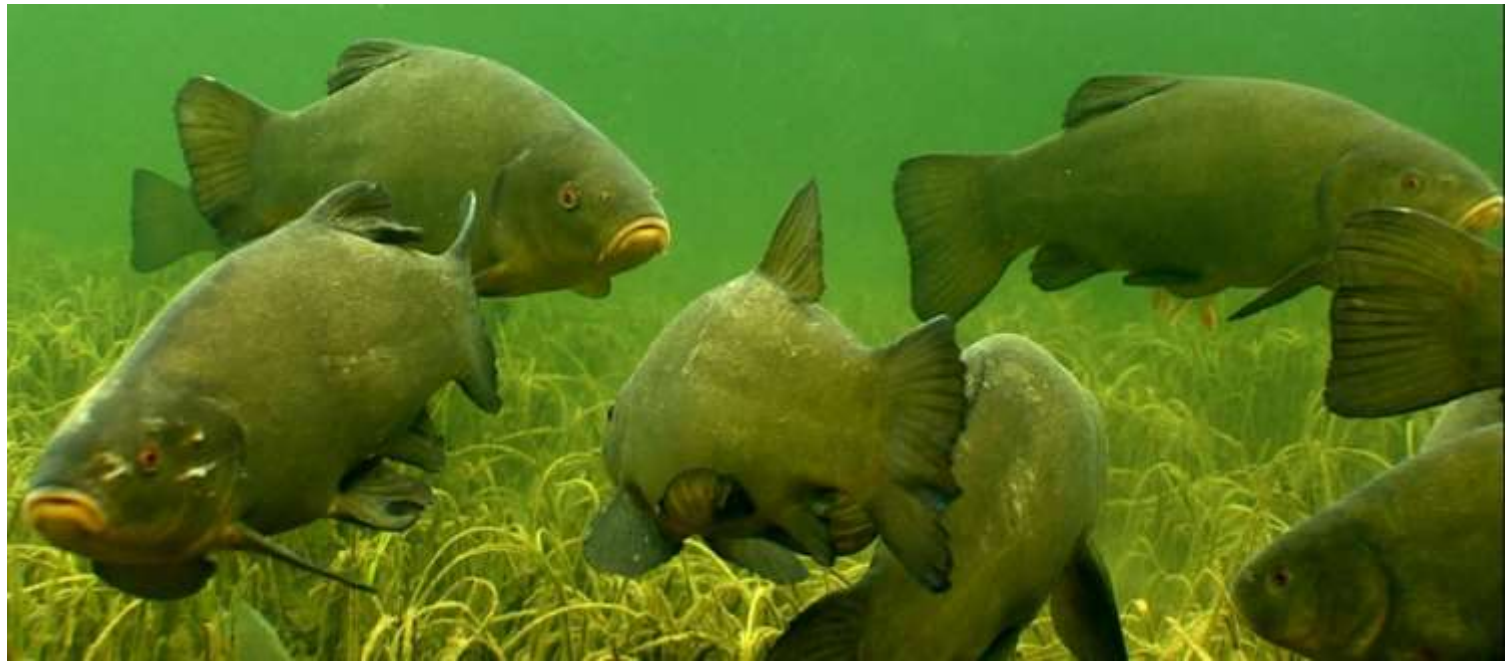
Evaluating & predicting impacts of globally invasive freshwater fishes using multi-population comparisons

Sunčica Avlijaš*, Nicholas Mandrak, Jonathan Fischer-Rush, Anthony Ricciardi



CAISN CANADIAN AQUATIC INVASIVE SPECIES NETWORK

Ministère des Forêts, de la Faune et des Parcs Québec

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McGill

Context-dependency of invasion

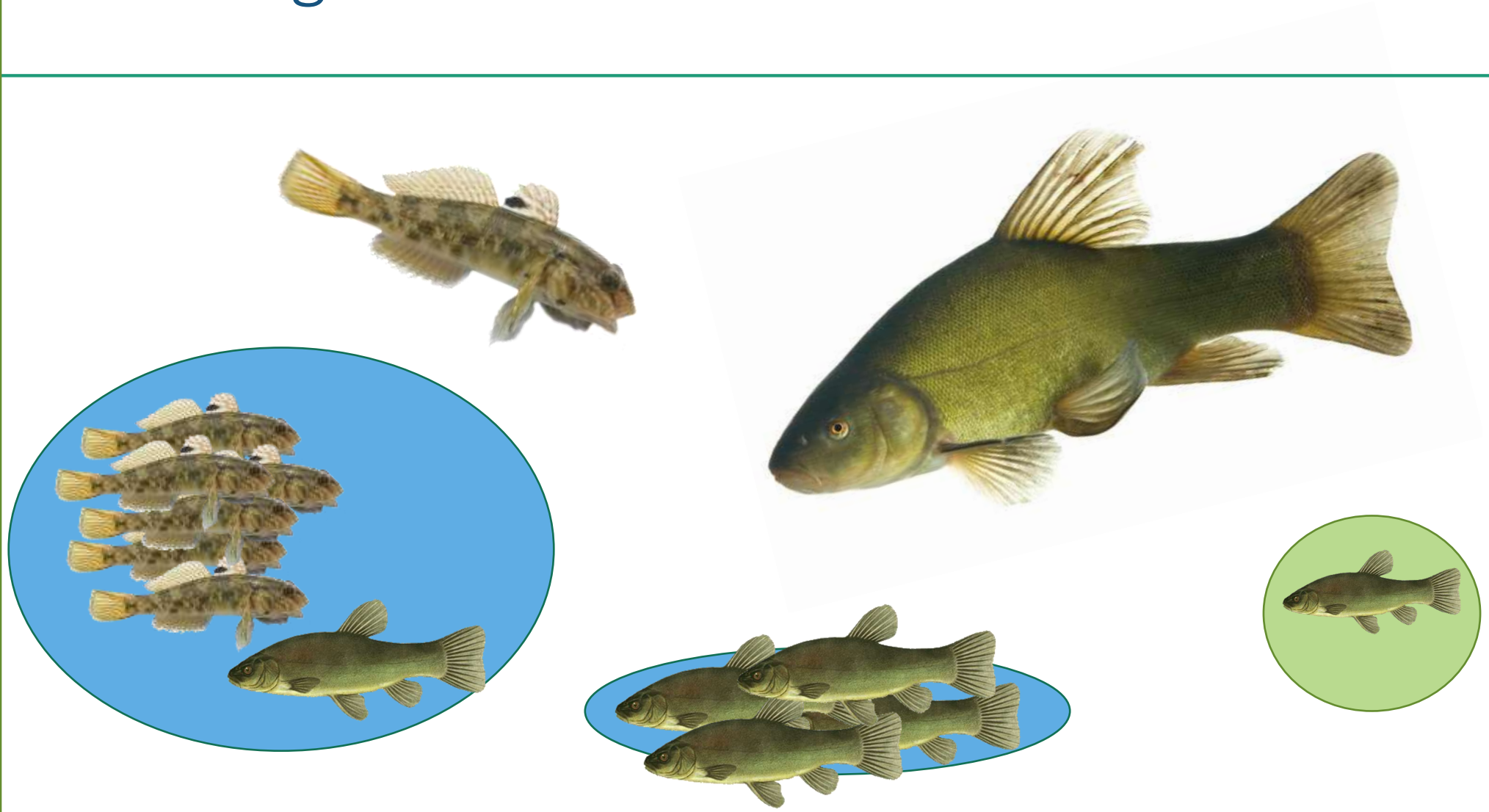
?

