

# Behavioural variation in round goby (*Neogobius melanostomus*) individuals during the invasion process



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ICAIS 2016

# Non-indigenous species (NIS)

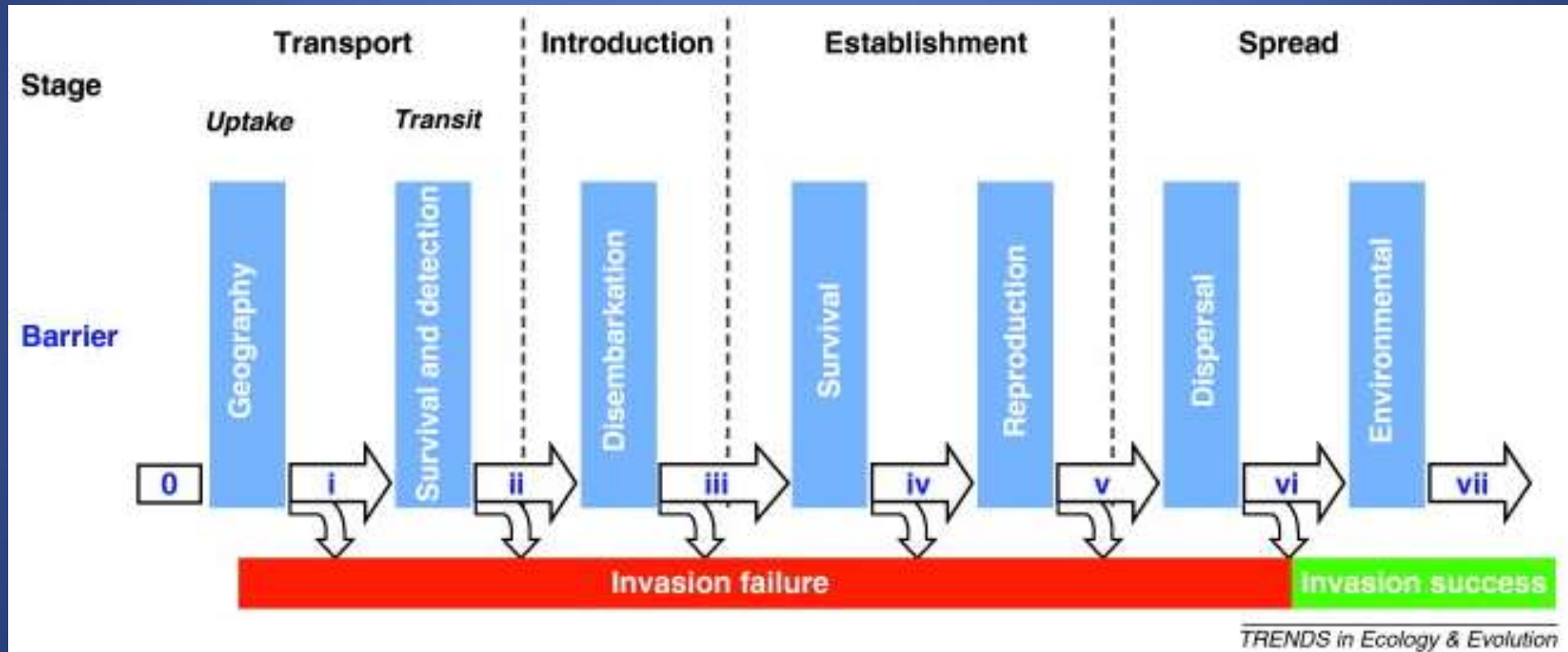
- Species found outside their native range



# Great Lakes: Pathway for NIS?



# Invasion Process

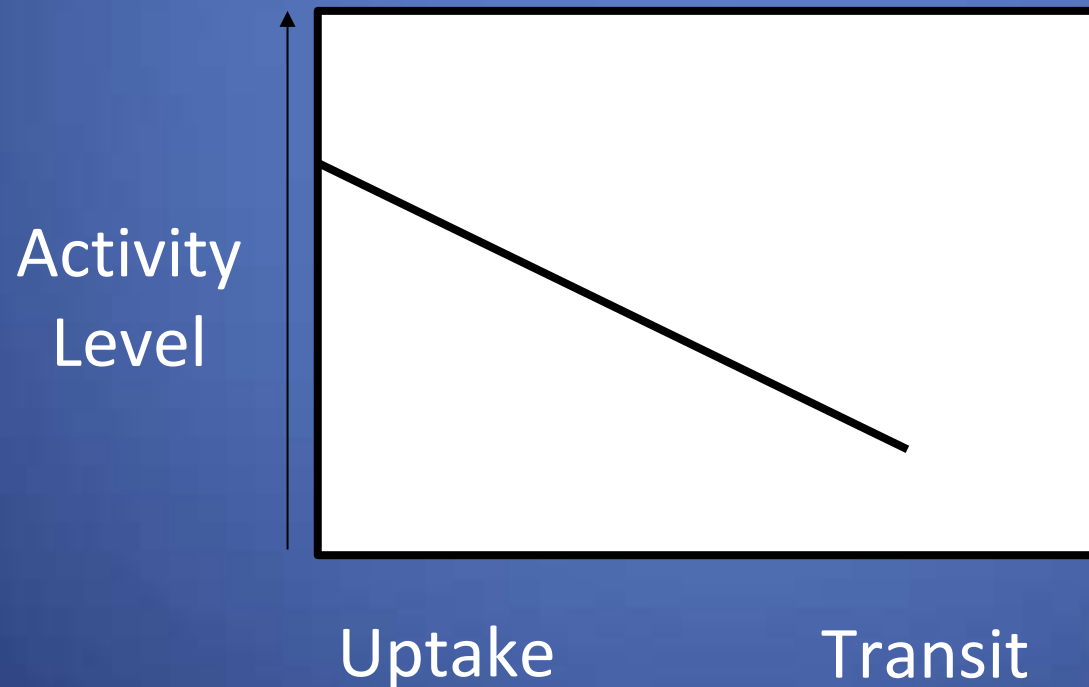


# Invasion Process

- Each barrier comes with different selection pressures
- Non-random subset of individuals
- Mechanism that can facilitate transition between each stage:
  - Behaviour

