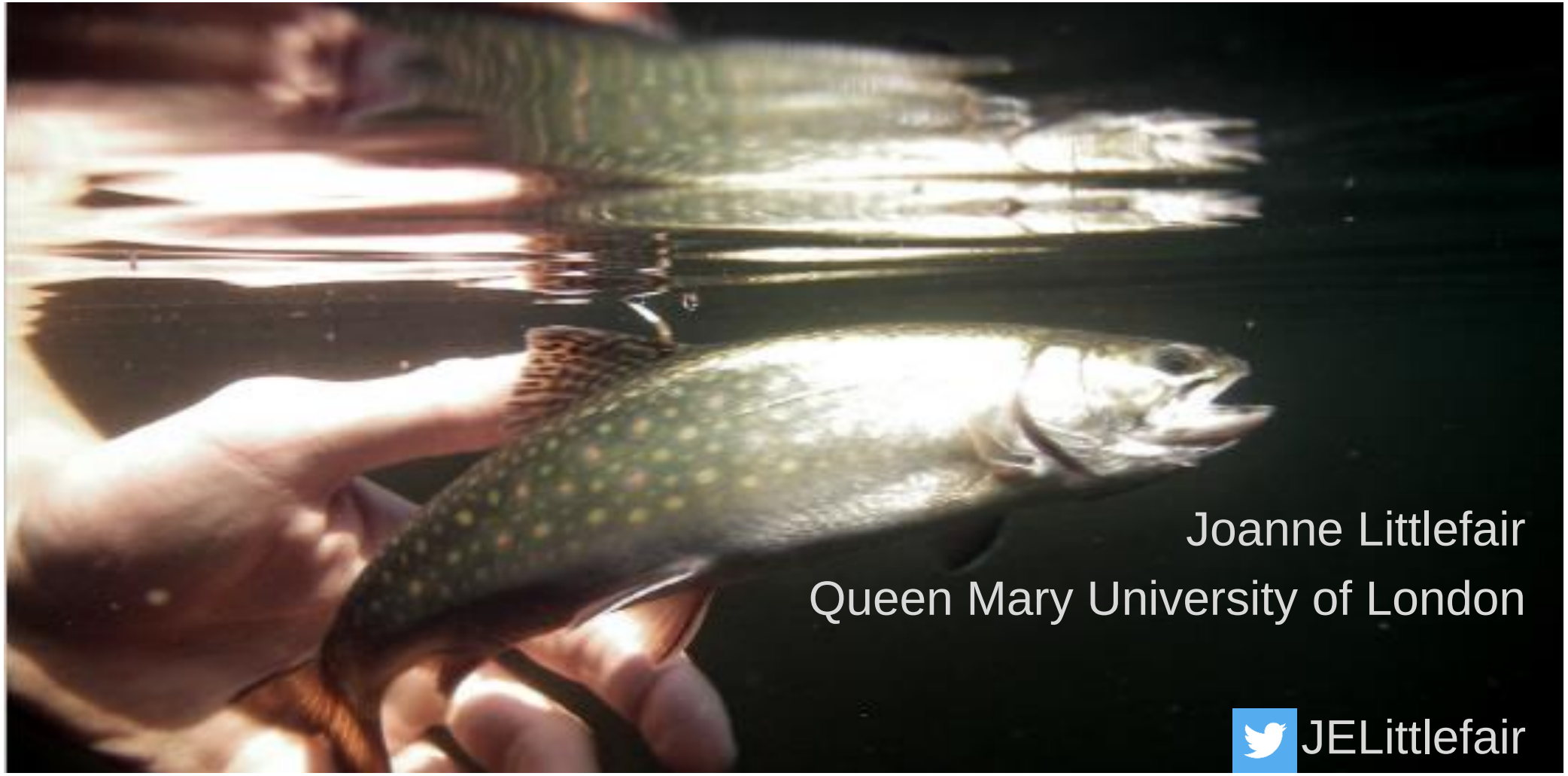
Environmental monitoring with eDNA: from local to regional signal



