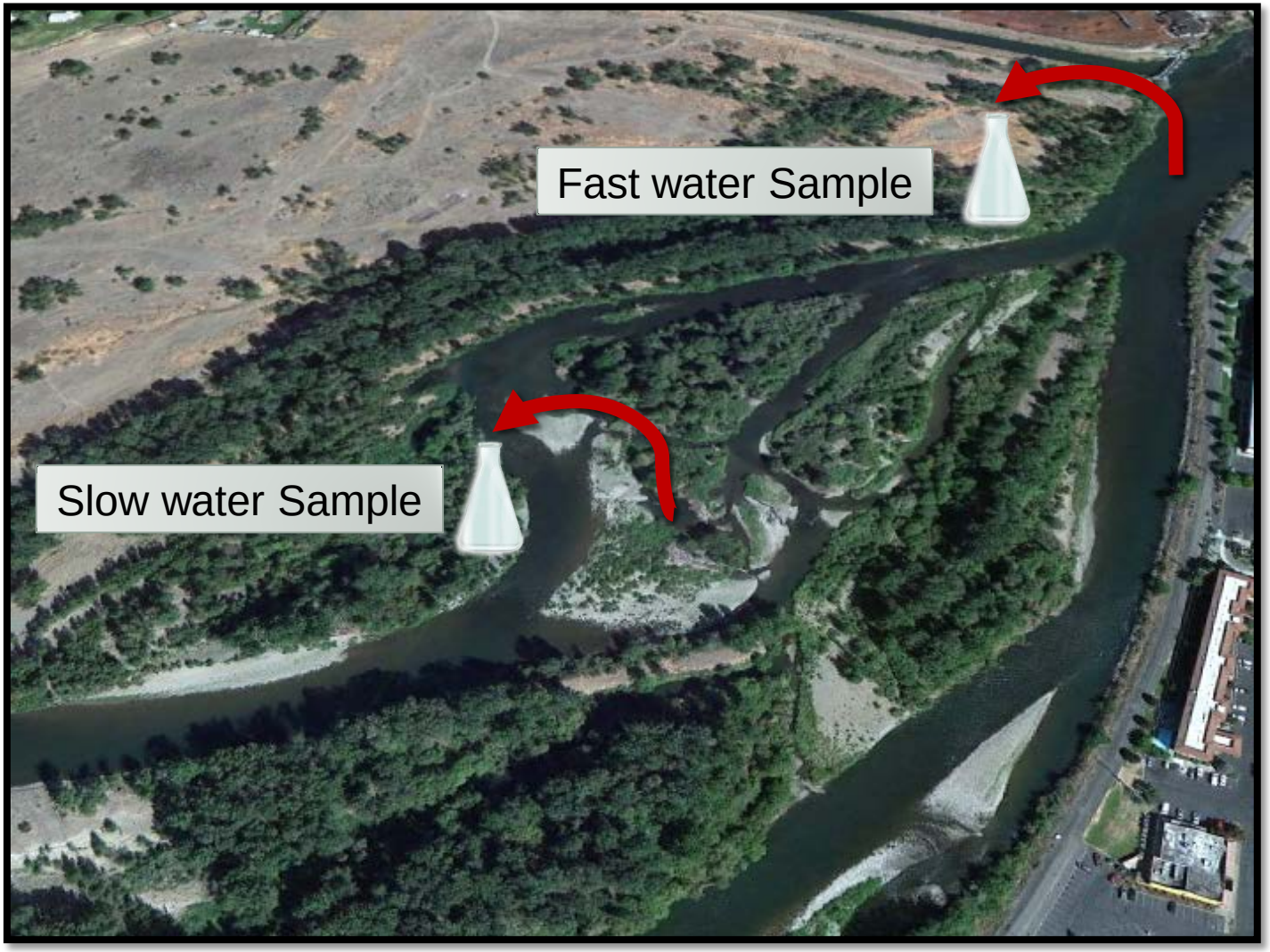




Thomsen et al. 2012

Diffusion/Transport