# Behavioural Flexibility

- Ability to adjust one's behaviour in response to changing environmental conditions



# Behavioural Syndrome

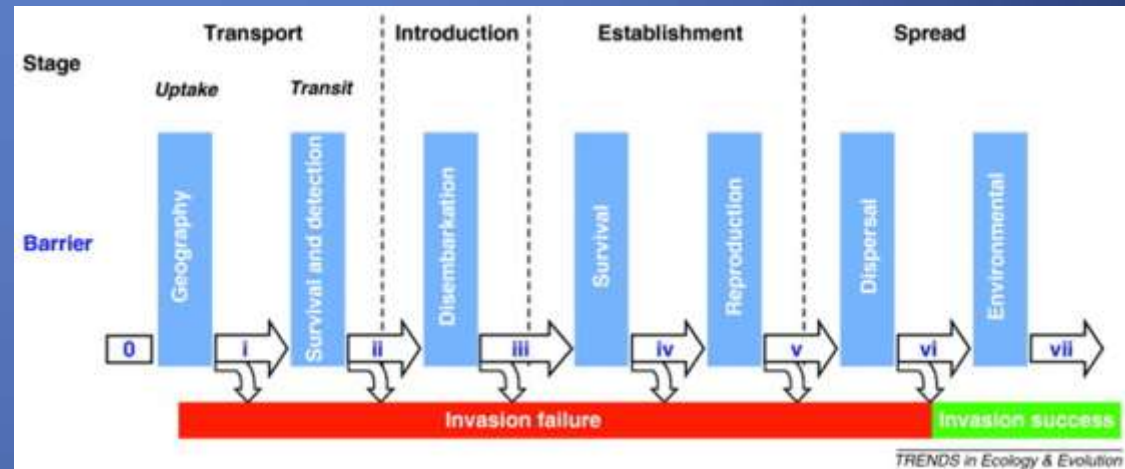
- Suite of correlated behaviours often seen across multiple contexts and times



# “Invasion Syndrome”

- Correlated suite of behavioural traits that enhance invasion success across multiple stages of the introduction process

- Aggression
- Asociality
- Boldness
- Exploration





# “Invasion Syndrome”



Western  
mosquitofish  
(*Gambusia affinis*)