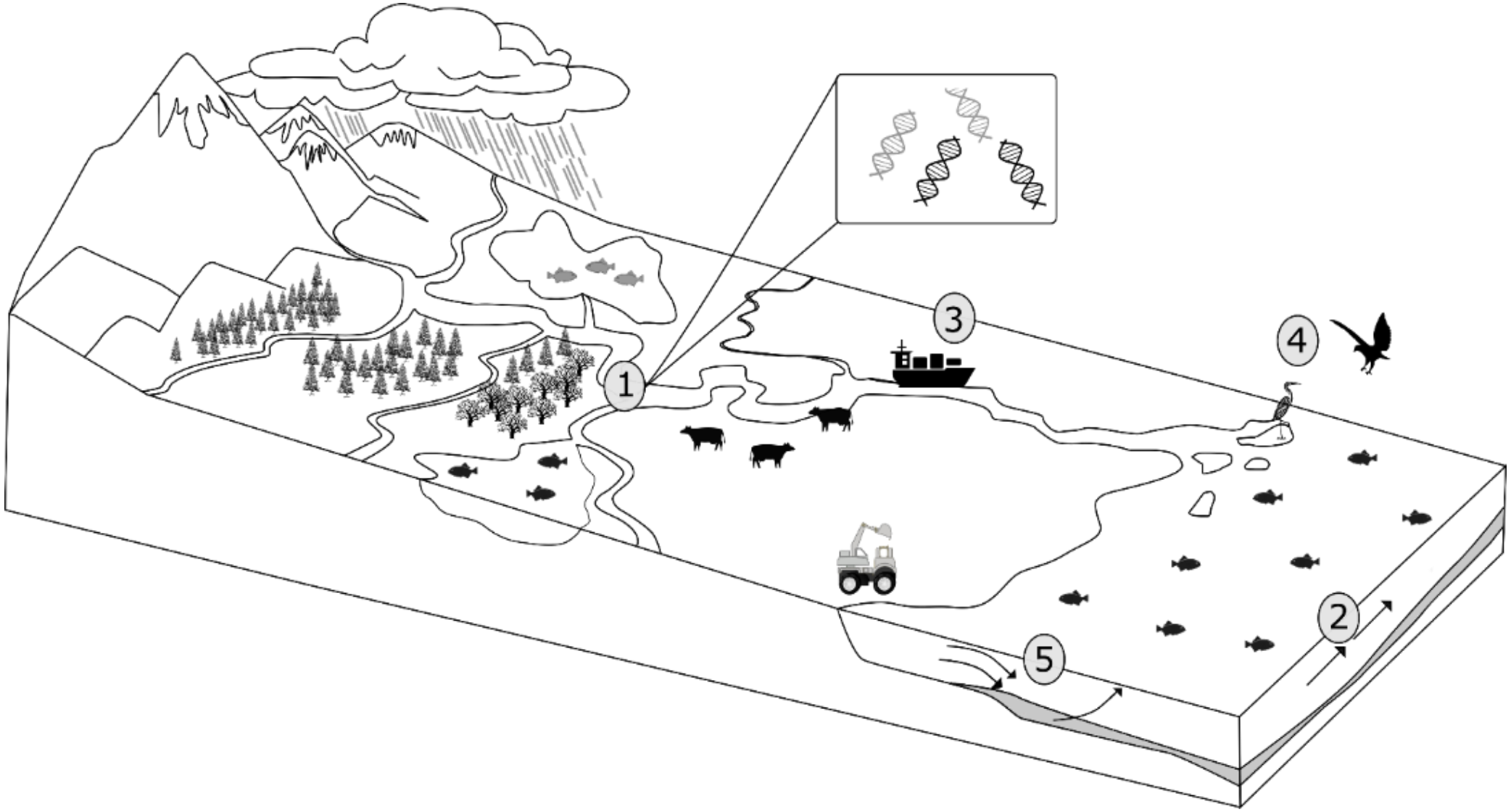
USGS
science for a changing world

Asian Carp Monitoring Program

NatureMetrics
DNA-Based Monitoring

PRECISION BIOMONITORING

- Zooplankton
- Amphibians
- Molluscs