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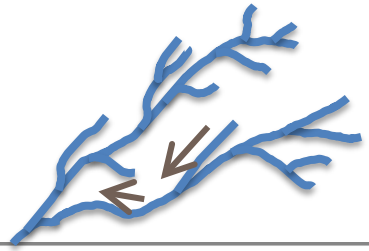
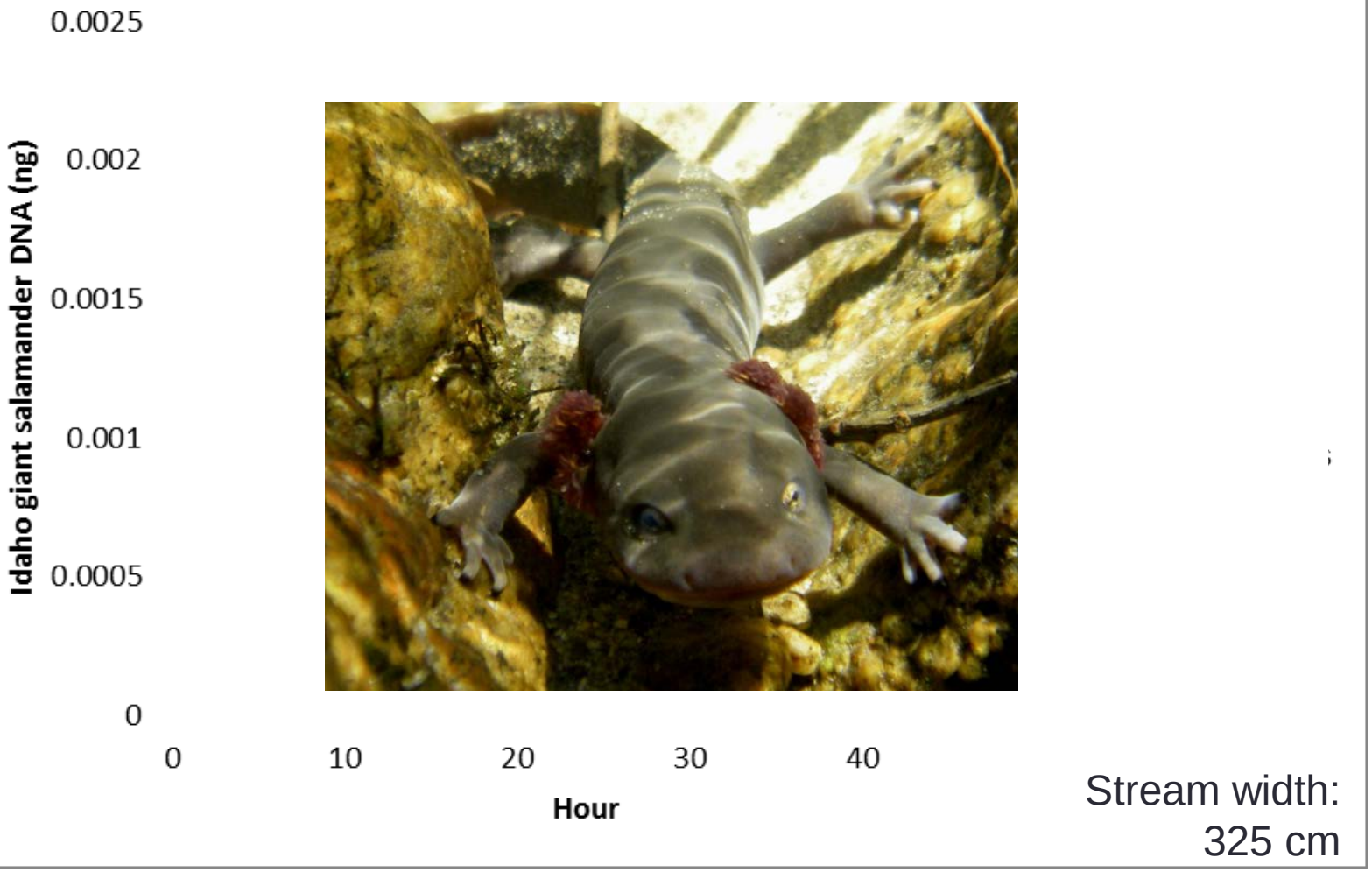
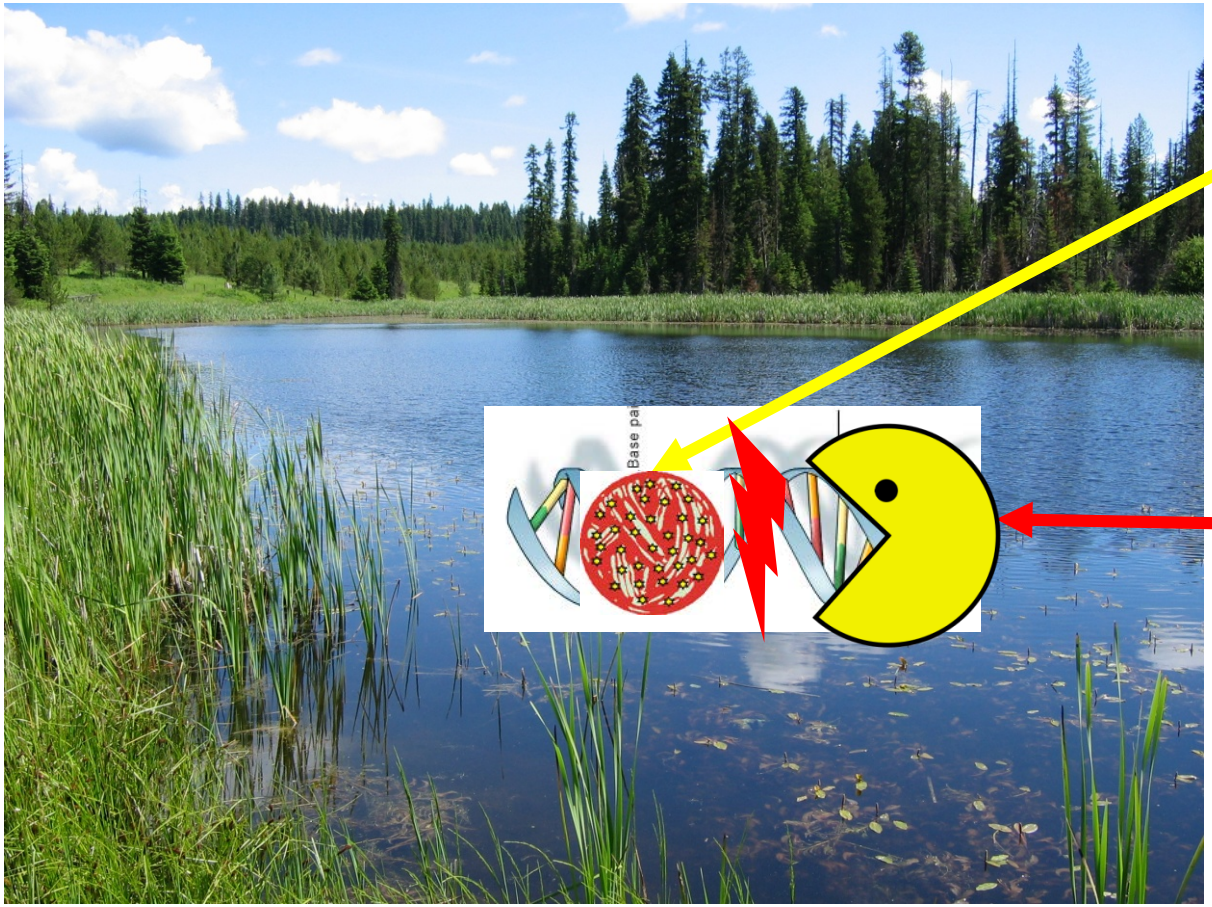




