Multi-scale occupancy modeling of dreissenid mussels: a comparison of eDNA and plankton tow survey methods

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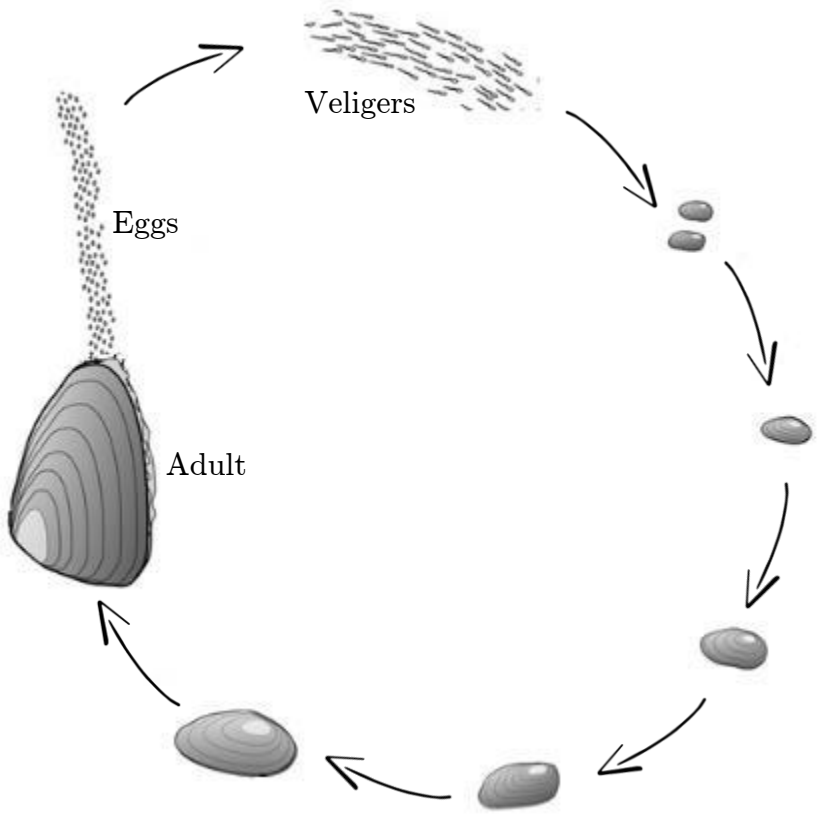
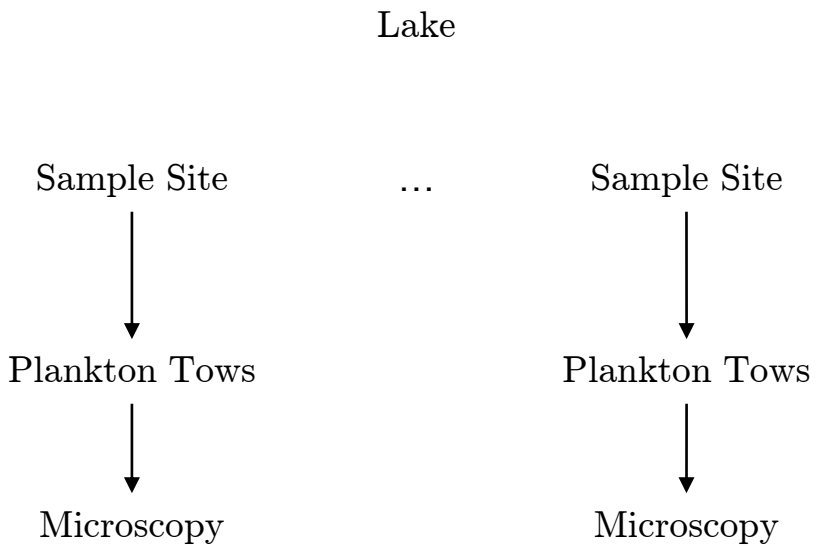
Motivation

- Dreissenid mussels
  - Zebra mussels (*Dreissena polymorpha*)
  - Quagga mussels (*Dreissena bugensis*)