SITE A

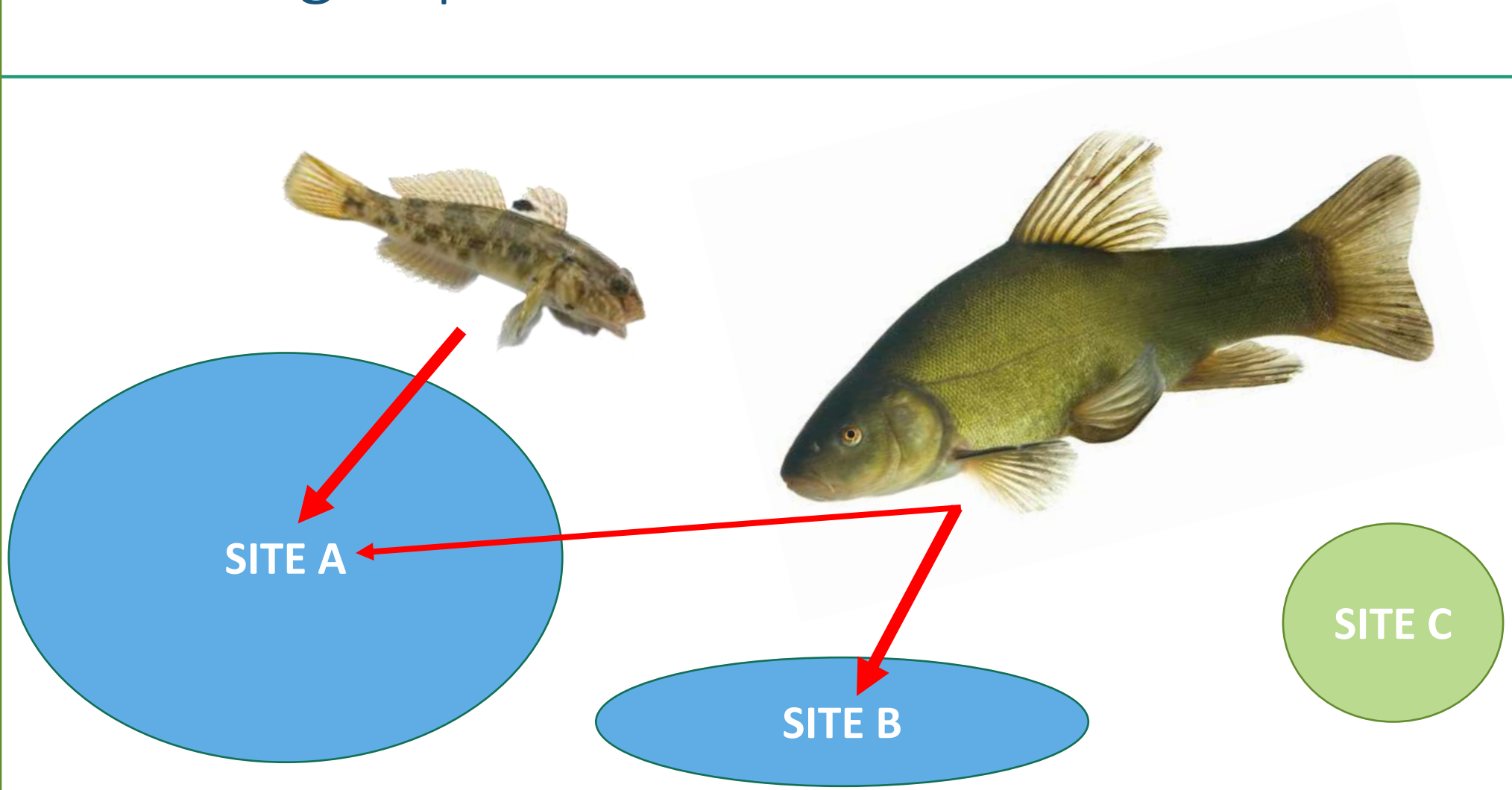
SITE B

SITE C

Predicting Establishment



Predicting Impacts



Large-scale geographic comparisons

OUTLINE

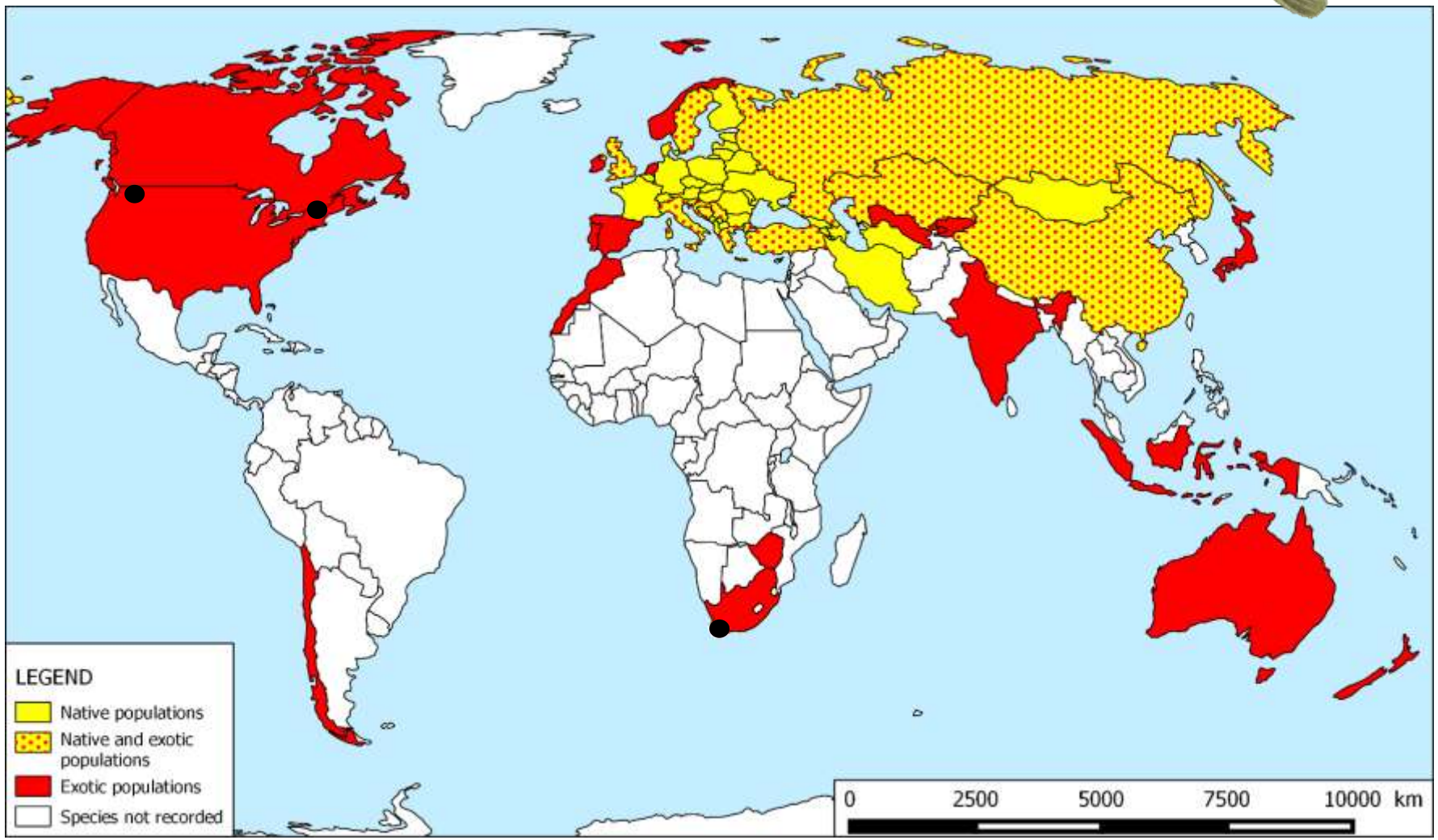
Evaluating & Predicting Impacts

1- Tench as a model species

2- Quantifying impacts of Tench and Round Goby in the St. Lawrence River

3- Predicting Invasion patterns using morphometric analysis

Tench (*Tinca tinca*)

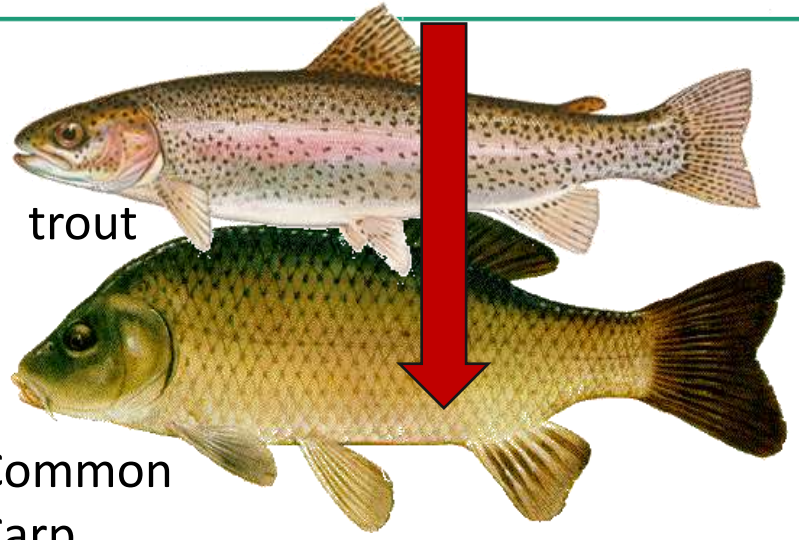


Countries with at least one system invaded by Tench

Tench Impacts

turbidity

macrophytes

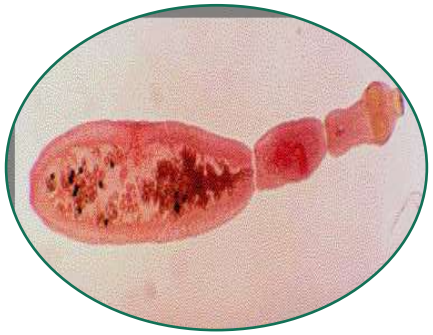


trout

Common Carp

molluscs

periphyton



pathogenic cestode

(Schallenberg & Sorrell 2009, Brönmark 1994, Innal & Erk'akan 2006, Washington Fish & Wildlife 2014, Marcogliese et al. 2009)

Tench Impacts

HYPOTHESIZED COMPETITION (diet overlap studies)

waterfowl

Copper Redhorse

European Eel

European Perch

Rudd

(Giles et al. 1990, Kennedy and Fitzmaur 1970, Masson et al. 2013)

METHODS

Quantifying impacts of Tench and Round Goby on resident fish communities in the St. Lawrence River

Round Goby

Tench

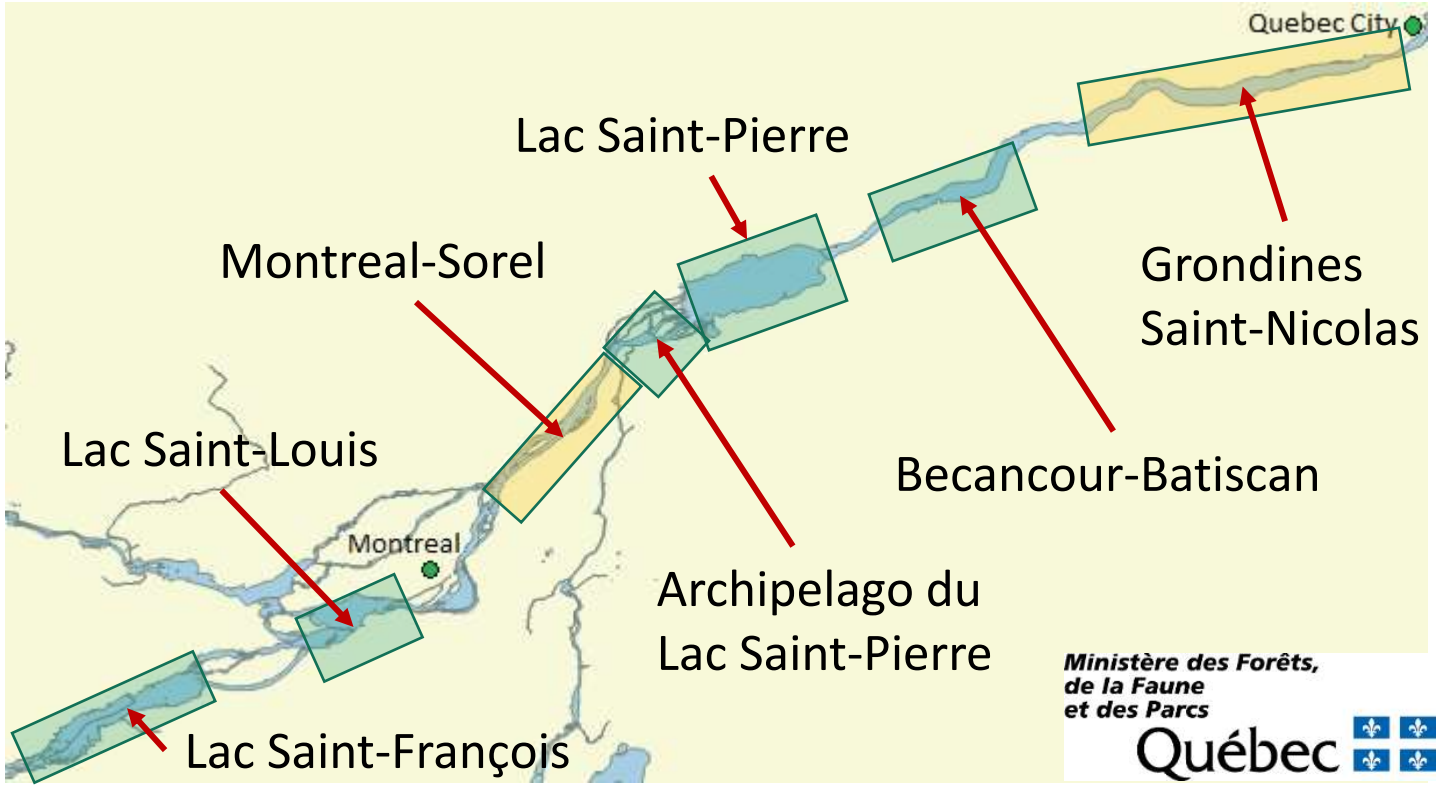
(A) Historical analysis: pre-invasion versus post-invasion

(B) Spatial analysis: invaded versus uninvaded

(C) Diet study: identify potential competitors

(D) FR Experiments: per capita effects``

St. Lawrence River Historical Data



Sampled by sector:

1995-present

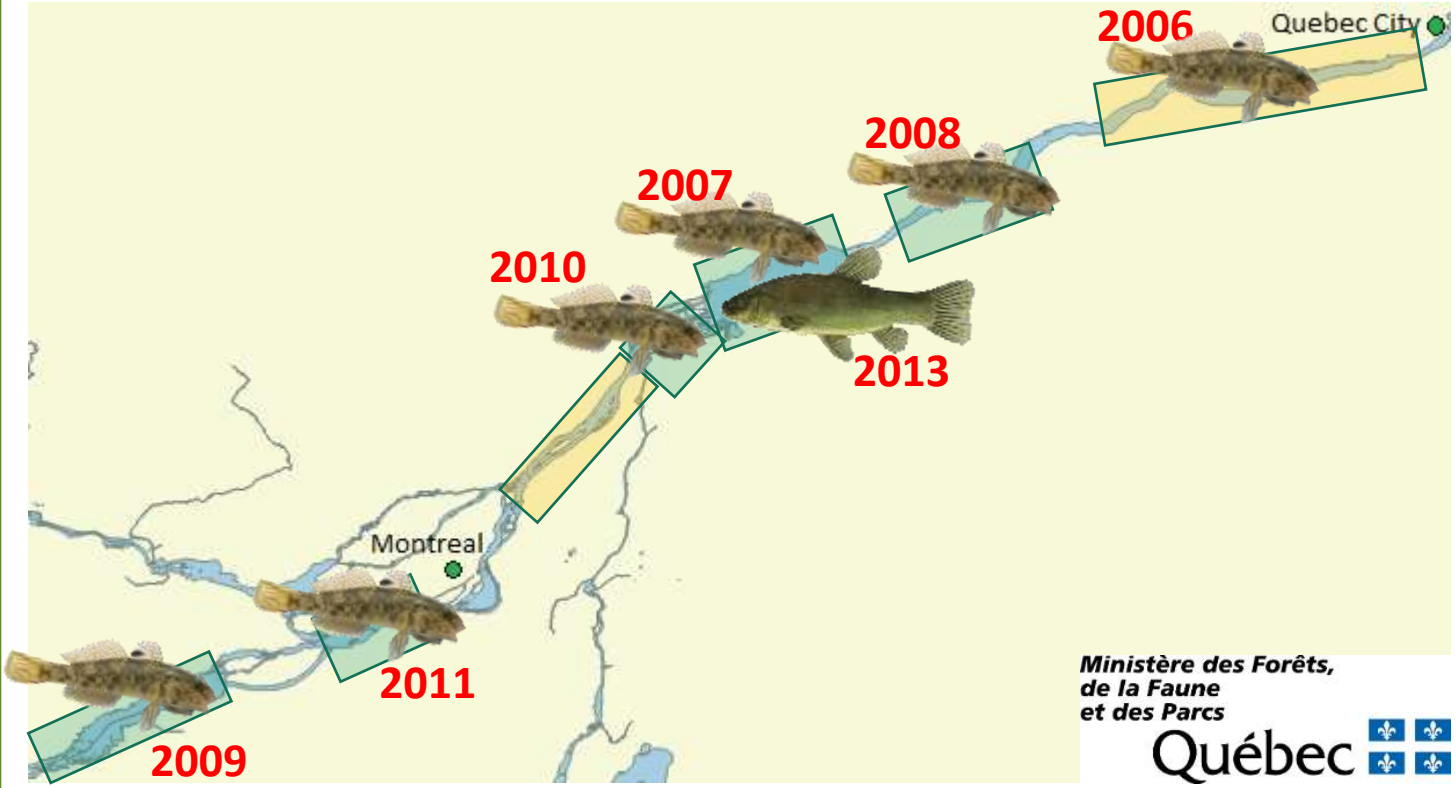
One sector/ year

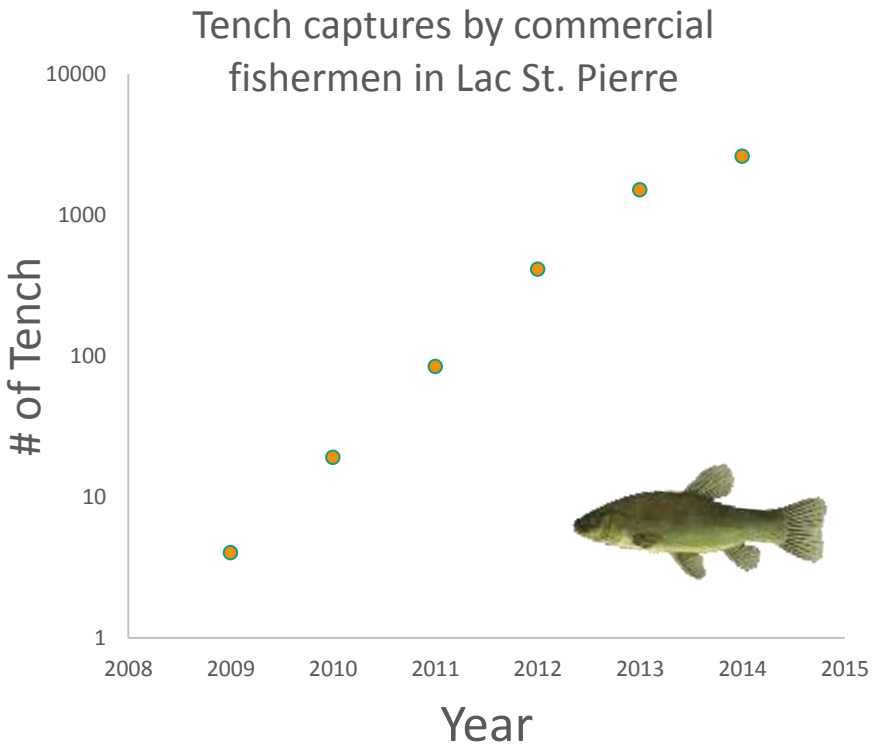
Gill nets

Seine nets

SPREAD

Round Goby and Tench in the St. Lawrence

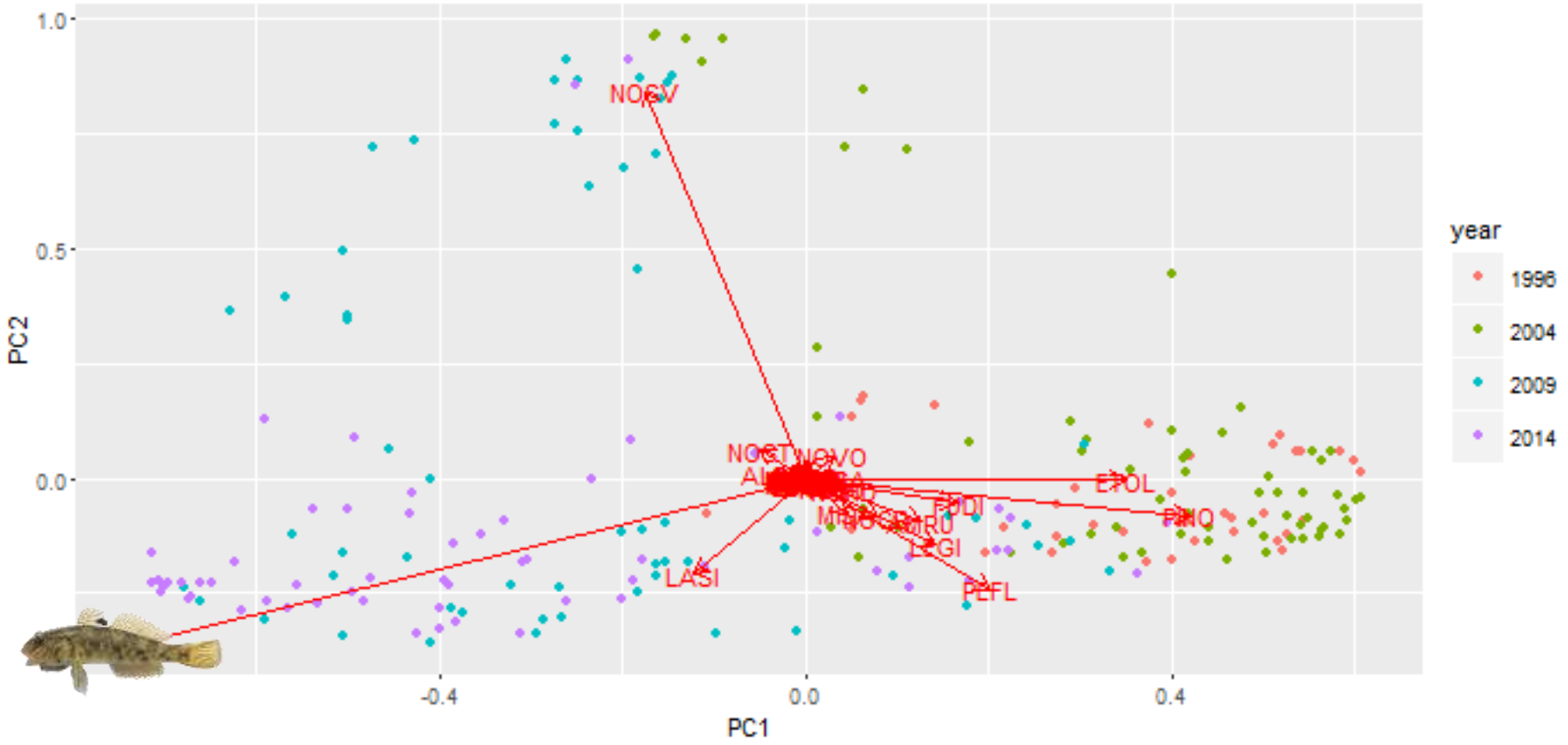




RESULTS

Have fish communities changed after these invasions?

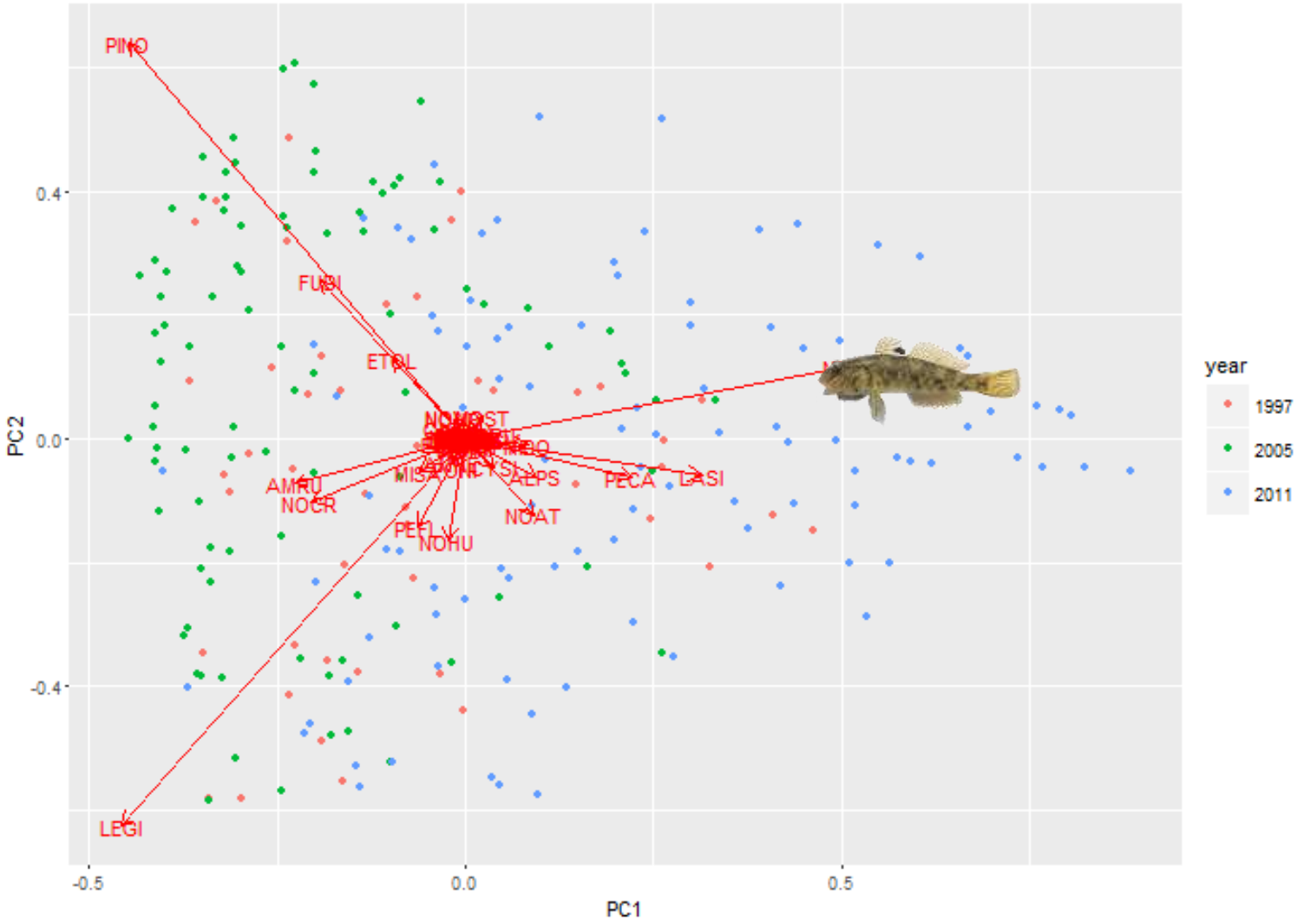
Lac Saint-François



RESULTS

Have fish communities changed after these invasions?