- No detections at 50 m

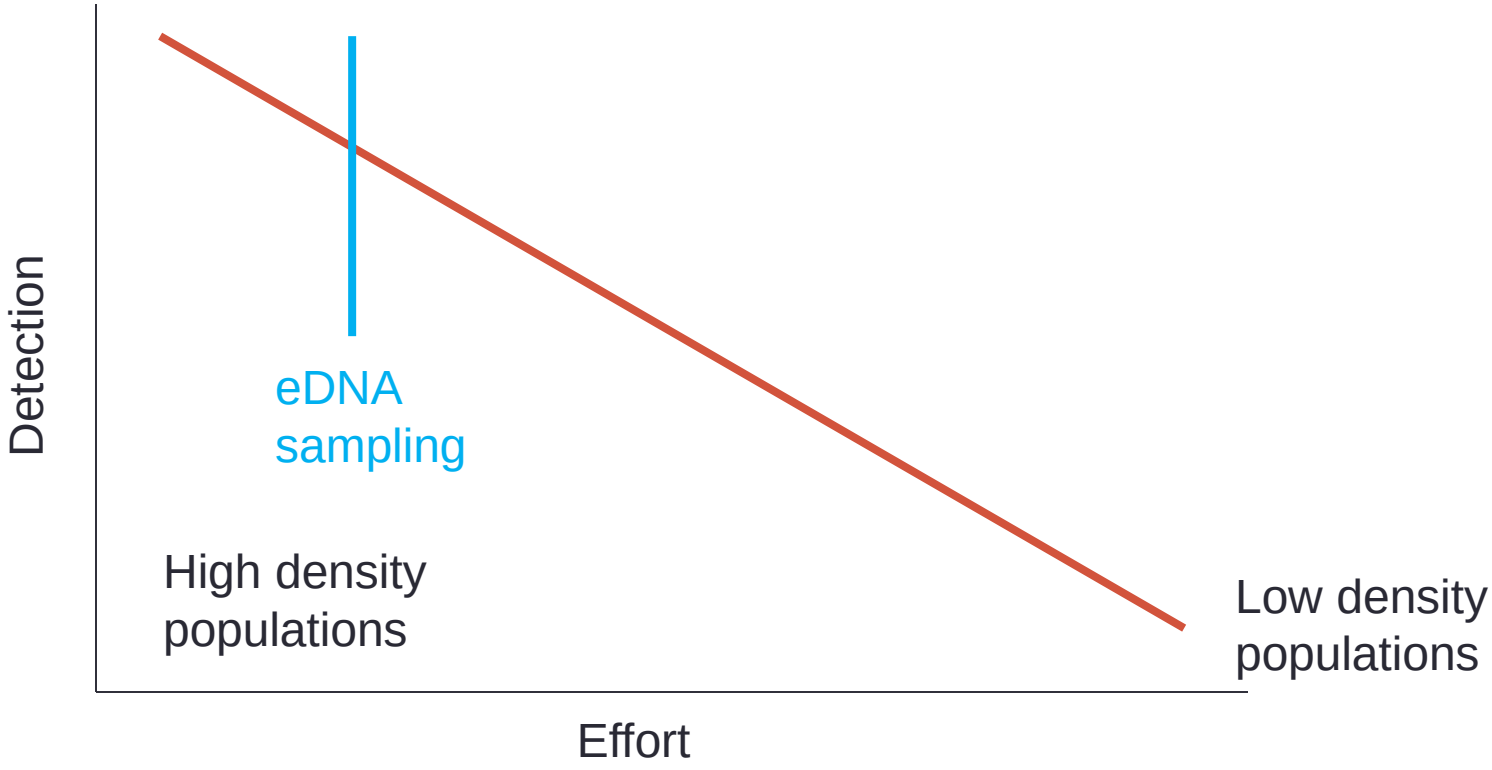
Pilliod et al. in review

eDNA Degradation