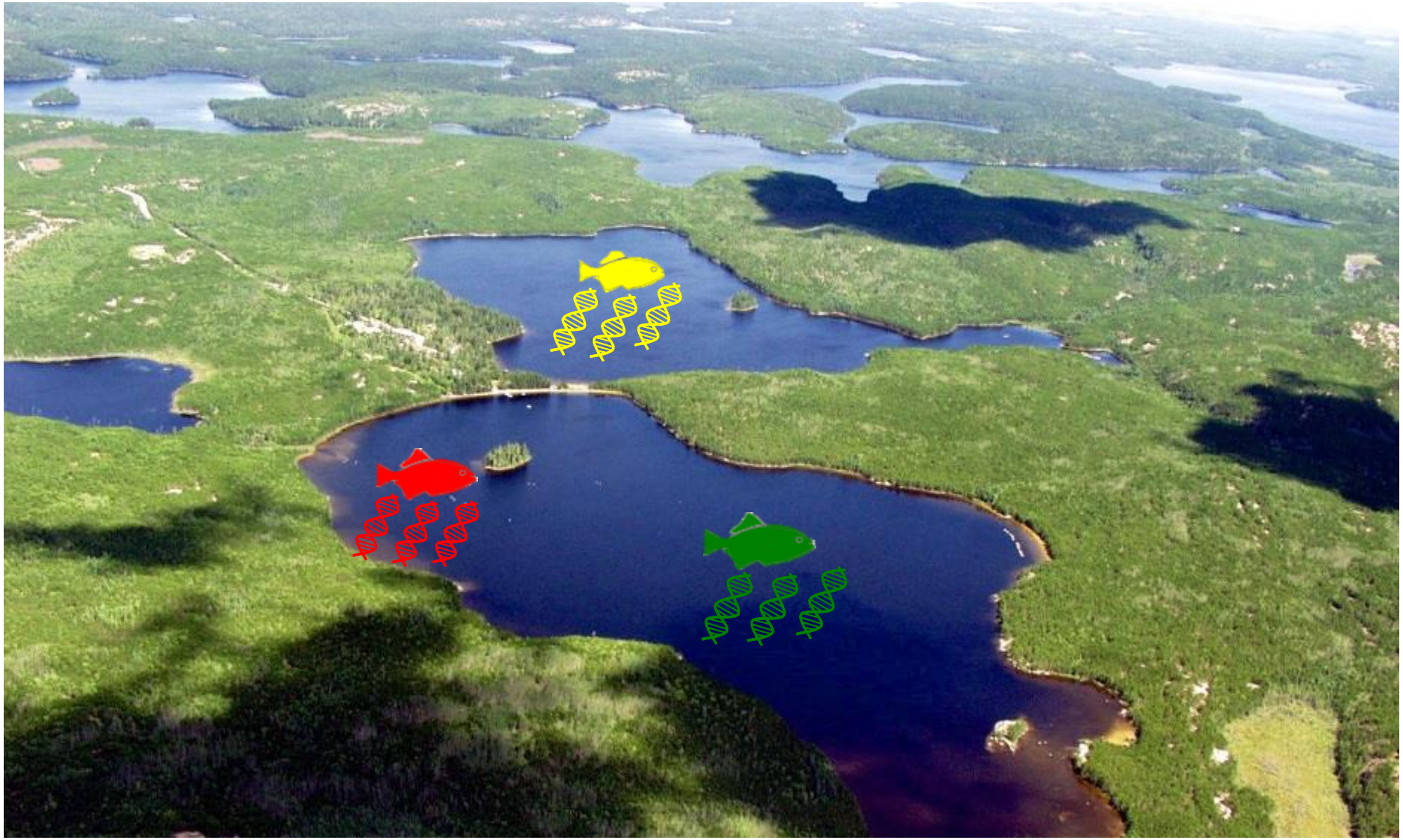


Aquatic systems have a high degree of connectivity

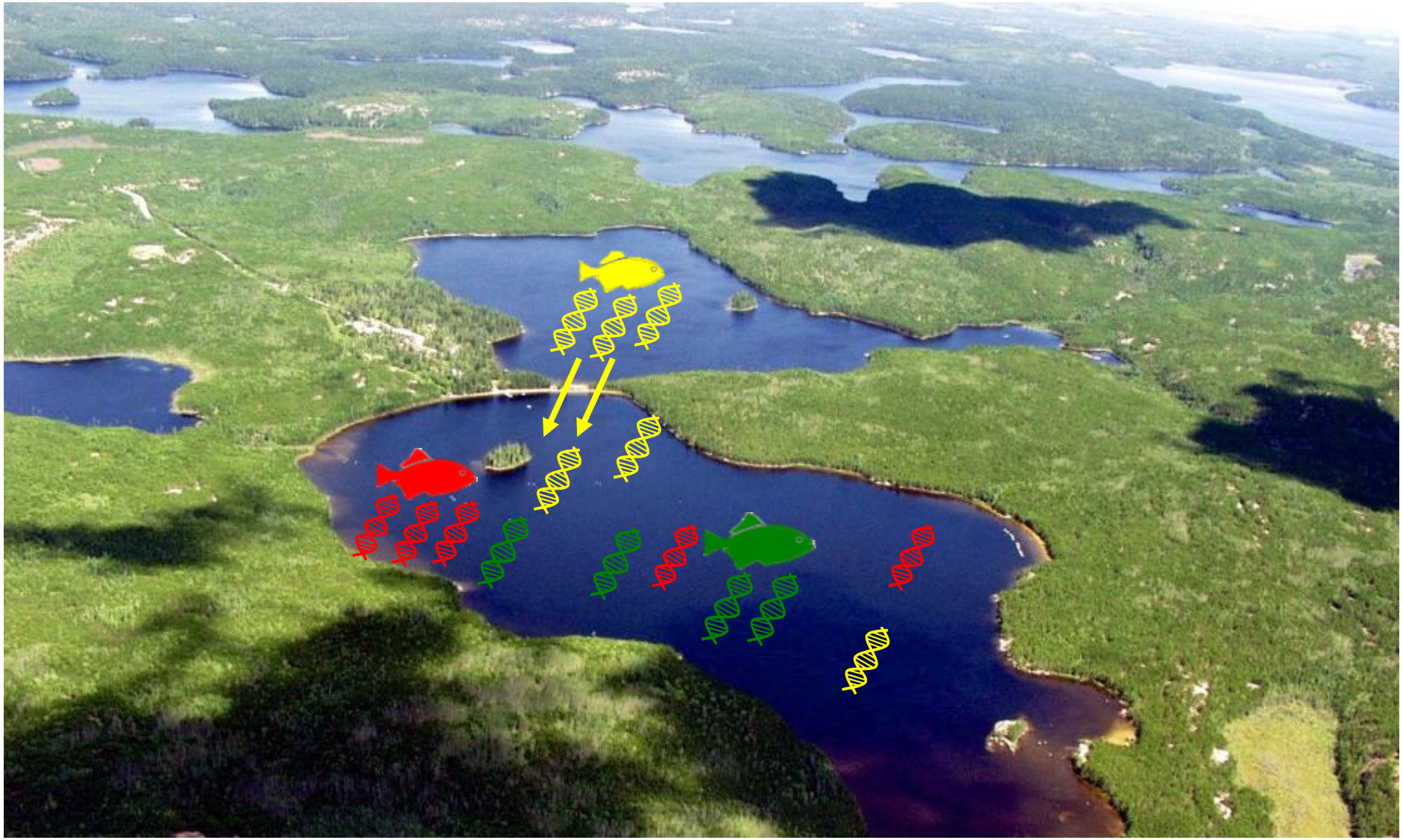
eDNA molecules persist and are transported

Do molecules reflect the true distribution of species?