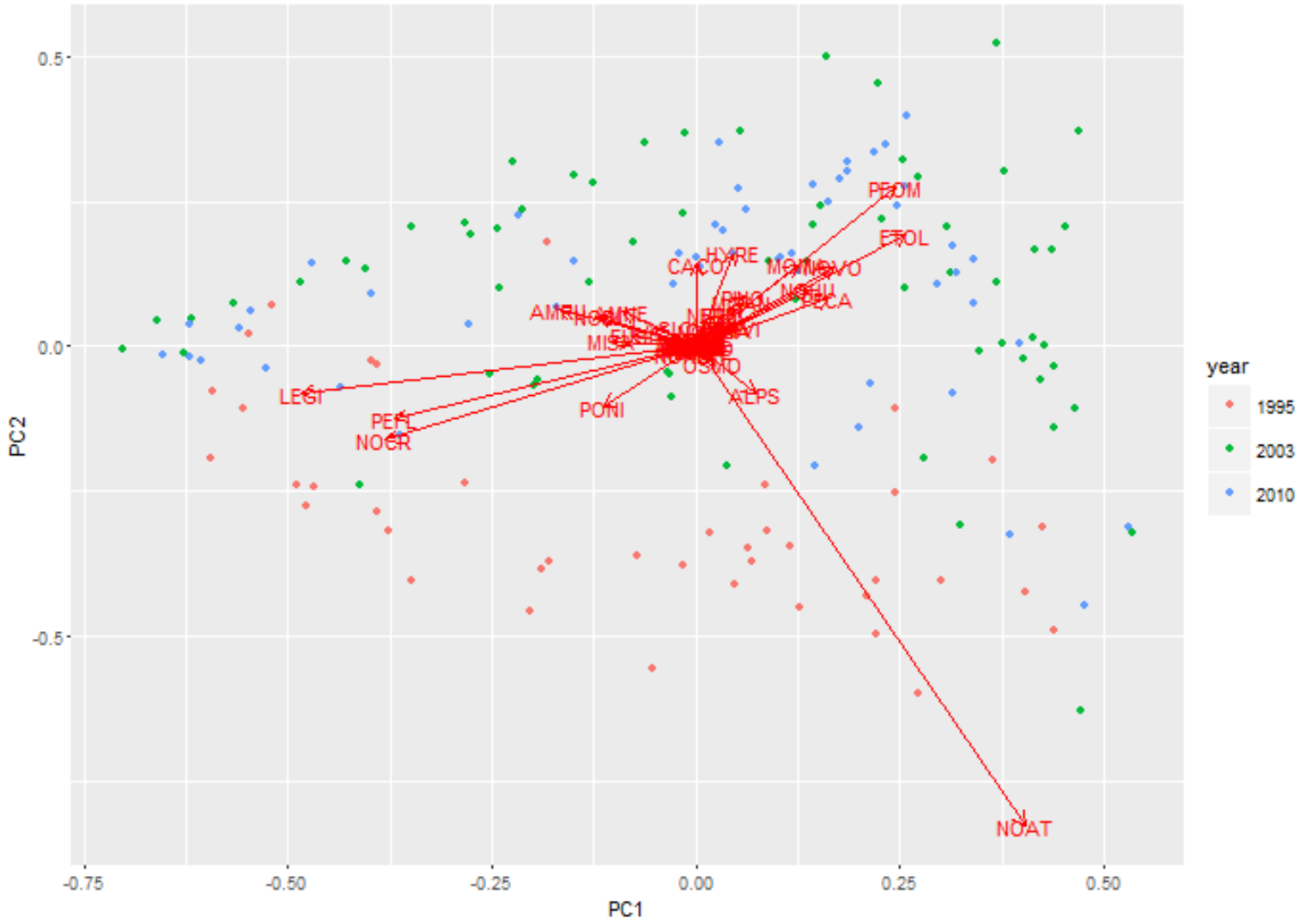
Lac Saint-Louis



RESULTS

Have fish communities changed after these invasions?

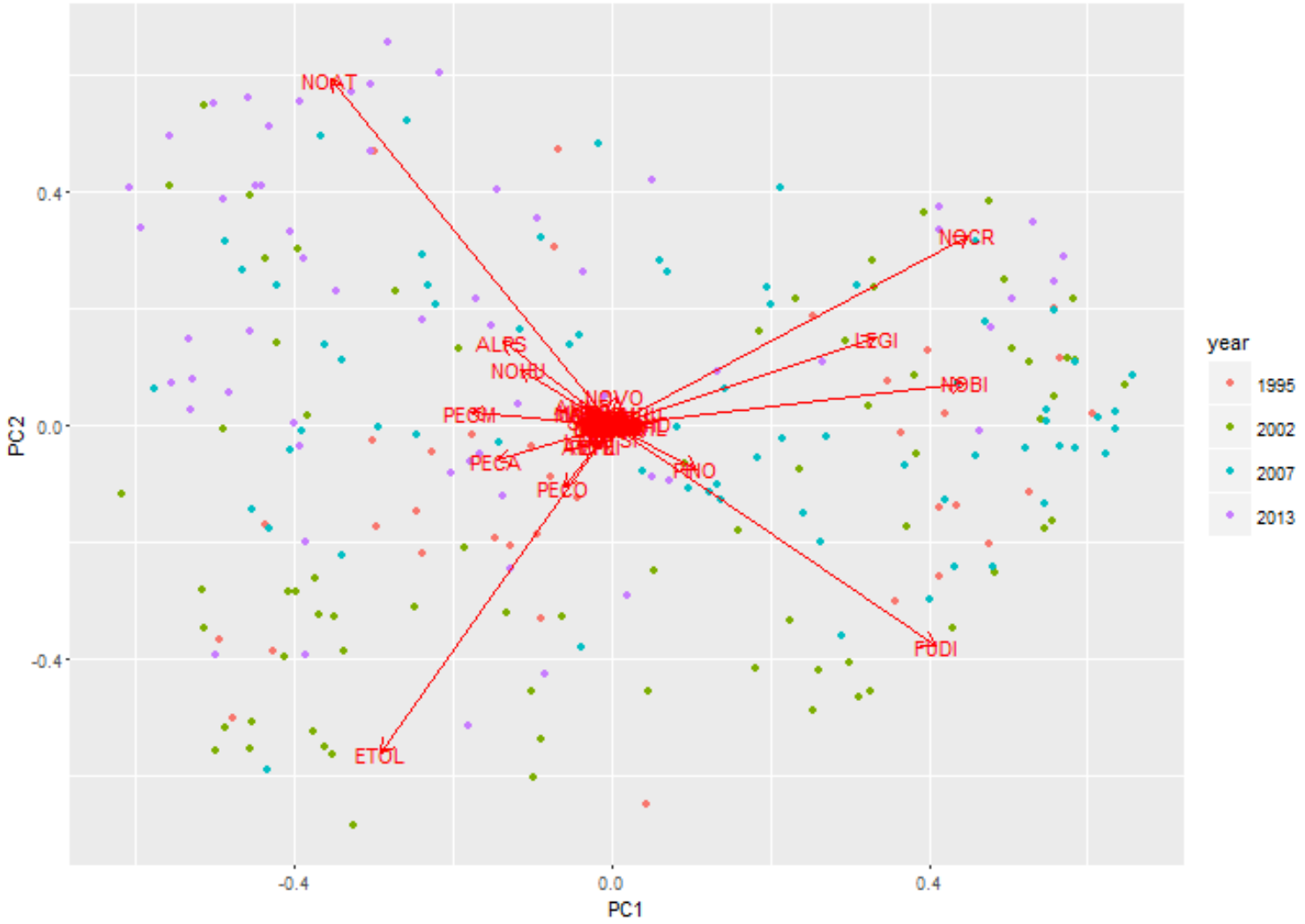
Archipelago du Lac Saint-Pierre



RESULTS

Have fish communities changed after these invasions?