- Asociality
- Dispersal

# Ontogenetic Shifts in Behaviour

- Change of behaviour during ontogeny



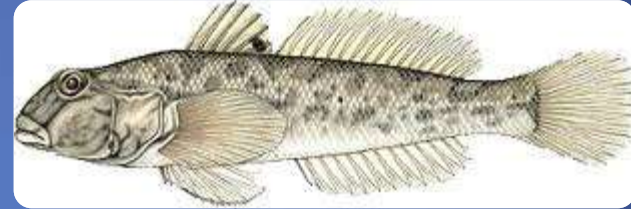
Juveniles



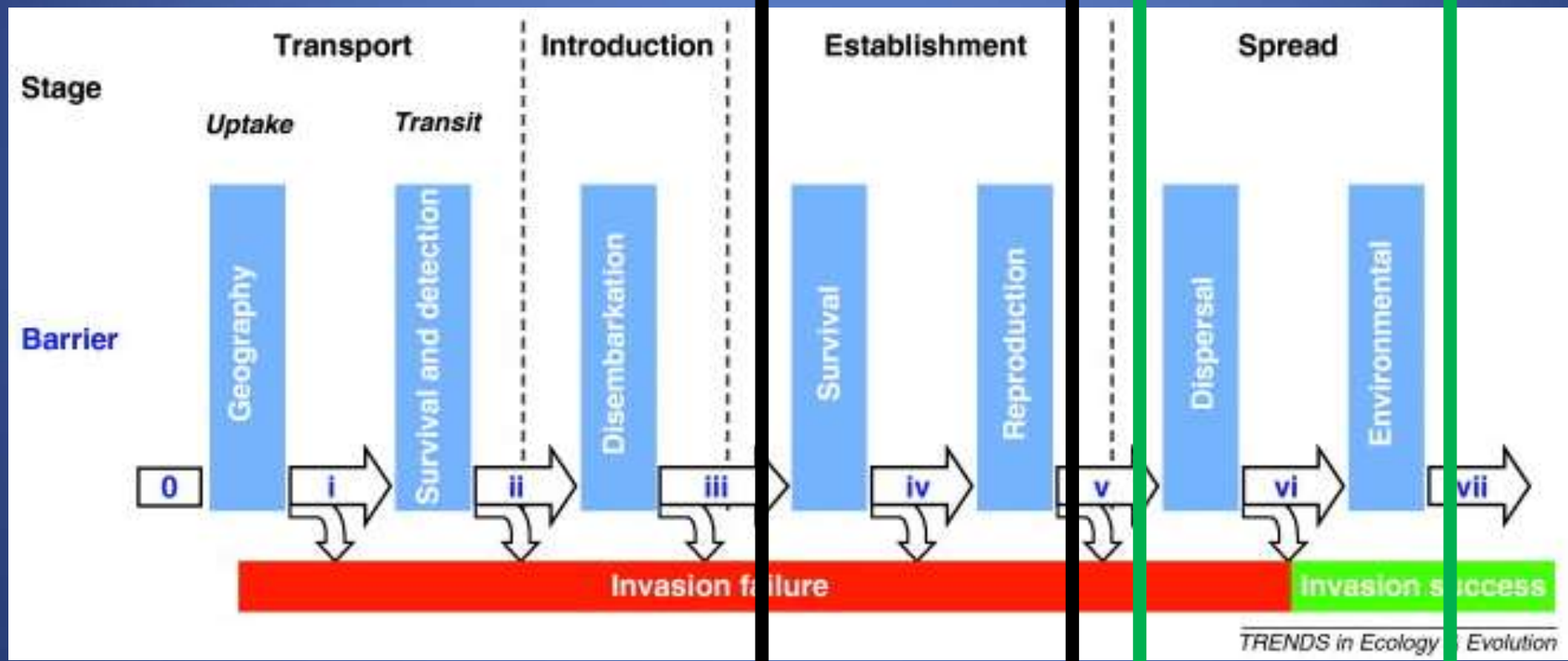
Adults

# Round Goby (*Neogobius melanostomus*)

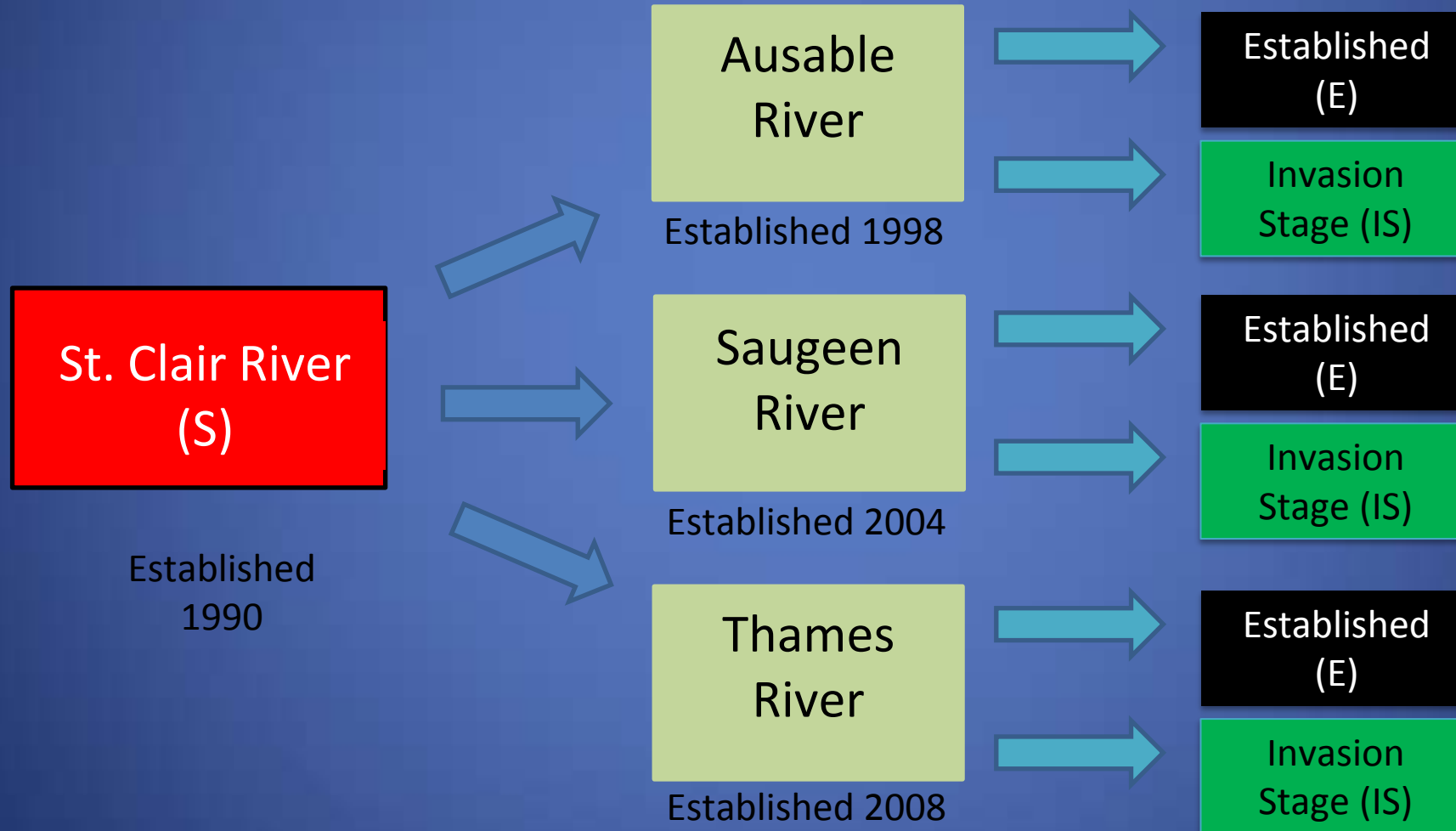
- Origin: Ponto-Caspian and Black Sea
- Invaded Great Lakes 1990
- Physiologically tolerant, high reproductive rates, aggressive, highly competitive