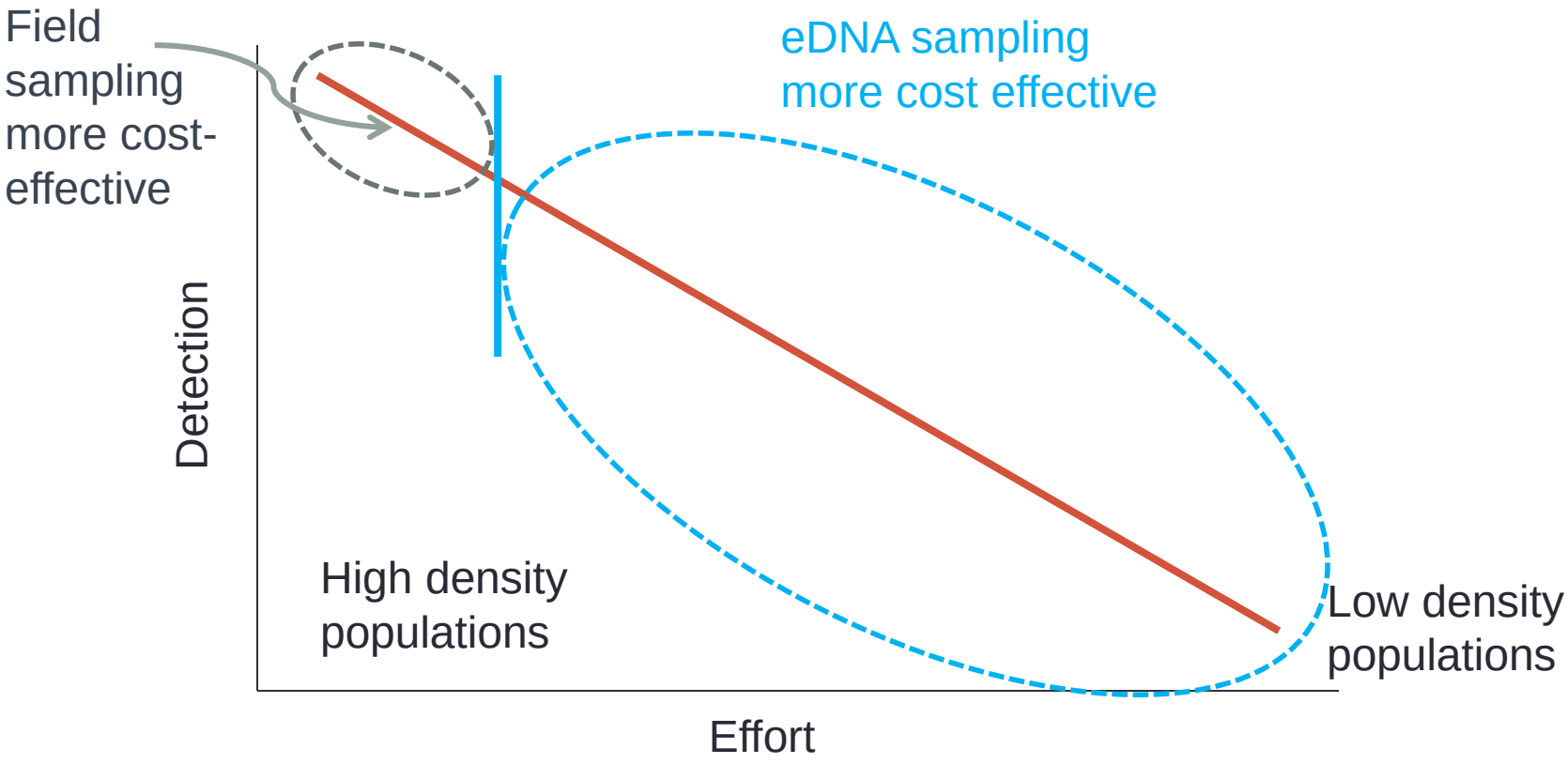


- DNA of ~100 bp can persist 14 – 21 days (Dejean et al. 2011)