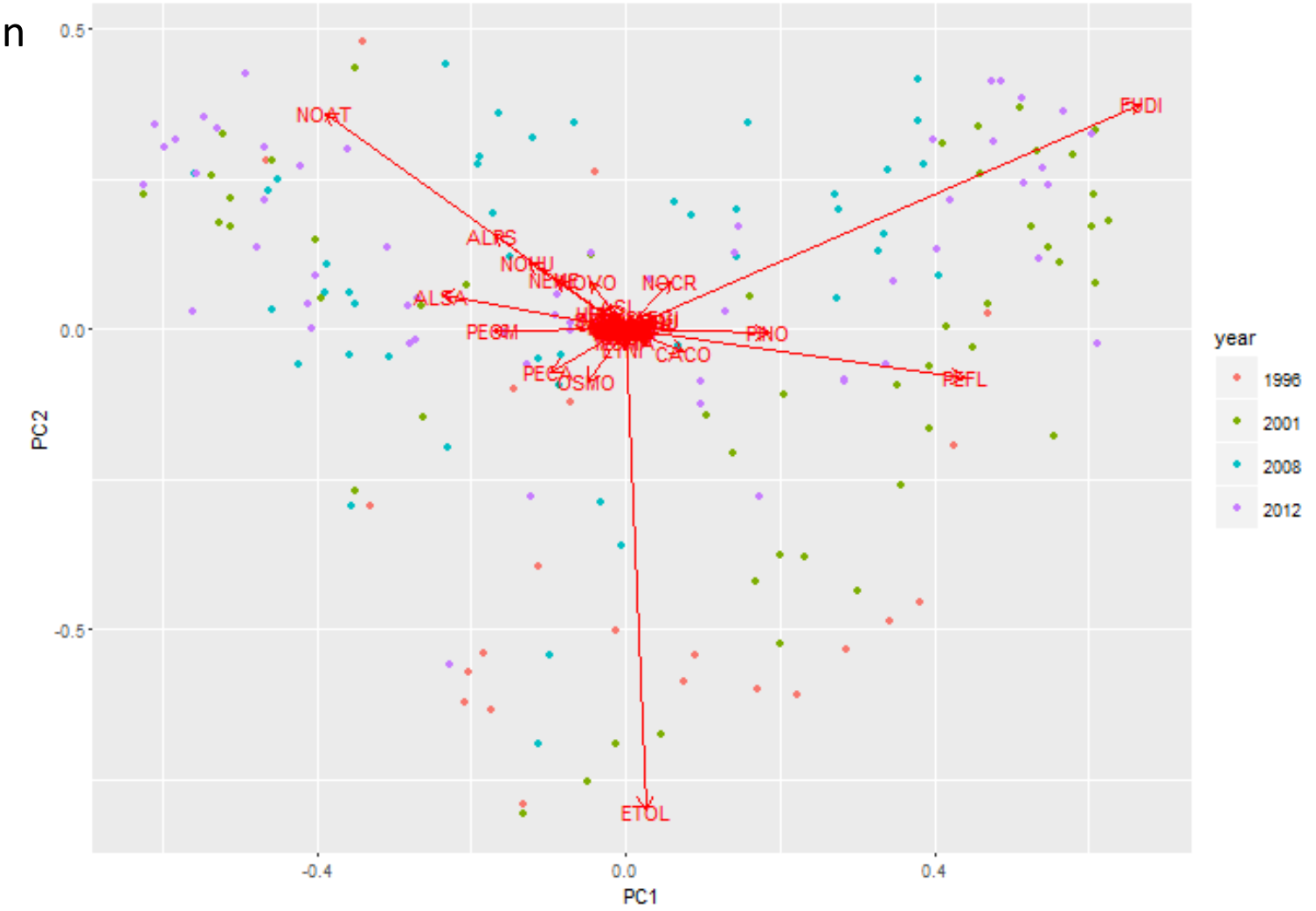
Lac Saint-Pierre



RESULTS

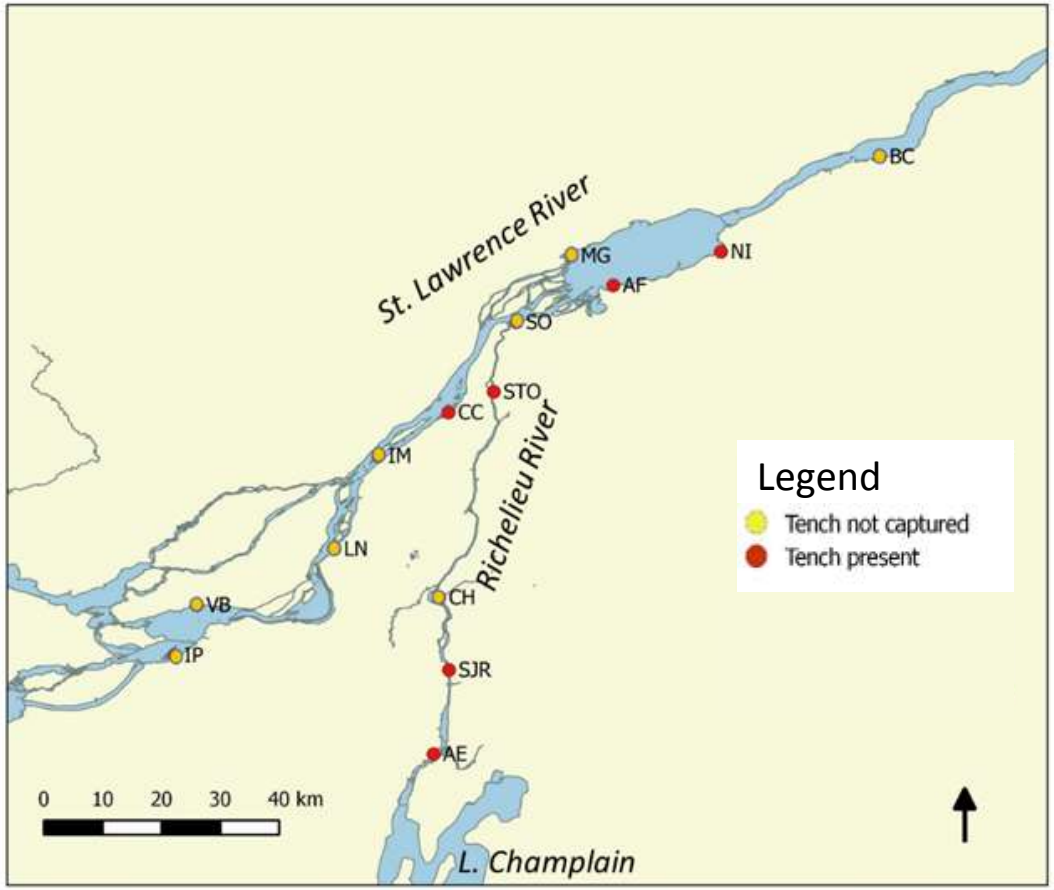
Have fish communities changed after these invasions?

Becancour-Batiscan



NEXT STEP

Field study: invaded vs. uninvaded

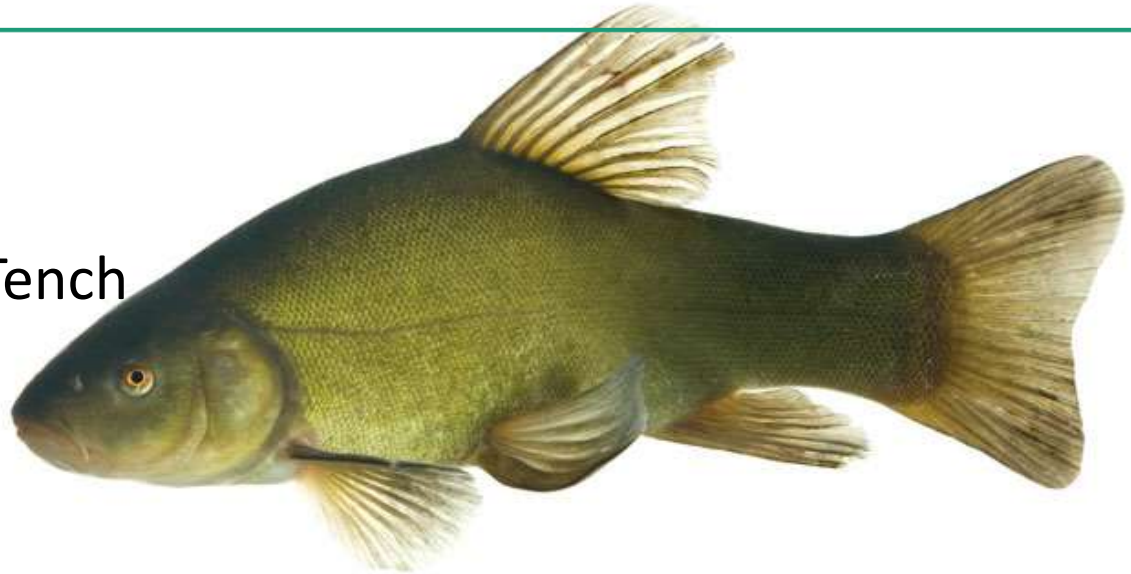


Sites sampled in the St. Lawrence River 2015

Quantifying impacts

Round Goby

Tench



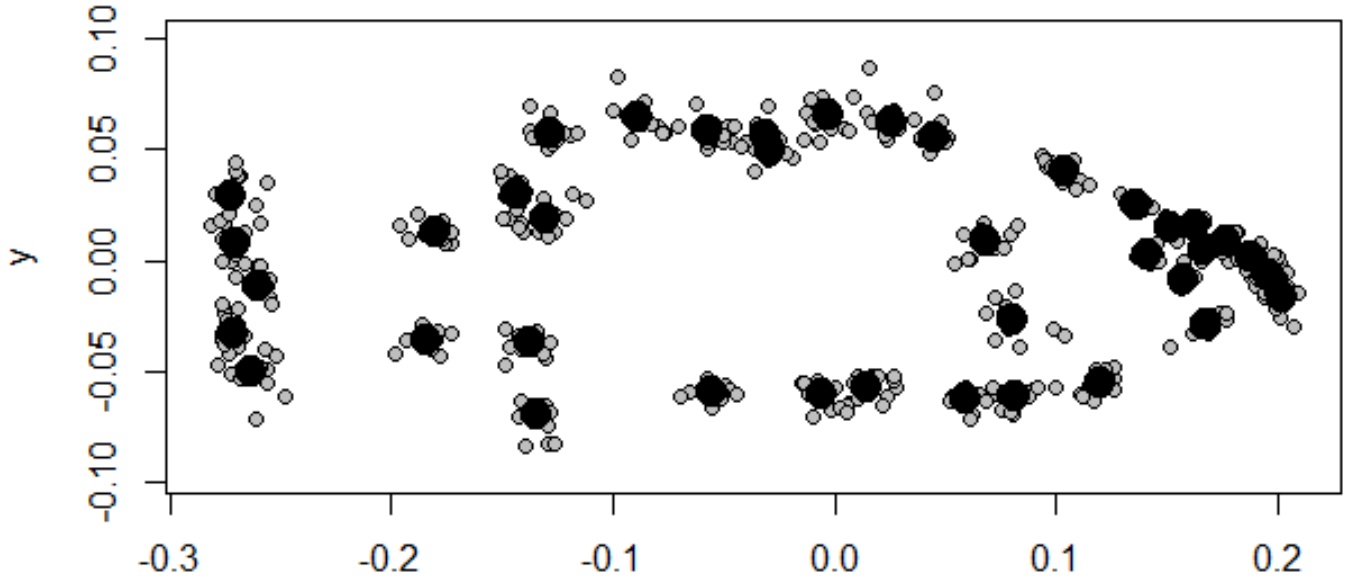
(A) Historical analysis: pre-invasion versus post-invasion