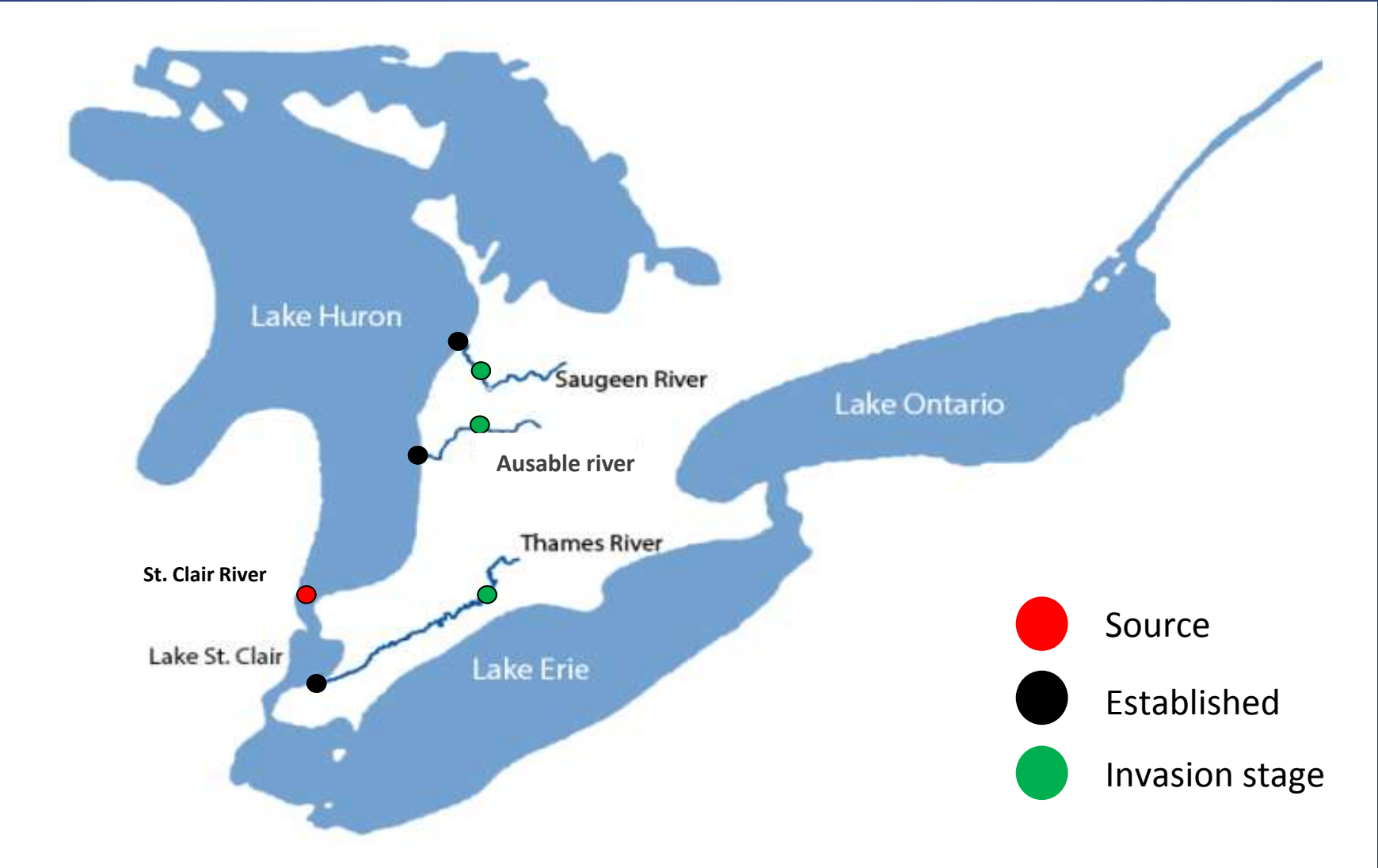


# The Invasion Process



# Sampling Sites





# Field Sampling Techniques

- Invasion front surveying



# Behavioural Assay Sample Collection

30 round gobies  
(juveniles  
and adults)



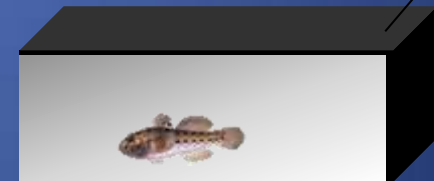
Transported  
back to  
GLIER



Acclimate  
one week



Commence  
behavioural  
trials





# Objective

- Investigate how behavioural traits play a role in invasion success in North America for the round goby