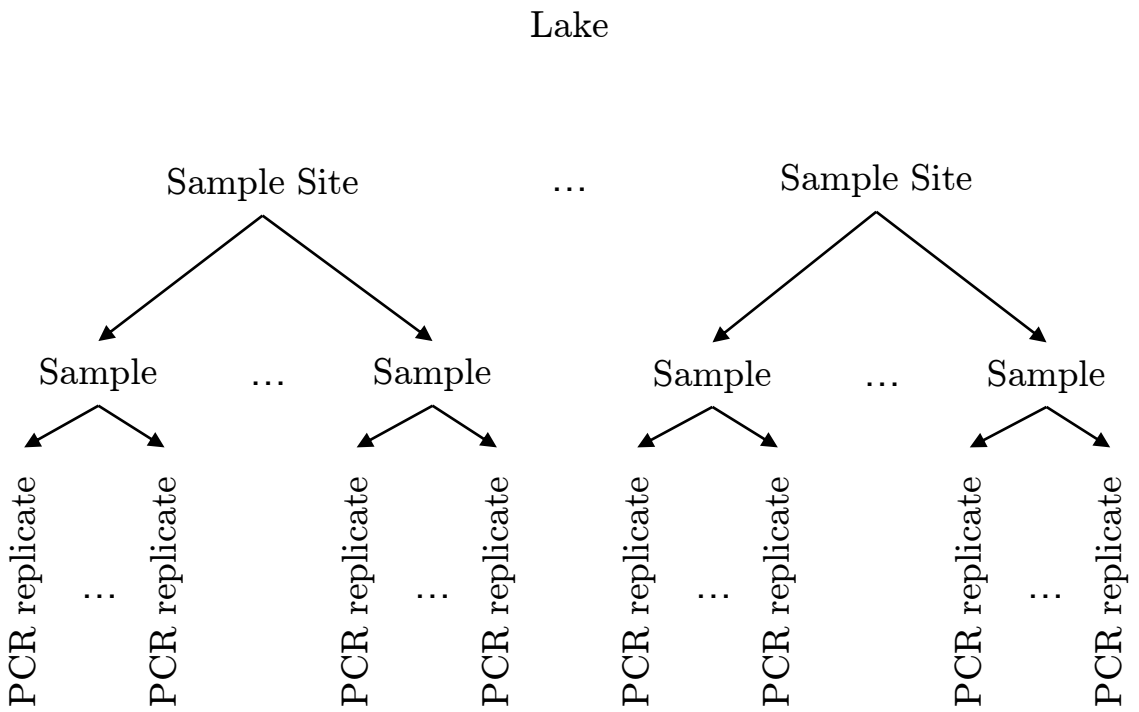
- Research question:
  - How do the detection probabilities and false negative rates of dreissenid mussels compare for plankton tow methods and eDNA survey methods?



Plankton Tow Surveys



eDNA Surveys



Occupancy Models

- Allow for imperfect detection
- Learn about detection probabilities
  - Need replication

Future Work

- Fit occupancy models to the two data sets

- Back to the research question:
  - How do the detection probabilities and false negative rates of dreissenid mussels compare for the two early detection methods?

Acknowledgments

Adam Sepulveda, U.S. Geological Survey, Northern Rocky Mountain Science Center

Photo References

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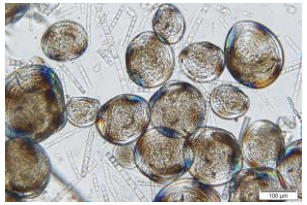
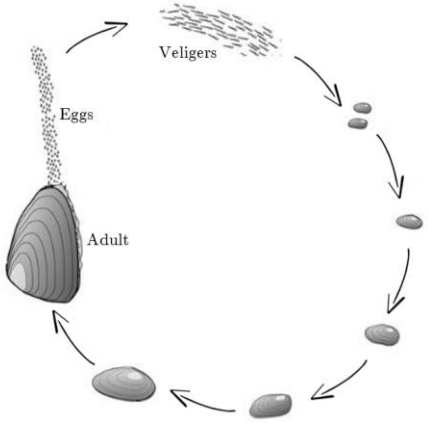
Motivation

- Hundreds of millions of dollars spent annually on control and mitigation efforts
- Change the water body ecosystem
- Most often moved to uninfested waters by humans
- Once an population is established, there is not much that can be done in terms of eradication
- Early detection can provide 3-5 years advanced notice to plan and install necessary technologies