(B) Spatial analysis: invaded versus uninvaded

(C) Diet study: identify potential competitors

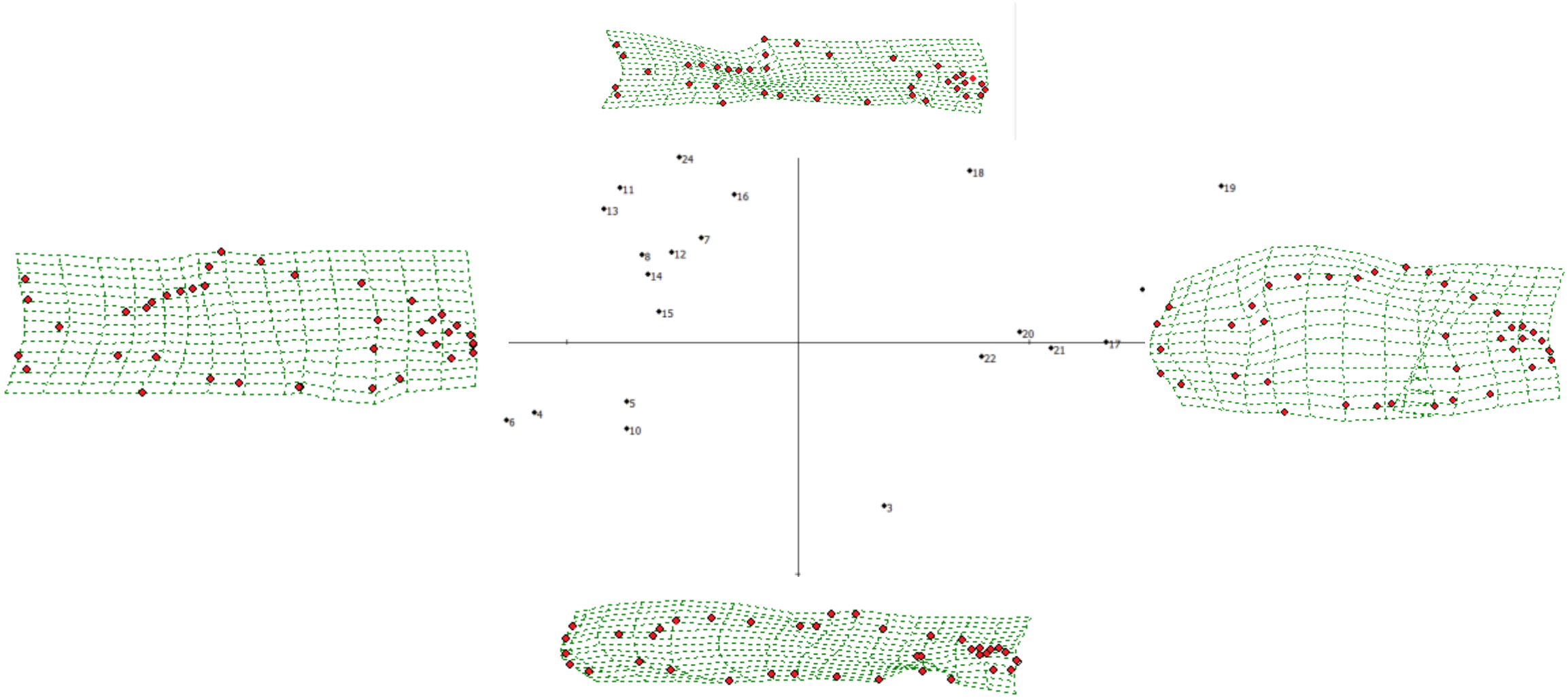
(D) FR Experiments: per capita effects

Forecasting Impact using Morphometric analysis

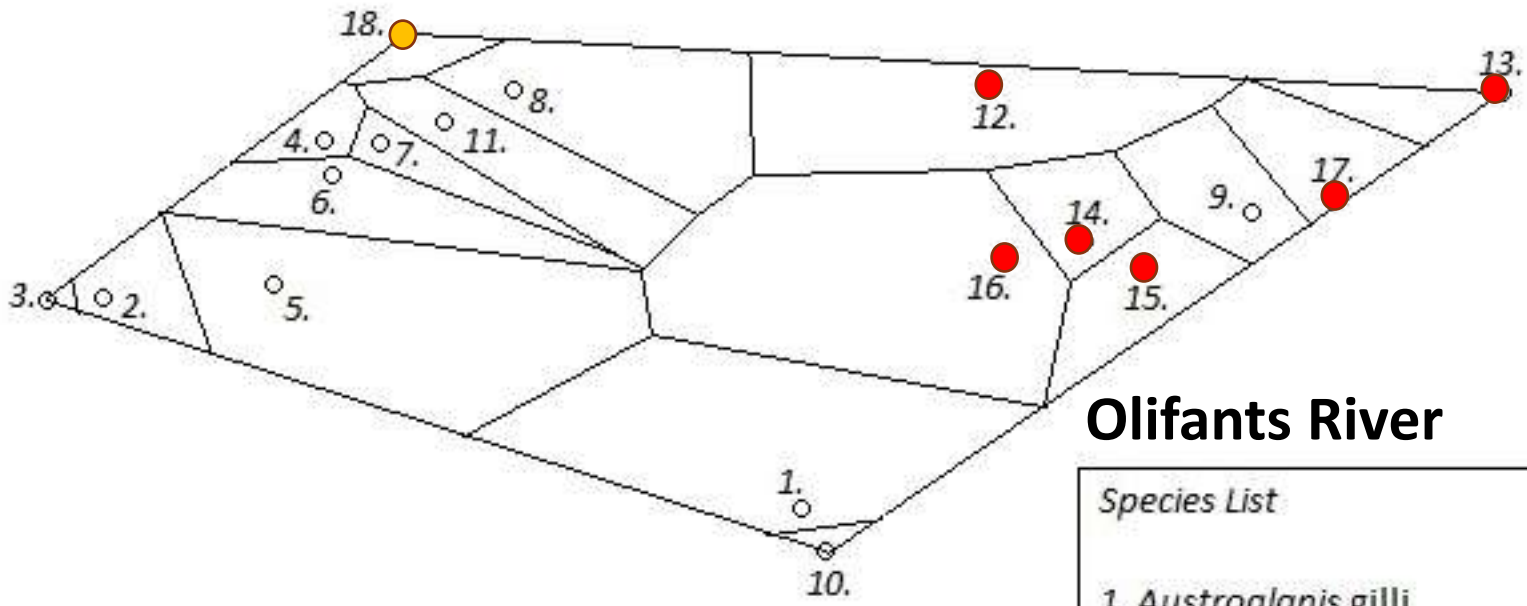


Data sources: archived collections & field photographs

Morphometrics of native & non-native fishes in three South African rivers



Morphometrics of native & non-native fishes in the Olifants River (S. Africa)



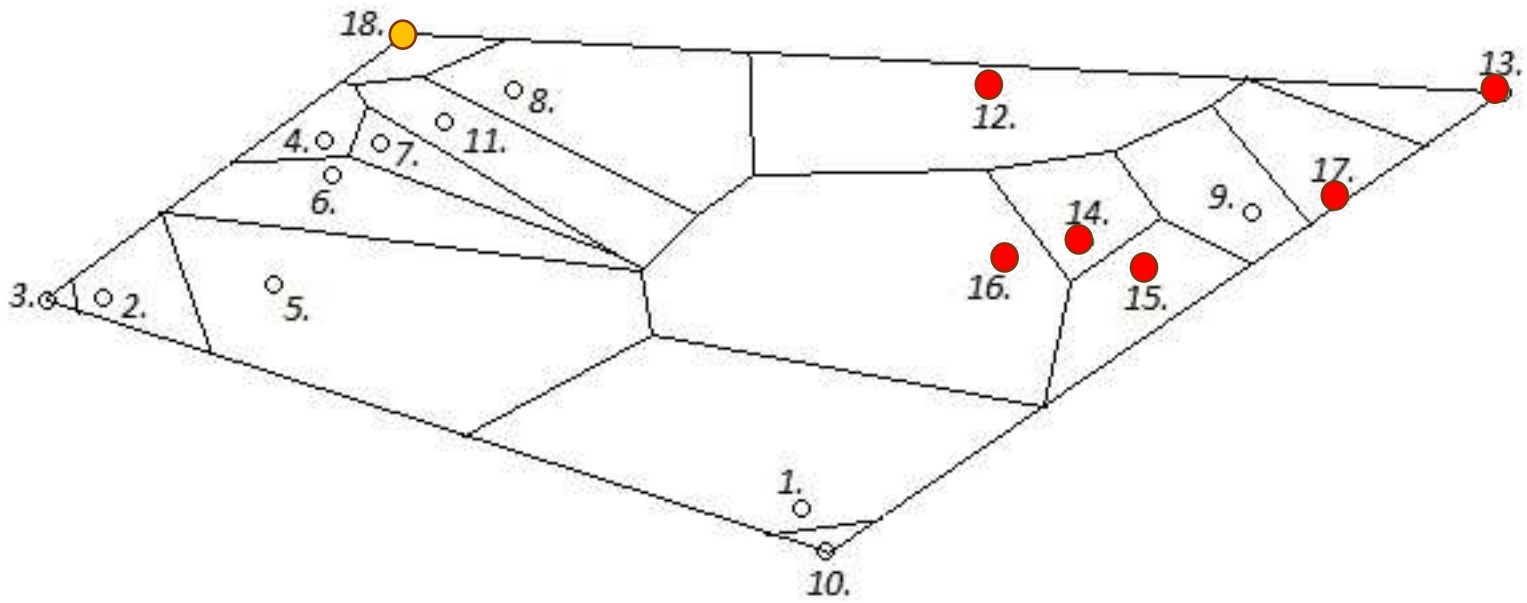
- Introduced species
- Tench

Olifants River

Species List

1. *Austroglanis gilli*
2. *Barbus* andrewi
3. *Barbus calidus*
4. *Barbus serra*
5. *Galaxias zebratus*
6. *Labeo seeberi*
7. *Labeobarbus capensis*
8. *Pseudobarbus phlegethon*
9. *Sandelia capensis*
10. **Austroglanis barnardi*
11. **Barbus erubescens*
12. *Cyprinus carpio*
13. *Lepomis macrochirus*
14. *Micropterus dolomieu*
15. *Micropterus salmoides*
16. *Micropterus punctulatus*
17. *Oreochromis mossambicus*
18. *Tinca tinca*

Morphometrics of native & non-native fishes in the Olifants River (S. Africa)

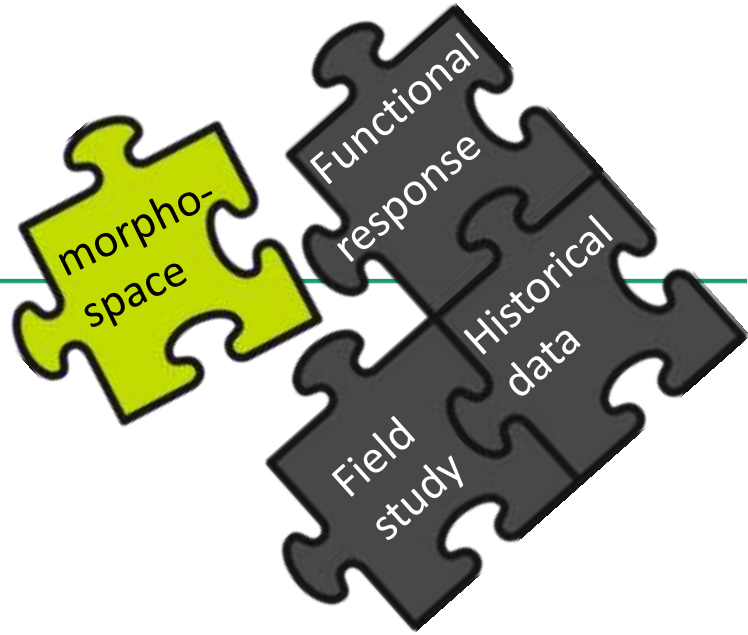


Ha: Impact increases with distinctiveness (e.g. novel predator)

Hb: Impact increases with similarity (e.g. competition, hybridization)

SUMMARY

Predicting Impacts



- Quantify Impact under different contexts
- Compare impact across disparate sites:
  - Relate abundance and per-capita effects to abiotic variables (Field surveys & Functional response experiments)
  - Incorporate effect of recipient community context (Morphometrics)