Spatial resolution of eDNA



Spatial resolution of eDNA

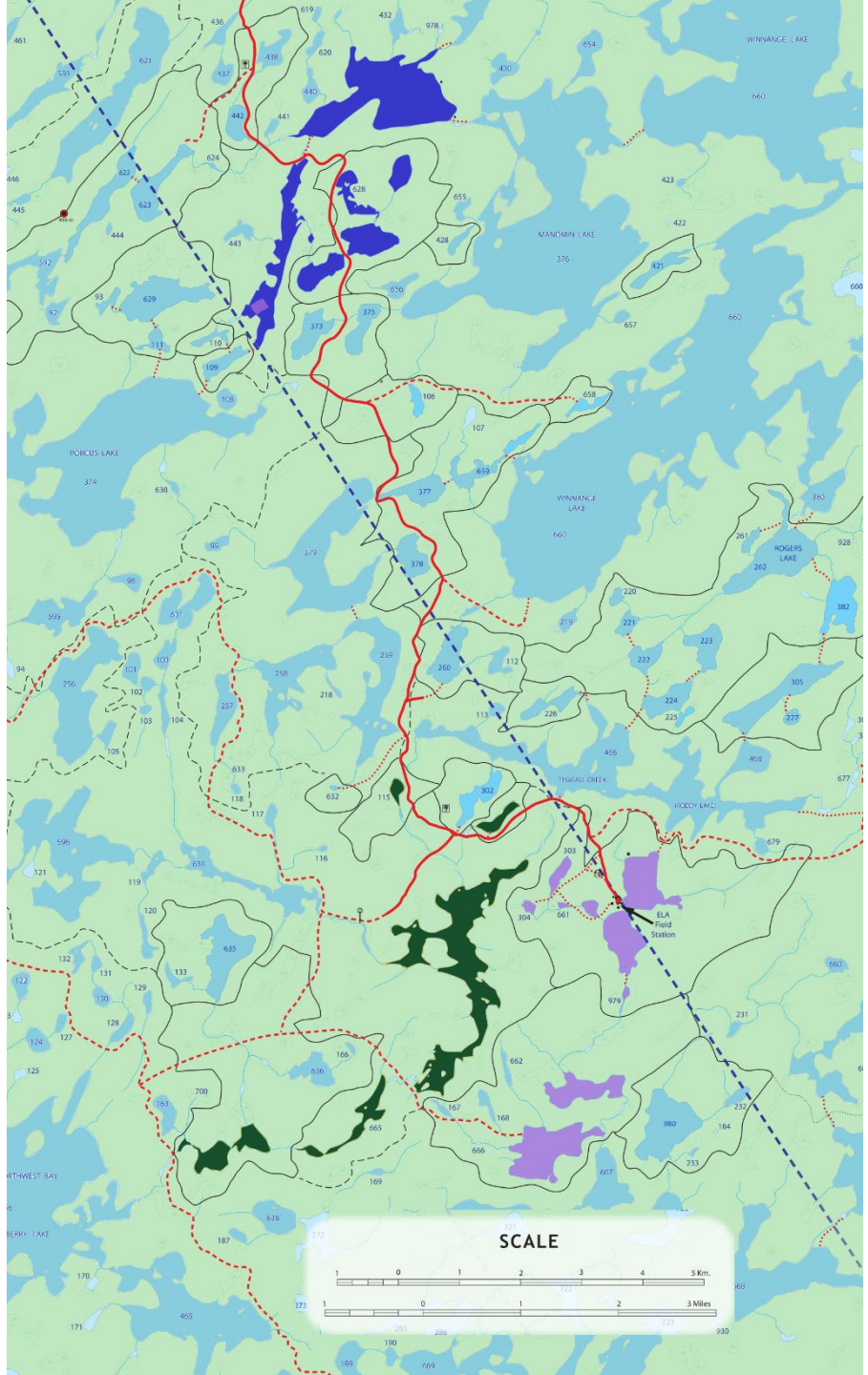


Validating eDNA for biomonitoring: transport of molecules

- Does eDNA reflect species richness?
- Does detection vary **within** the lakes?
- Does detection vary **between** lakes in a system?

= Regional vs local species detection

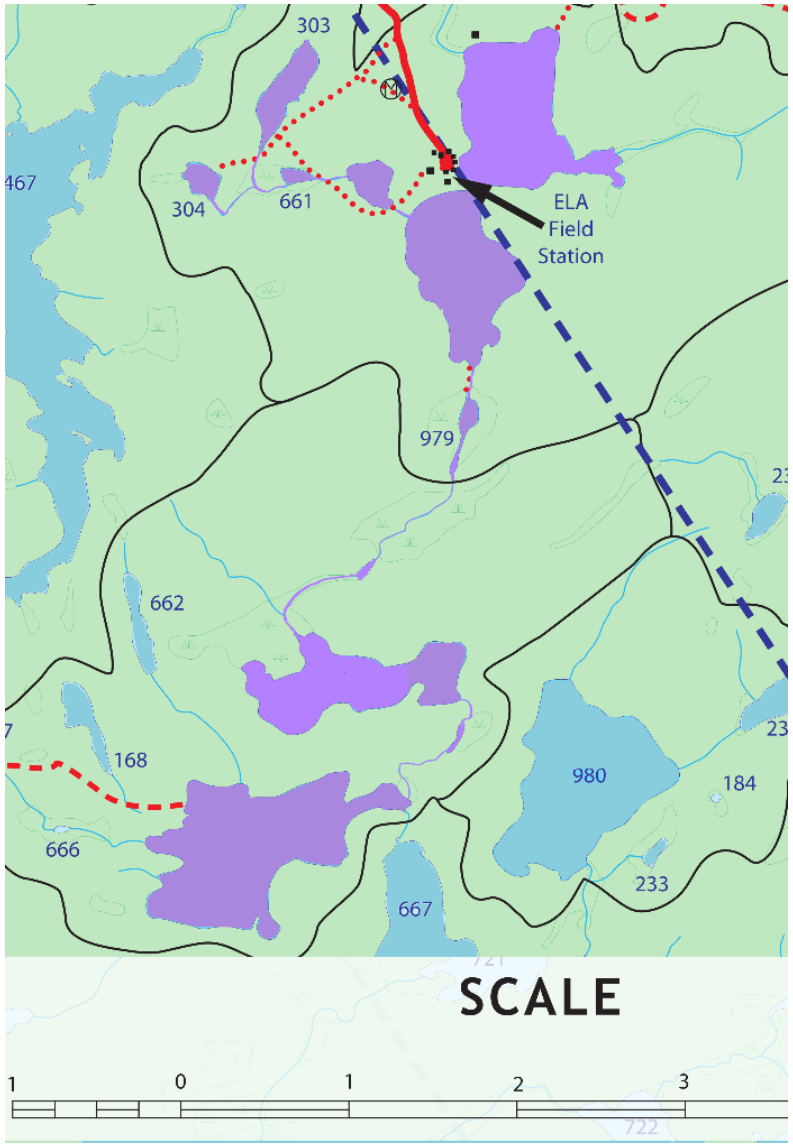
The Experimental Lakes Area ON, Canada



3 replicated lake chains

Certain species isolated to particular lakes

2017: field sampling



Took 430 samples in systematic layout

- **Capturing three levels of spatial variation:**
- Within-lake (epi, littoral, hypo, streams)
- Between-lake
- Between-network

Validated species richness with:

- 50 year dataset of species monitoring
- Additional validations in 2017

Lab work:

- Custom library preparation to sequence 12S region (fish), COI region (zooplankton)
- In-house analysis pipeline available from (https://github.com/CristescuLab/YAAP)

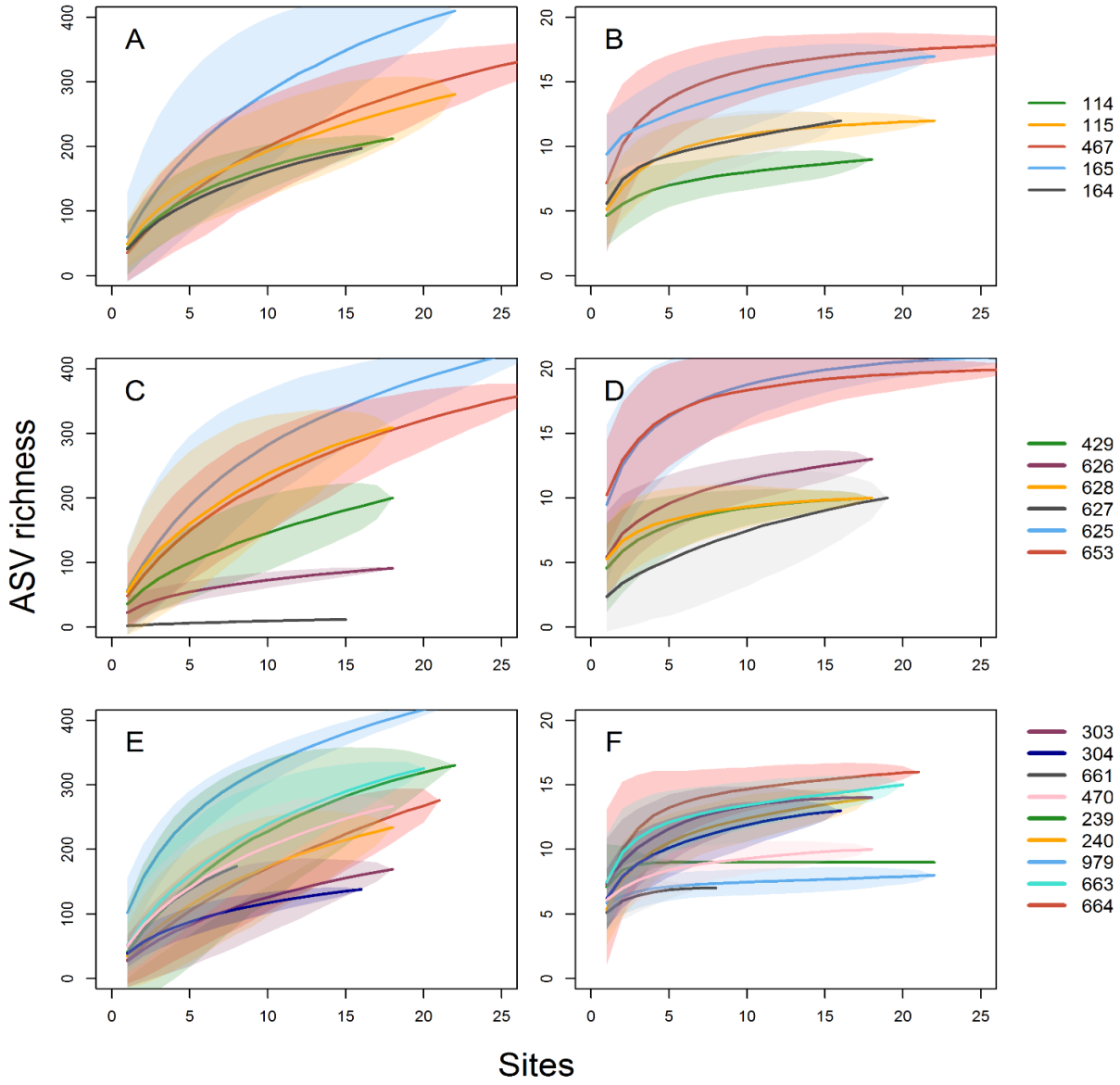
Results: species richness

COI gene (left) 12S gene (right)