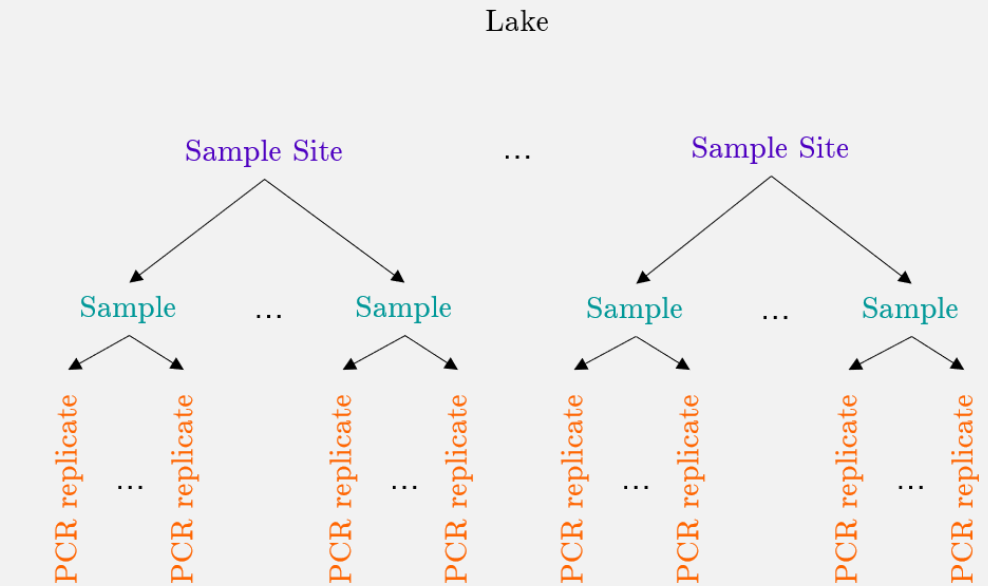
Research Question

- How do the detection probabilities and false negative rates compare for the two early detection methods?

Data

- Presence:
  Target species occupies the region **and** is detected
- Absence:
  Target species does not occupy the region **or** occupies the region and is not detected
- Detection Probability:
  Probability of detecting the target species if it is present

Multi-scale Occupancy Model for eDNA Surveys

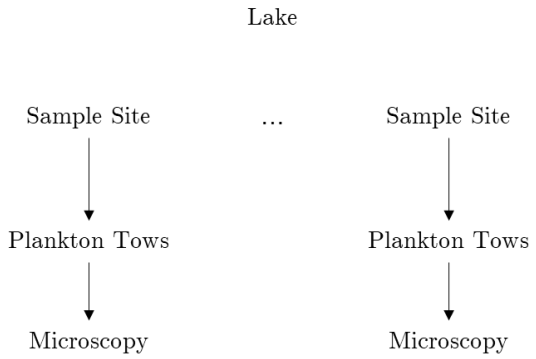


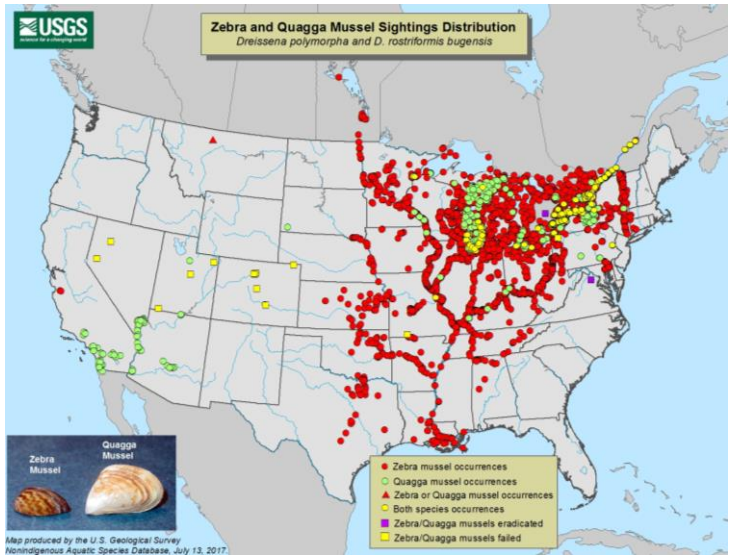
$Z_i \sim Bernoulli(\psi_i)$
ψ_i: probability that eDNA is present at the i^{th} site
z_i: latent occupancy state at the site level

$A_{ij}|z_i \sim Bernoulli(z_i\theta_{ij})$
θ_{ij}: conditional probability that eDNA is present in the j^{th} sample from the i^{th} site, given eDNA is present at the site
a_{ij}: latent occupancy state at the sample level

$Y_{ij}|a_{ij} \sim Binomial(K_{ij},\ a_{ij}p_{ij})$
p_{ij}: conditional probability of detection of eDNA in each replicate of the j^{th} sample collected at the i^{th} location, given that eDNA is present in that sample
Y_{ij}: the number of the K_{ij} replicates from the j^{th} sample collected at the i^{th} location that contain eDNA

Plankton Tow Surveys





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