eDNA Detection



eDNA Detection



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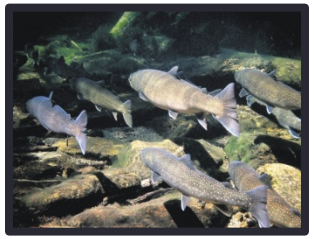
eDNA sampling in the Yakima Basin

Yakima Training Center

- Bull trout, spring and fall Chinook, brook trout
- Collect eDNA water filter samples 2-3x/year in fish-bearing streams



eDNA sampling in the Yakima Basin

Yakima River Basin

- Collect water filter samples in coordination with field surveys
- Compare detection probabilities of eDNA vs. field surveys
- Model occupancy of target species using covariates

eDNA sampling in the Yakima Basin

2012 progress

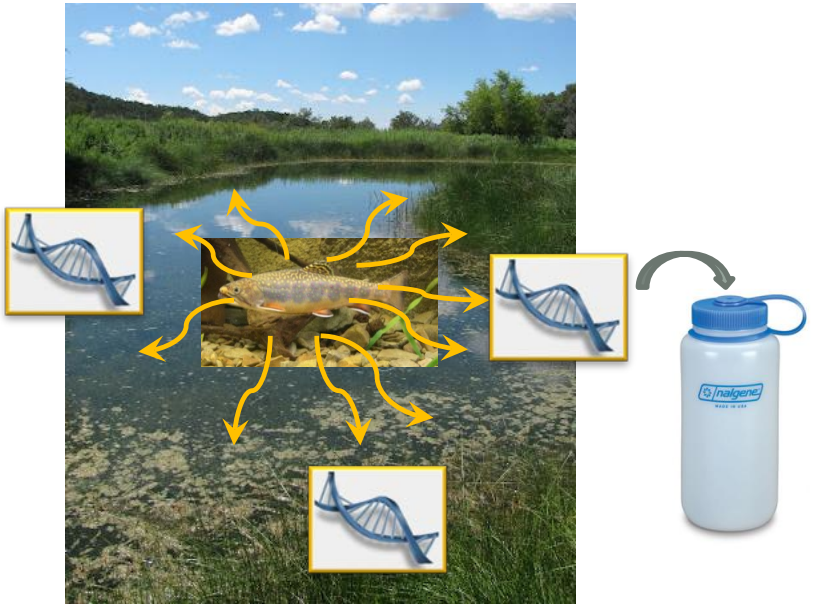
- Sampled known locations of bull trout, spring Chinook, fall Chinook
- Developed qPCR tests for bull trout and Chinook

eDNA sampling in the Yakima Basin

2013 planned work

- Sample streams at YTC and elsewhere
- Use known locations of fish to determine best sampling areas
- Develop and validate test for spring Chinook
- Use validated qPCR tests to analyze all samples

eDNA FAQs



Can we use eDNA for Species X?

How much does it cost?

Can we use eDNA to estimate abundance?

What are the chances of a false positive?

Will it really work in rivers?

Thank you

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Asian carp controversy

- Does eDNA detection = presence of live fish?

- Some places have since been confirmed by electrofishing.

eDNA projects - DoD

- Fort Huachuca
  - Sonoran tiger salamander
  - Chiricahua leopard frog
  - Arizona treefrog
  - Northern Mexican gartersnake
  - Threats





- Eglin Air Force Base
  - Reticulated flatwoods salamander
  - Ornate chorus frog


Products

- Site-specific protocols and results
- Generalized protocol with guidelines for:
  - designing field sampling programs
  - collecting eDNA samples in the field
  - developing PCR tests for new systems
  - evaluating the quality of laboratory tests