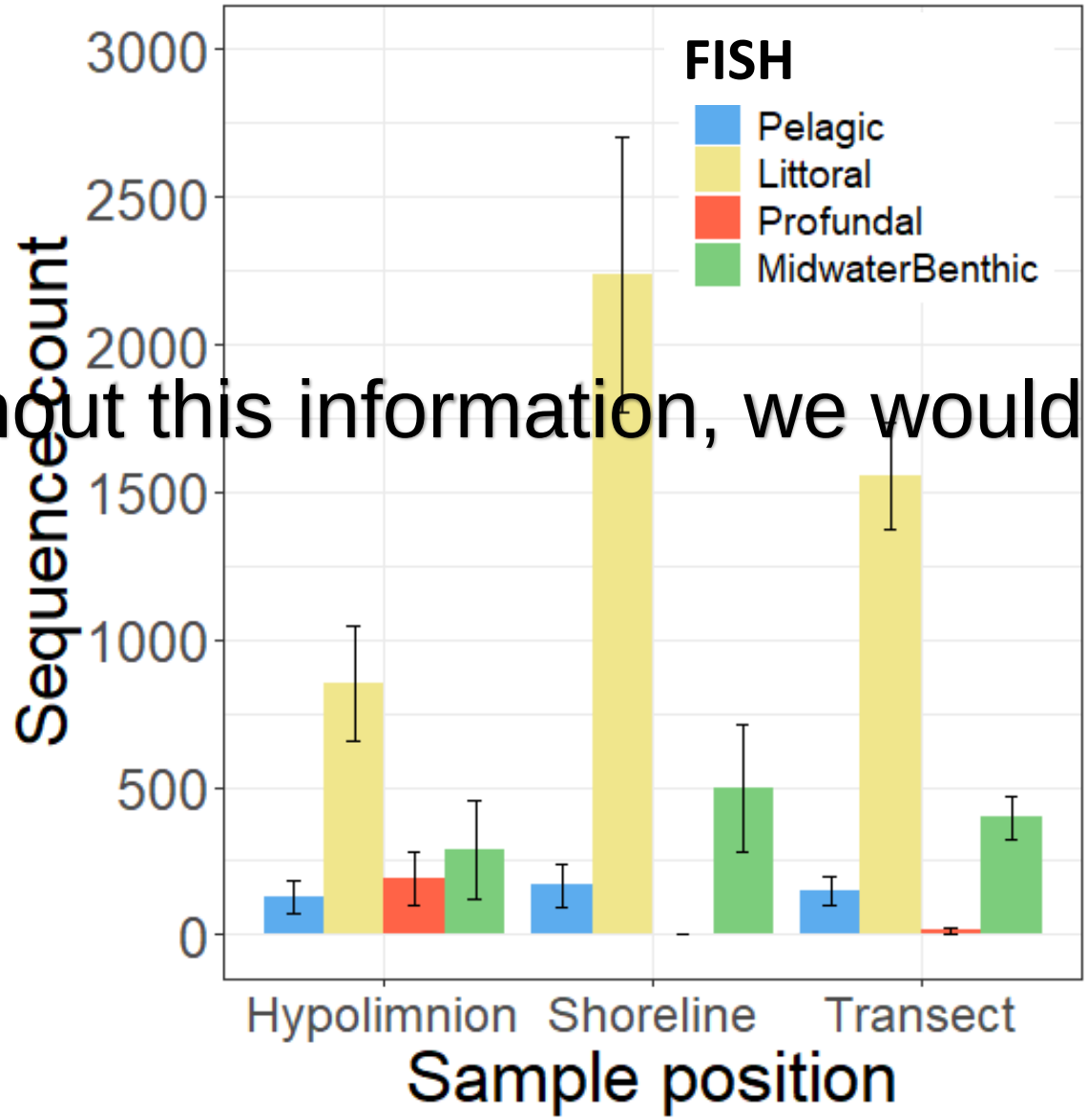
COI gene captures a huge array of diversity including insects, zooplankton, mammals, and birds.

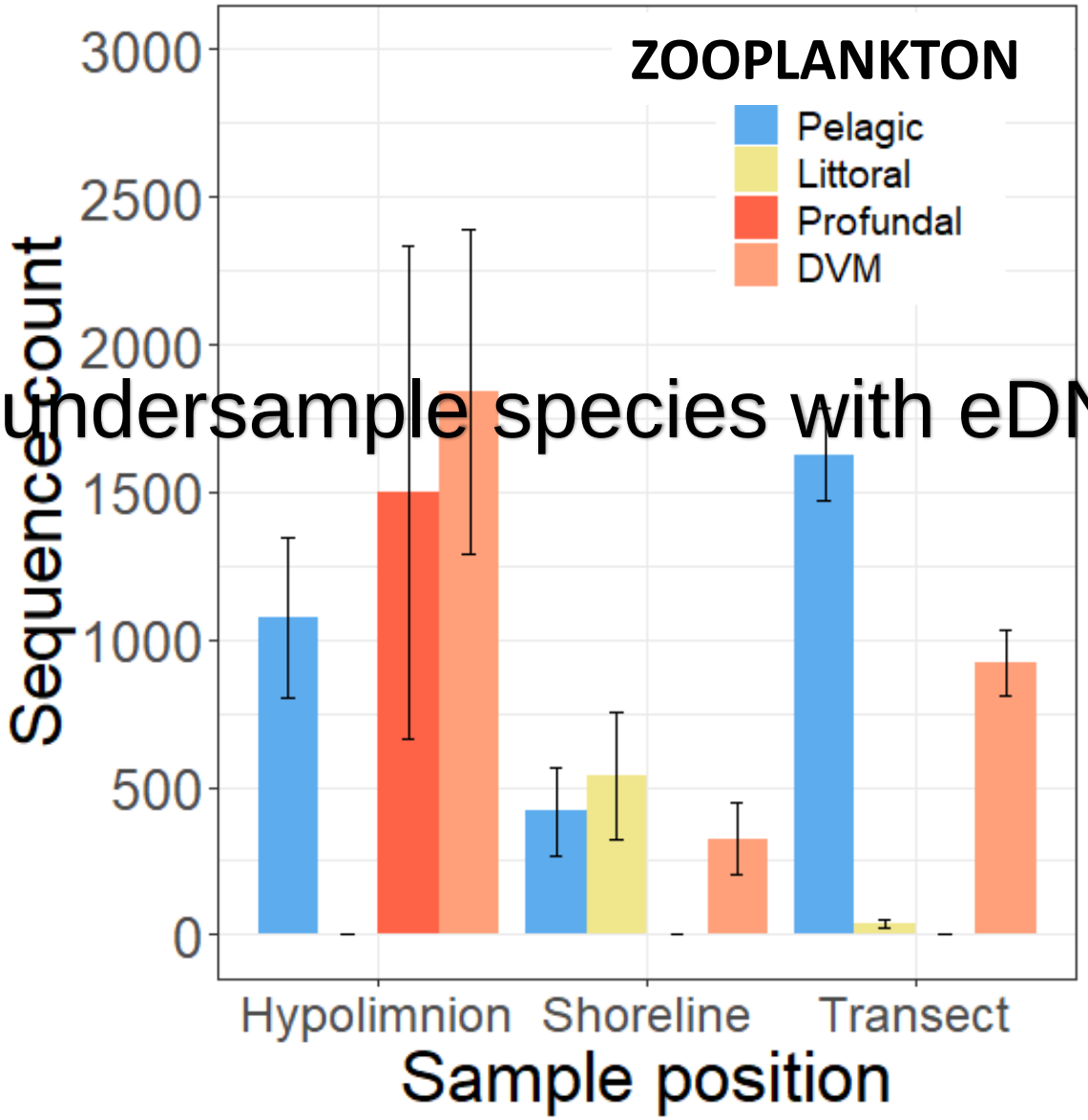
12S gene detects every fish known to exist at ELA, plus two additional detection not recorded at ELA but known in area (logperch, muskellunge).