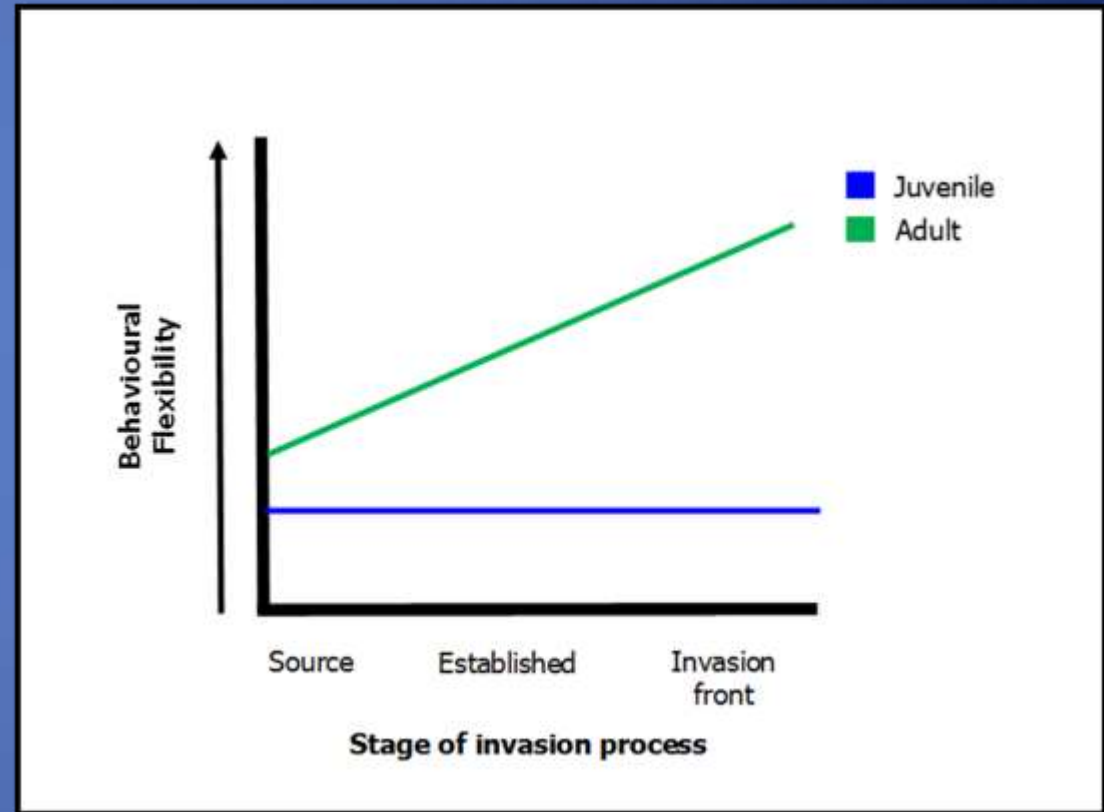


# Hypothesis and Predictions

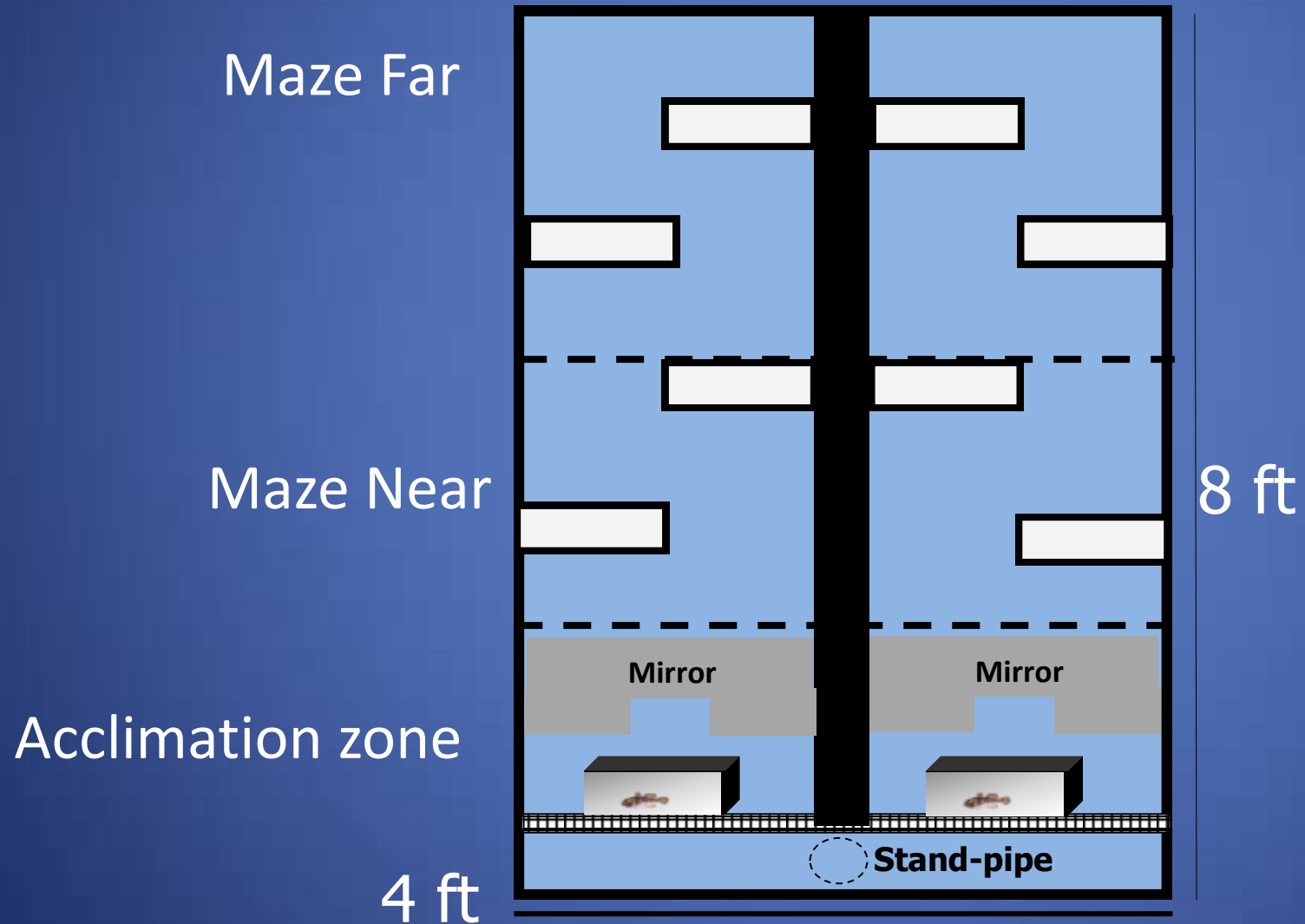
- There will be behavioural differences between round gobies:
  - At different stages of the invasion process  
(S, E, IS)
    - High activity
    - Boldness
    - Dispersal distance