THANK YOU

Acknowledgements

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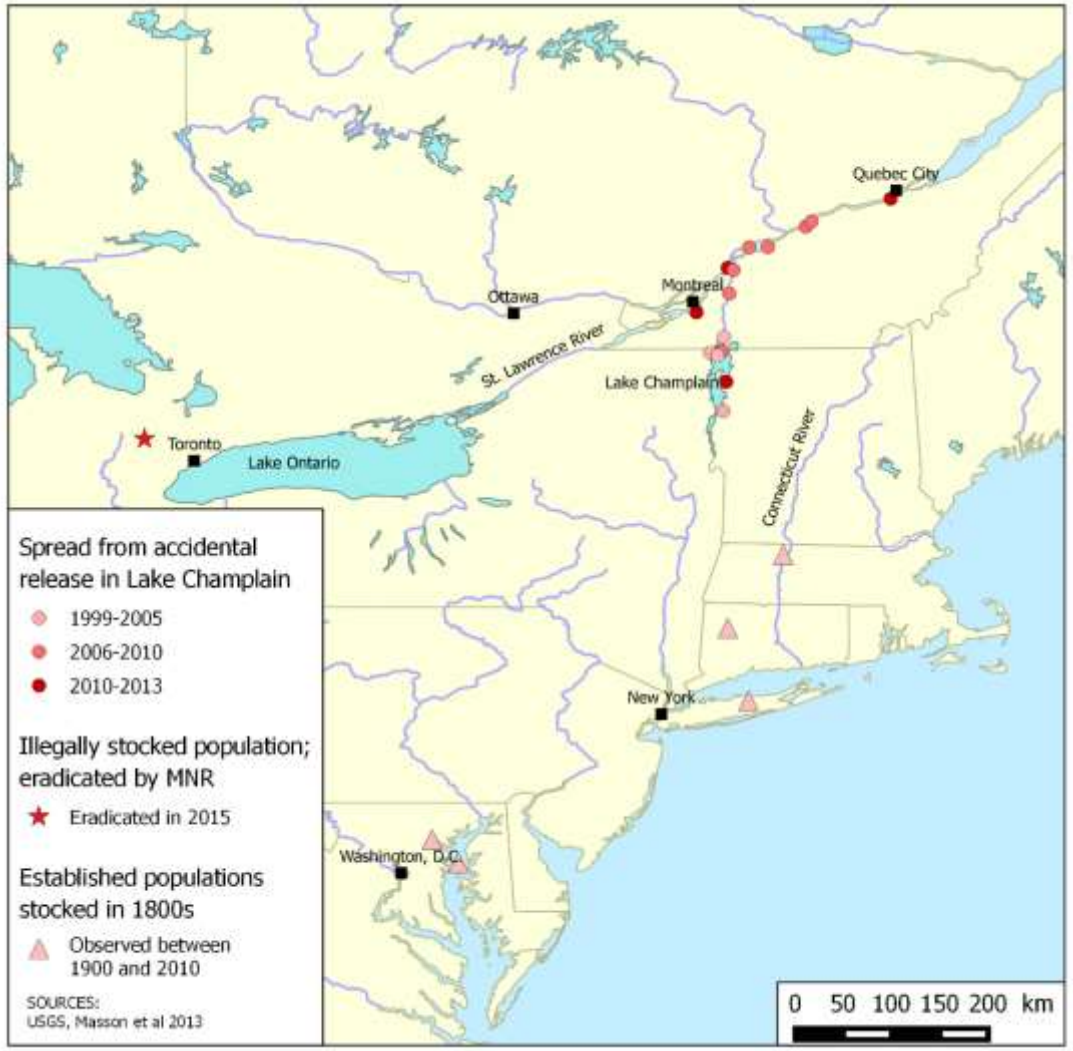
Ricciardi Lab McGill

Olaf Weyl, Darragh Woodford, Rowshyra Castaneda, Steven Crookes.

Tench in North America



(c) Diet overlap (H_1)

Competition

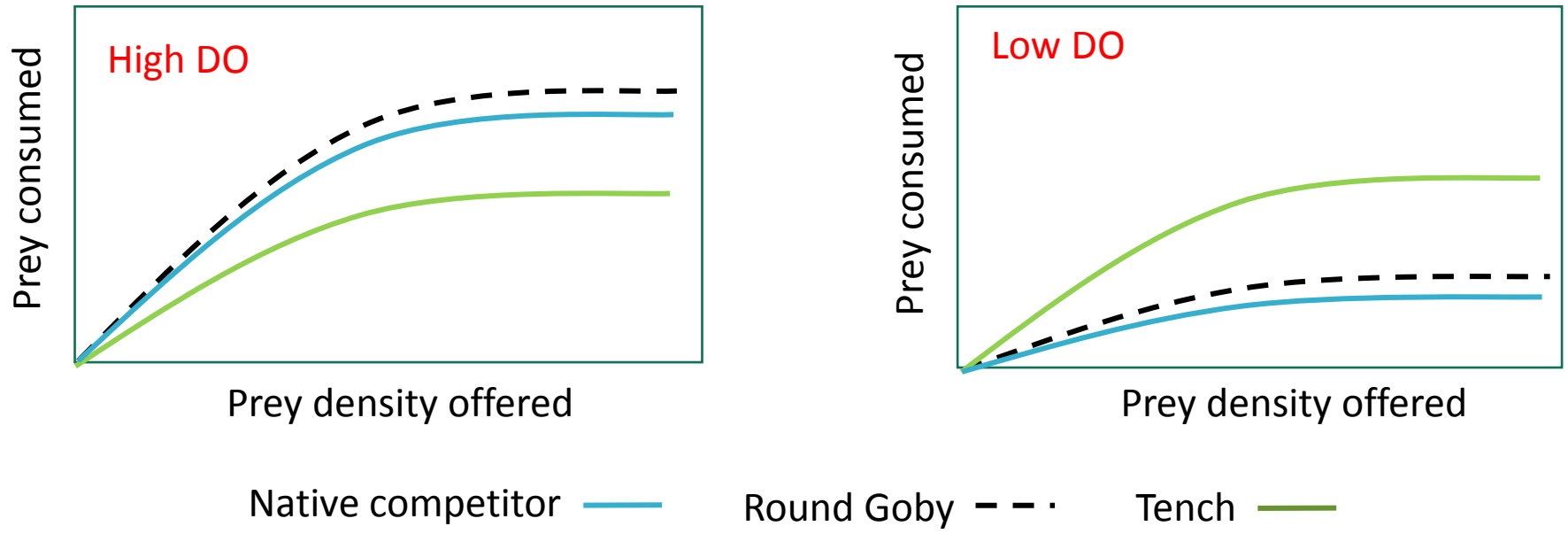
Tench, Round Goby & co-occurring fishes:

- stomach content ID
- quantify overlap
- Identify potential competition
- Correlate to declines (in a & b)

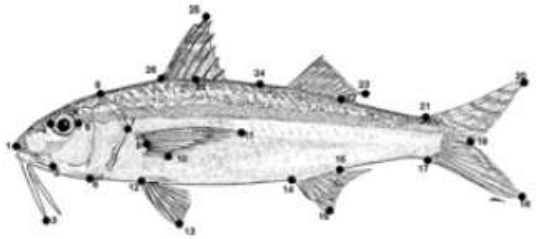
(d) Functional response experiments

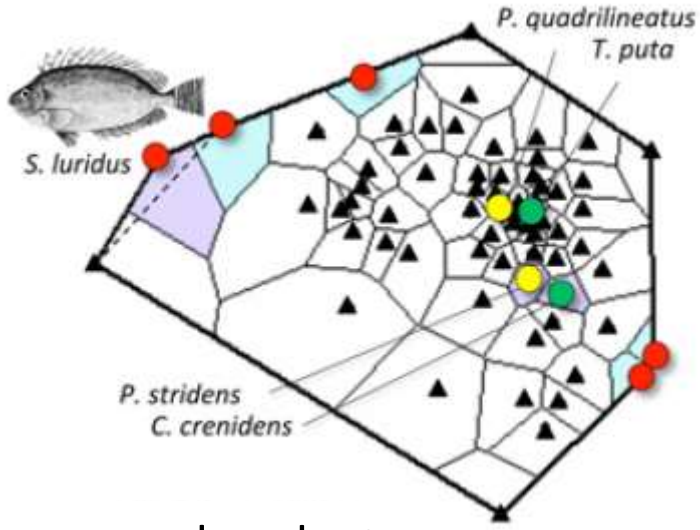
Fr experiments comparing per capita effects of invasive and native fishes under varying environmental parameters

- E.g. DO, Specific Conductivity, turbidity



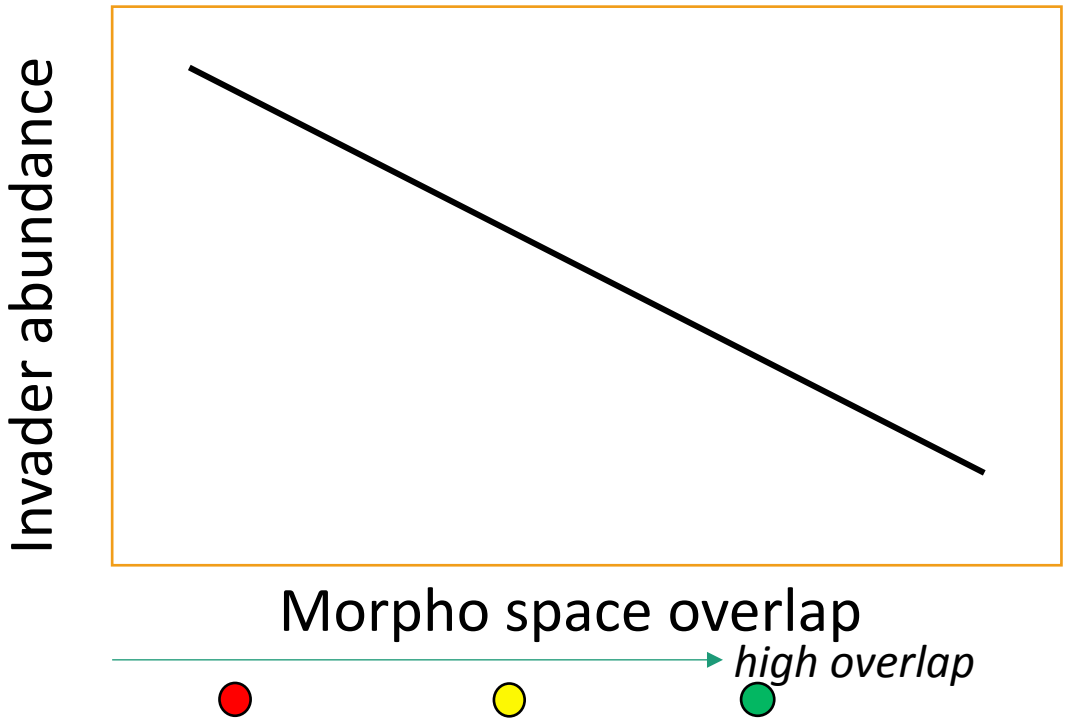
Shape space: modeling biotic interactions





- very abundant
- occasional to common; never very abundant
- rare
- native species

(Azzurro et al. 2014 in Ecology Letters)