Good species-level discrimination



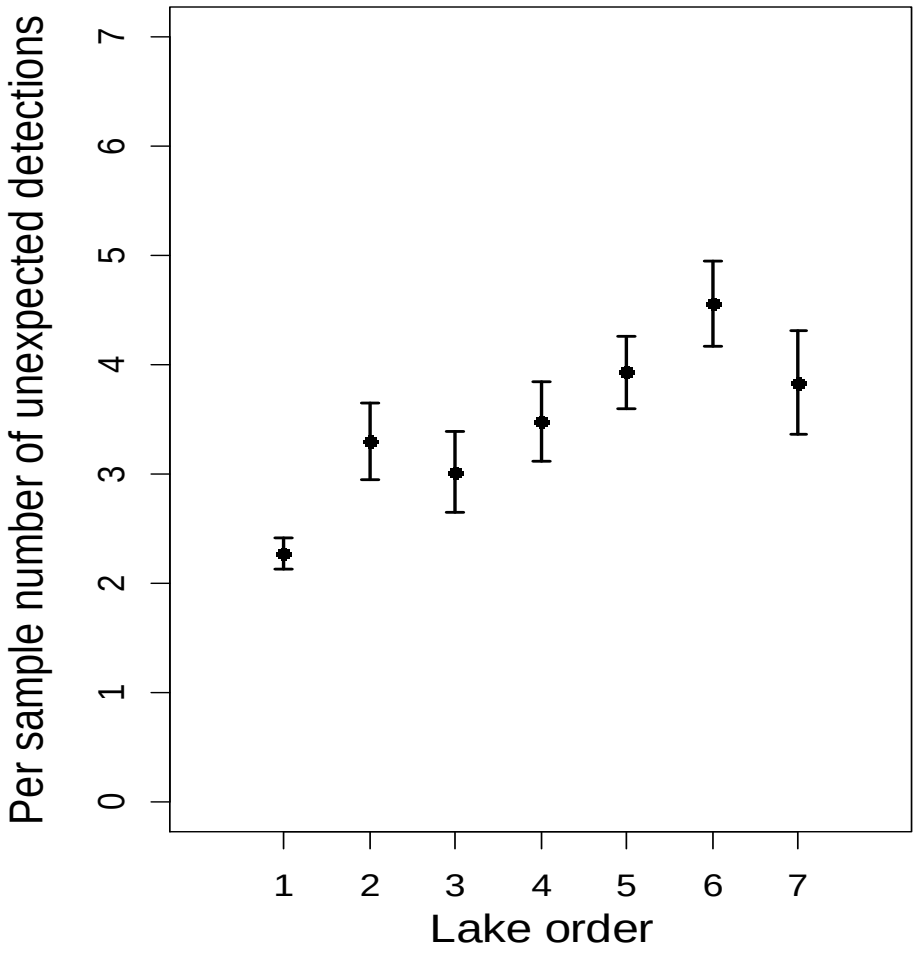
Results: within-lake variation

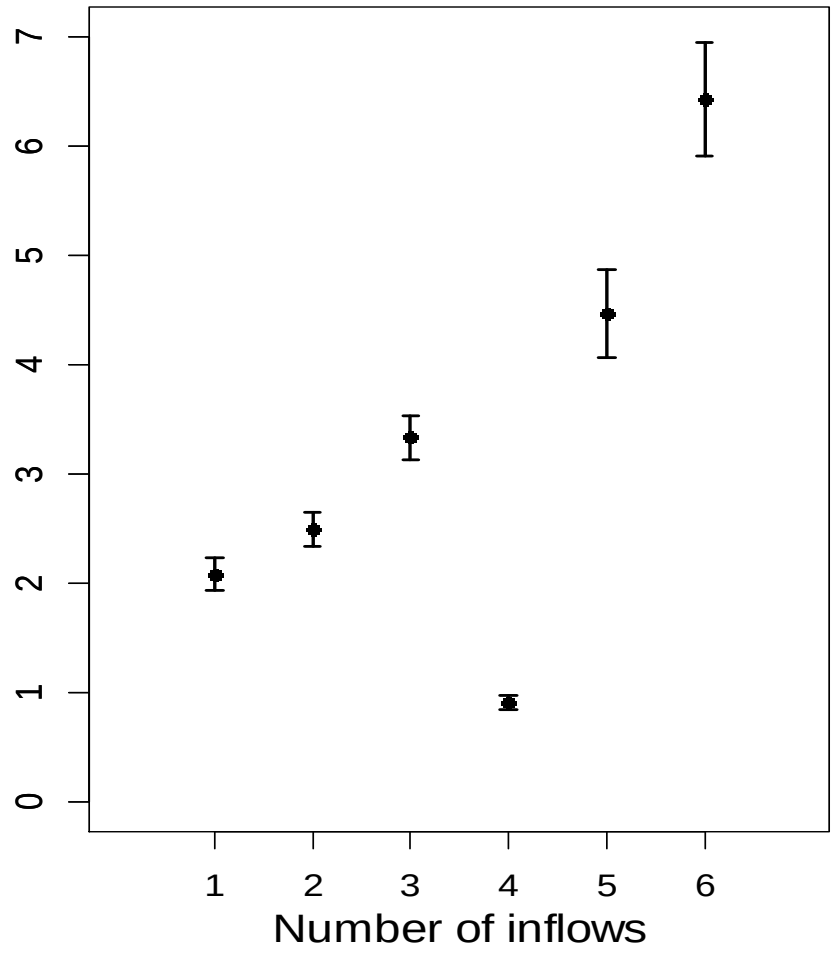




Without this information, we would undersample species with eDNA!