# Hypothesis and Predictions

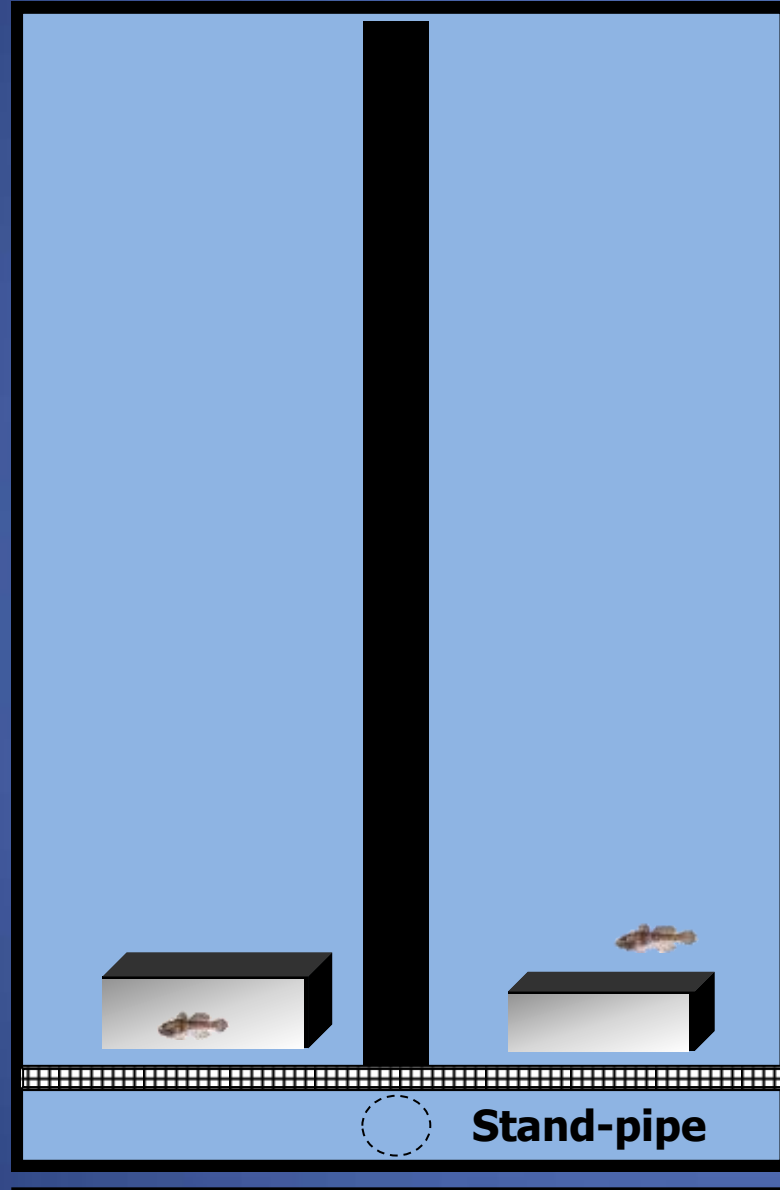
- Juveniles will have an “invasion syndrome” and be the main invaders
  - Higher activity (mobility)
  - Boldness (leave shelter sooner)
  - Asocial (mirror avoidance)
  - Disperse further