- Niche utilization is constrained by phenotype

Bower and Piller 2015, Journal of fish biology

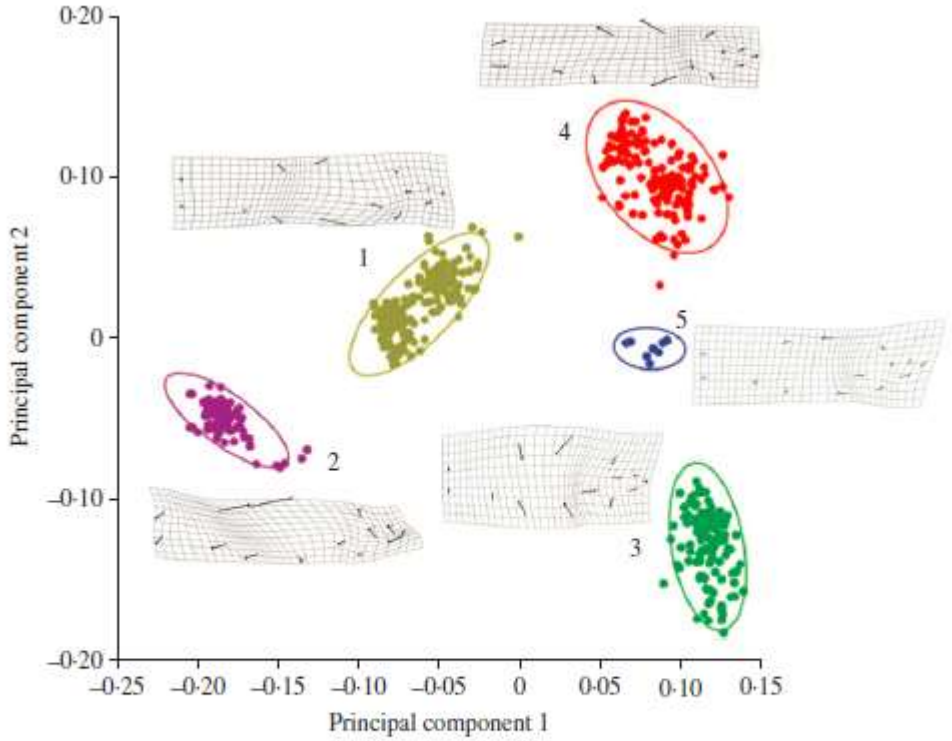
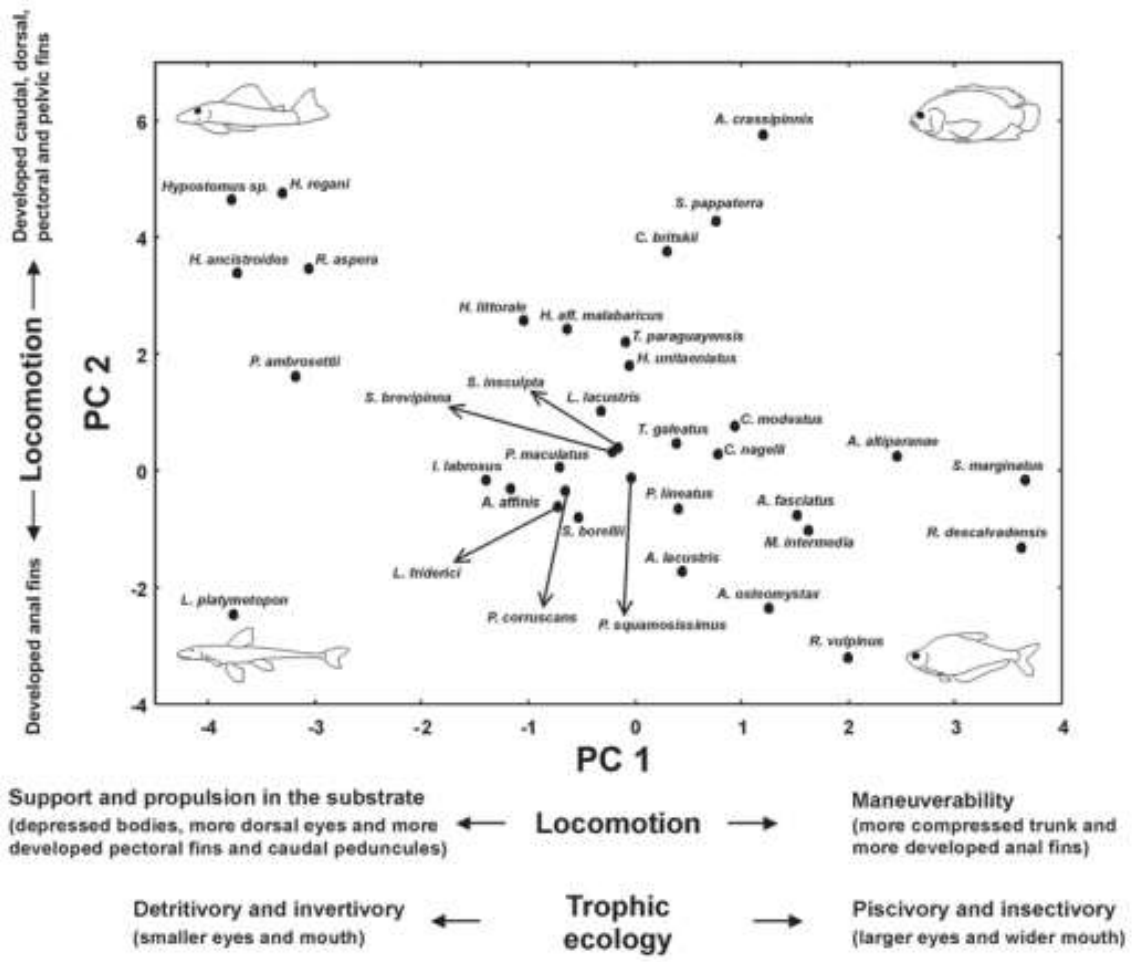


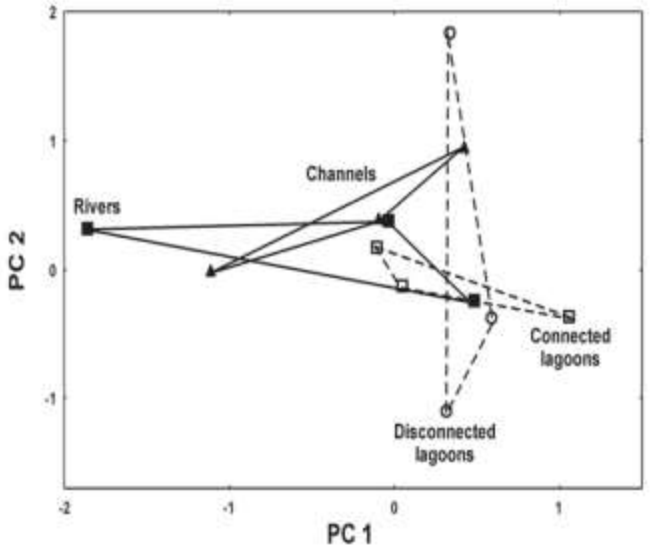
FIG. 3. Principal component analysis of all species from Tickfaw River (Lake Pontchartrain basin), with 95% confidence ellipses and consensus body shapes for each ecomorphotype: 1, generalist ecomorphotype (●); 2, top-water ecomorphotype (●); 3, structure-oriented ecomorphotype (●); 4, benthic ecomorphotype (●); 5, roaming-predator ecomorphotype (●). The first axis describes the changes in the dorsal-fin and pelvic-fin placement, and the variance in the second axis explains the compression in body shape dorso-ventrally.

- Morpho shape predicts trophic guild
- No correlation of shape with substrate or stream depth
- Found a correlation between flow and shape
- Weak correlation between depth and shape (in non-stream fishes)

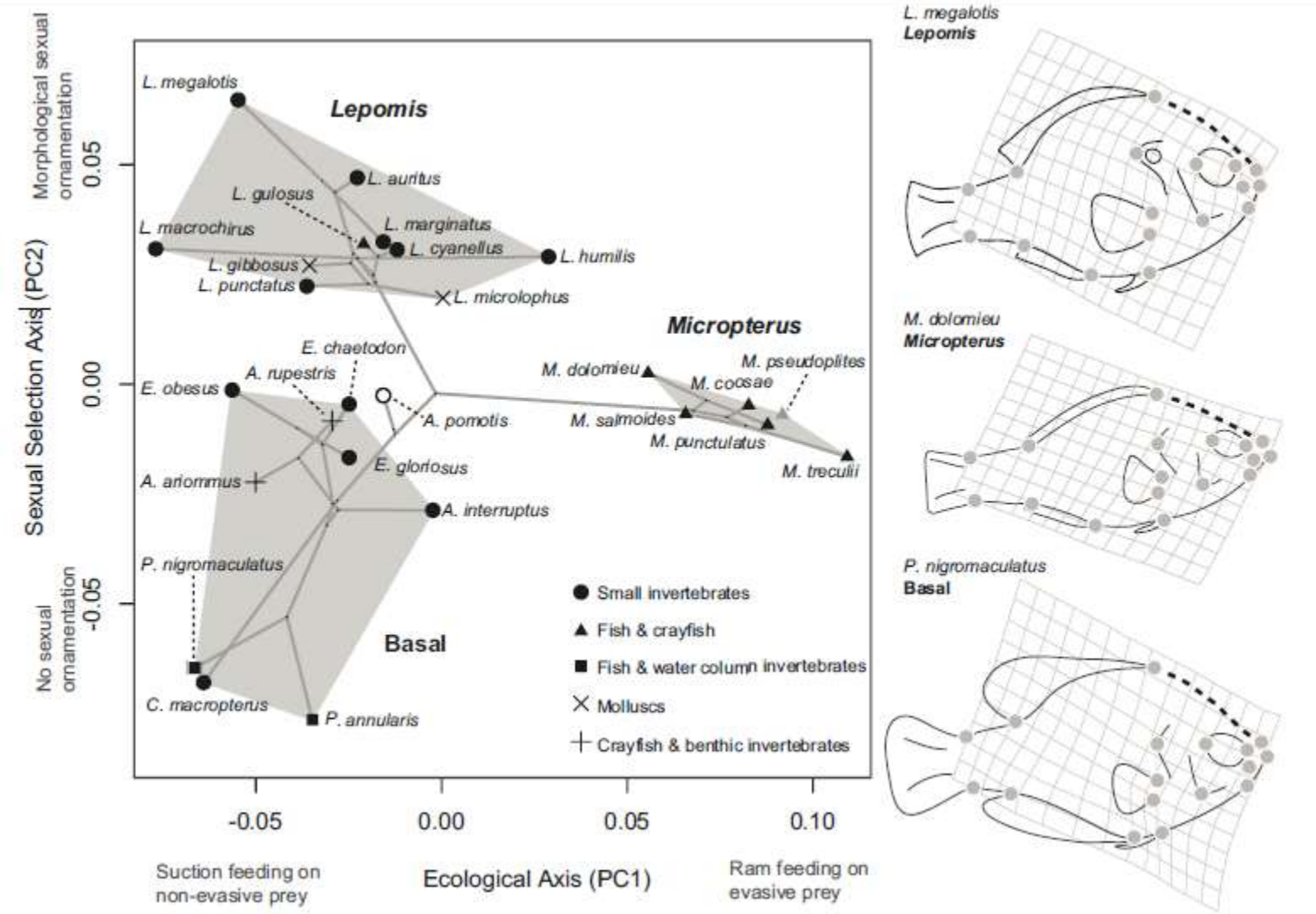
Oliveira et al. 2010, Neotropical Ichthyology



- Strong correlation to trophic guild
- Poor correlation with habitat



Smith et al. 2015, Evolutionary Biology



Comparison of centrarchids

- Found no correlation between habitat (pelagic vs benthic) and shape
- Strong correlation between shape and diet