Results: between-lake variation



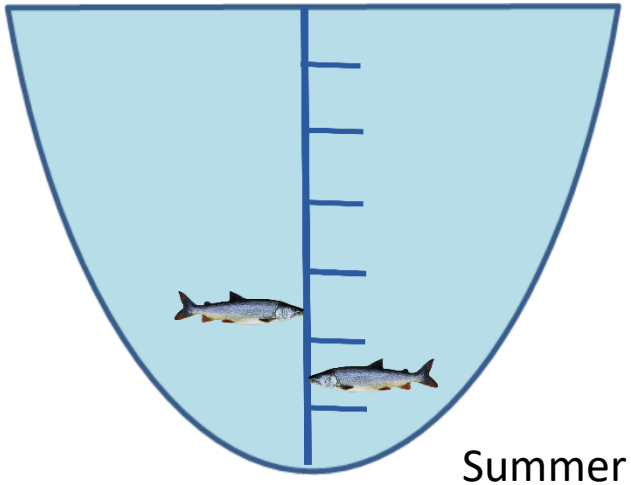


Unexpected detections appear to accumulate in downstream habitats

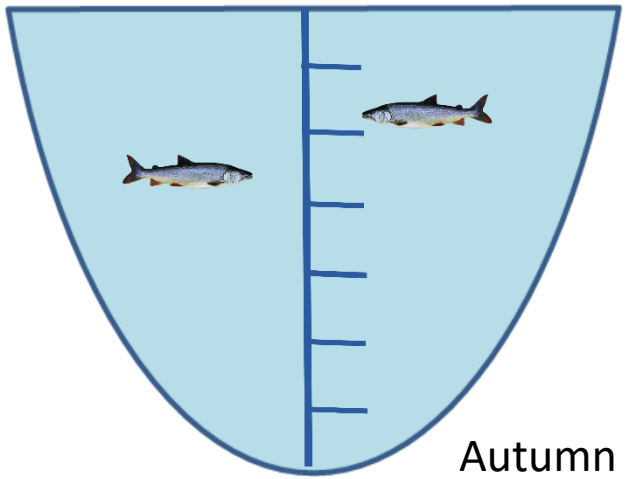
Summary

- The majority of eDNA is structured within habitats, reflecting local habitat use for fish and zooplankton
- However, small amounts can also move between habitats, reflecting upstream sp richness.
- Suggestive that formal criteria for occupancy need to be established.
- Field studies are essential for determining how eDNA behaves “in the wild” so that we capture all species richness!

Future work



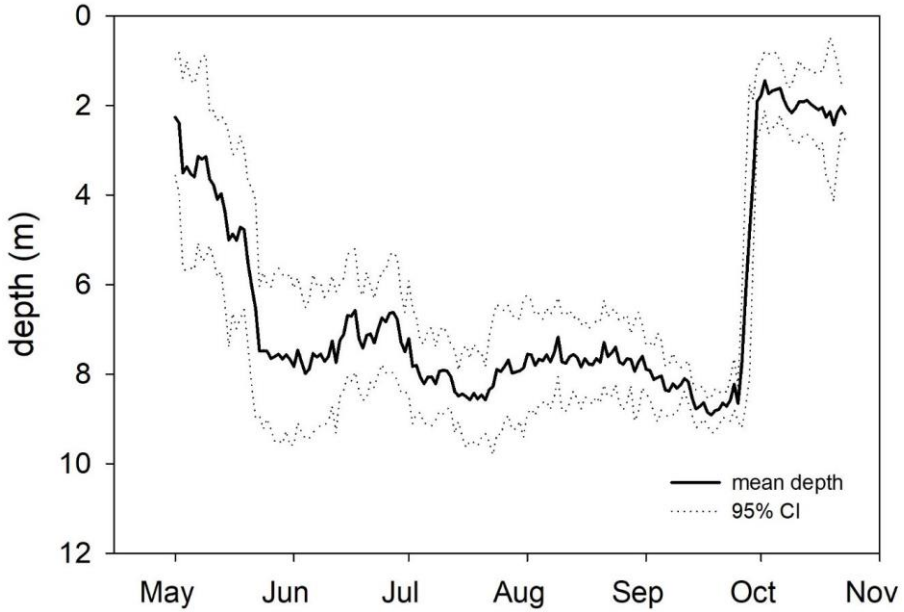
Summer



Autumn

- Extension of within-lake variation.
- Does eDNA reflect seasonal variation in fish habitat use?
- Validation with radio-telemetry data:

Lake 626 – grand mean depth each day



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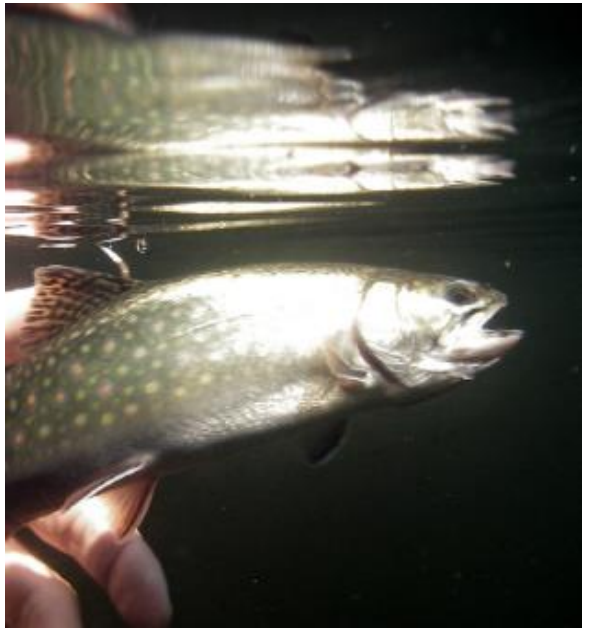

Thank you for your attention.

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