# Behavioural Assay



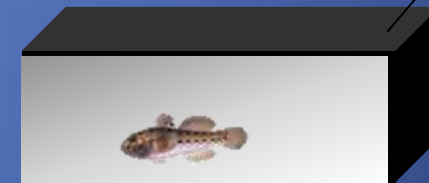
8 ft

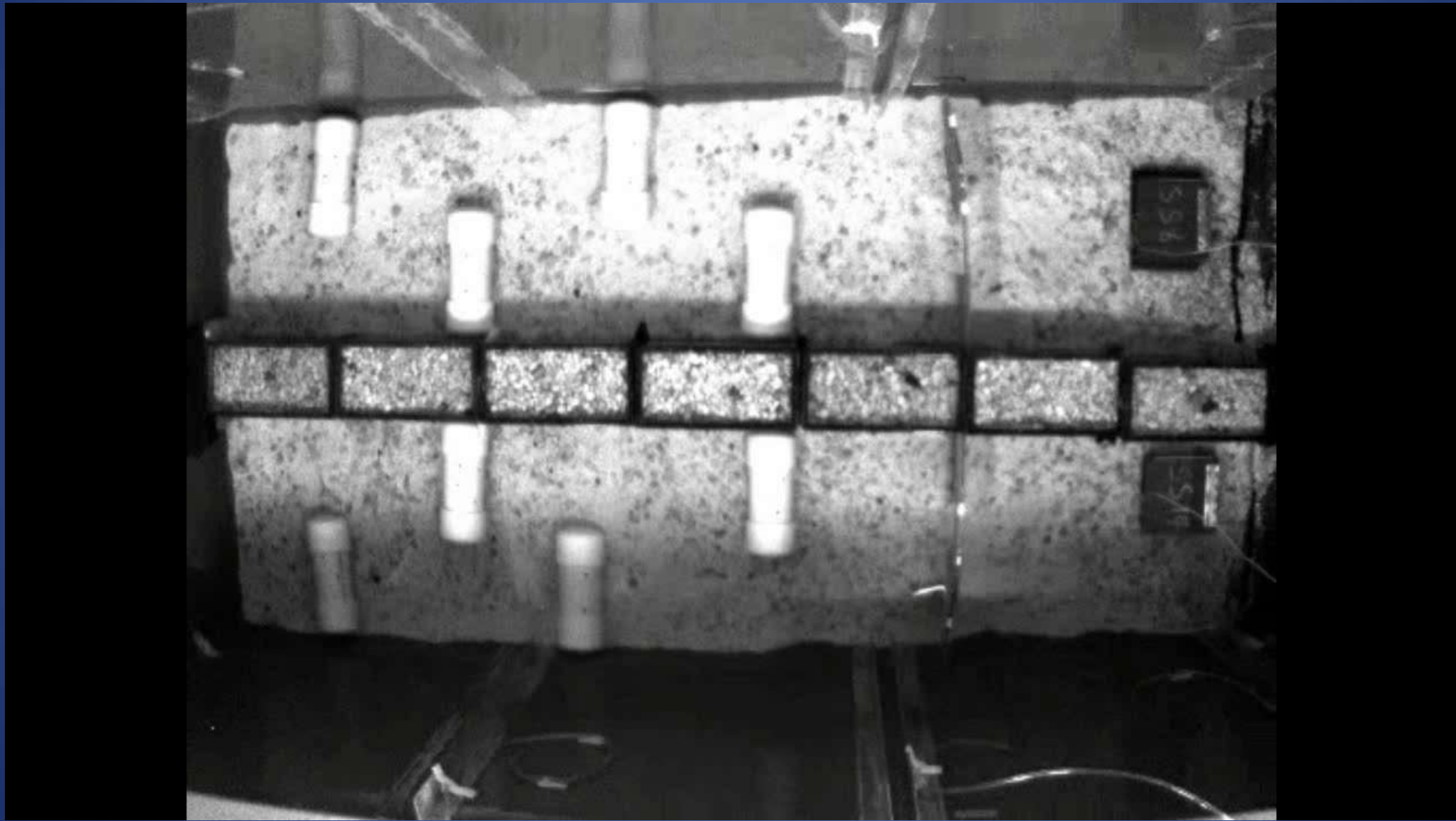


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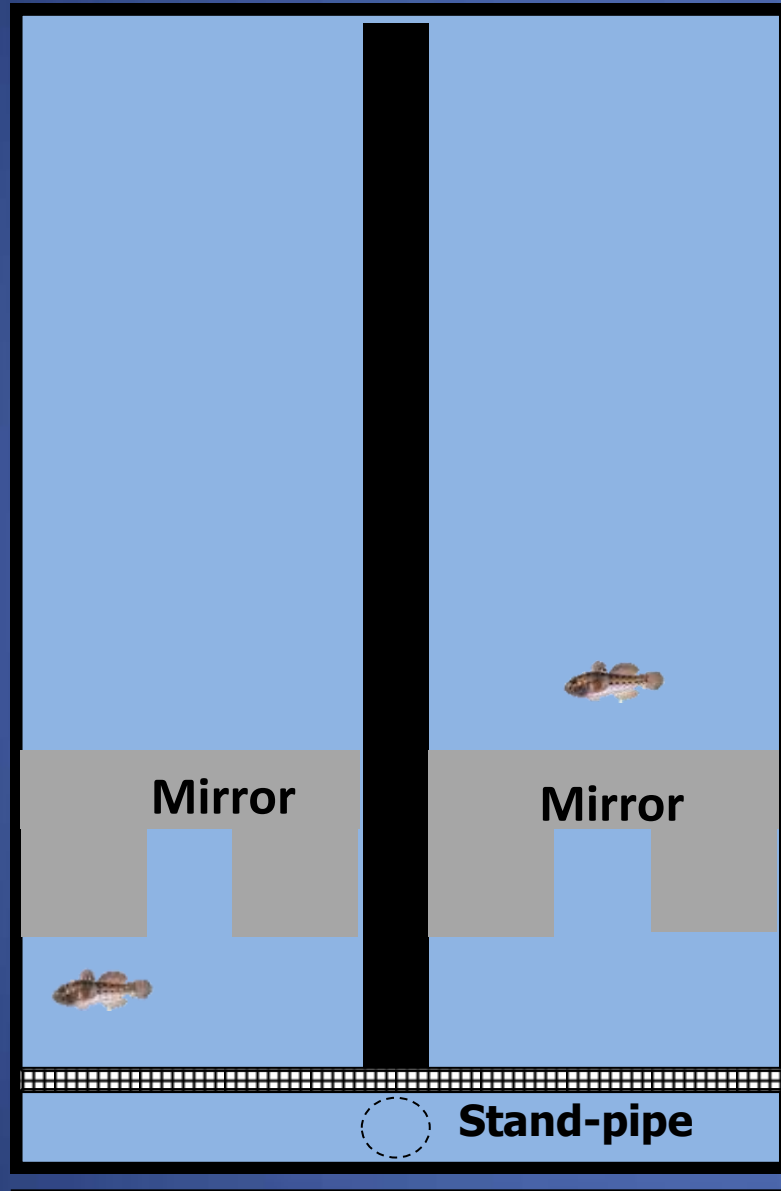
- **Boldness**

- Latency to leave the shelter
- assesses risk-taking



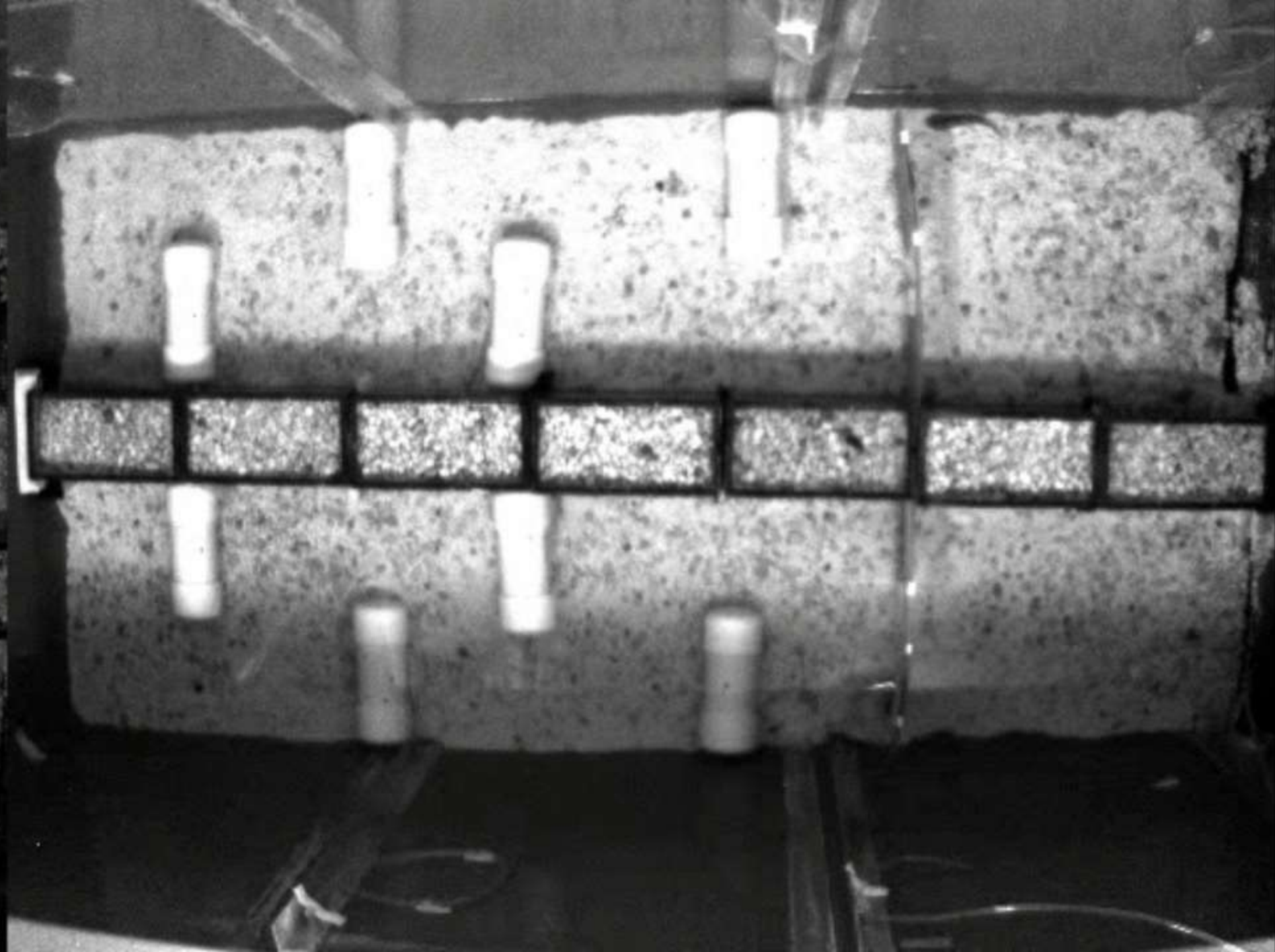


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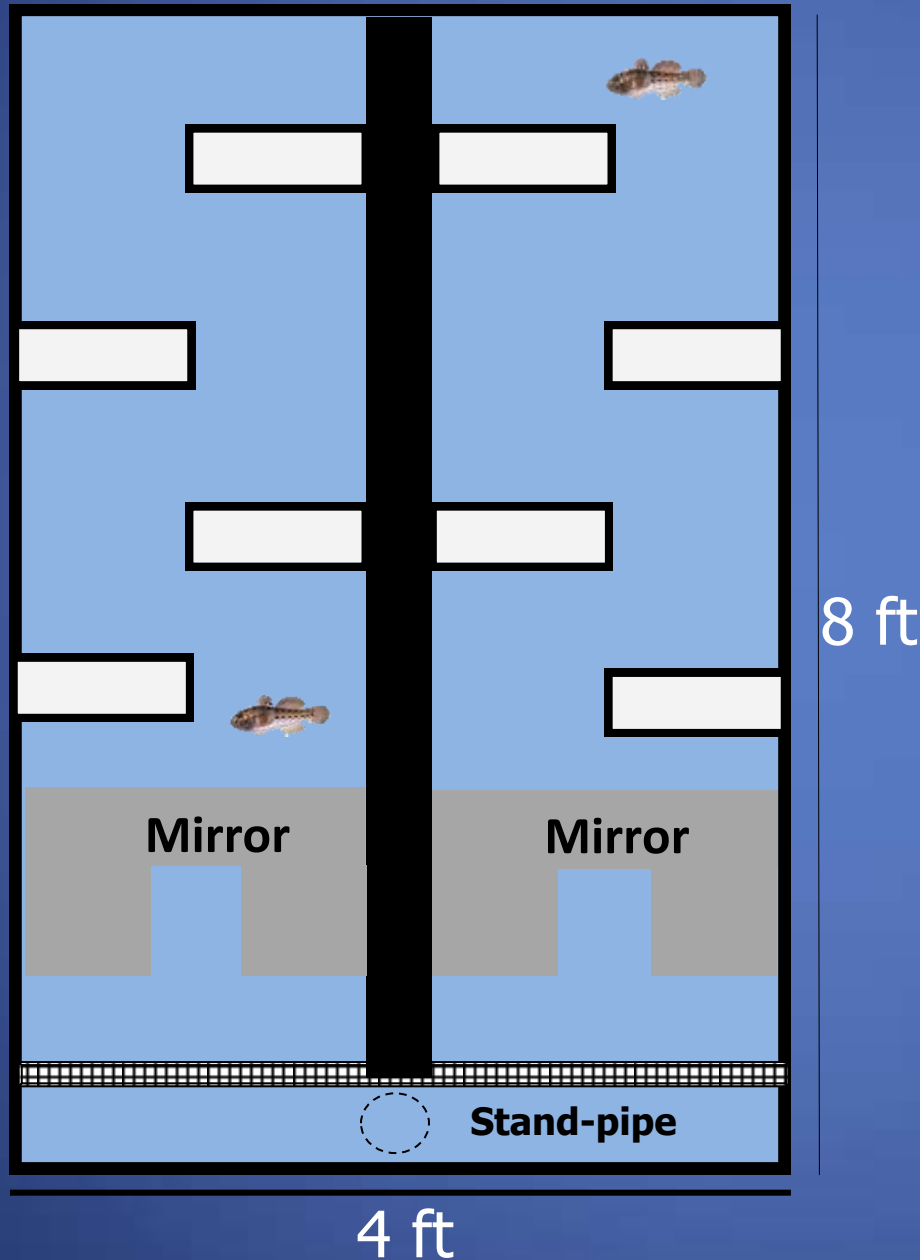


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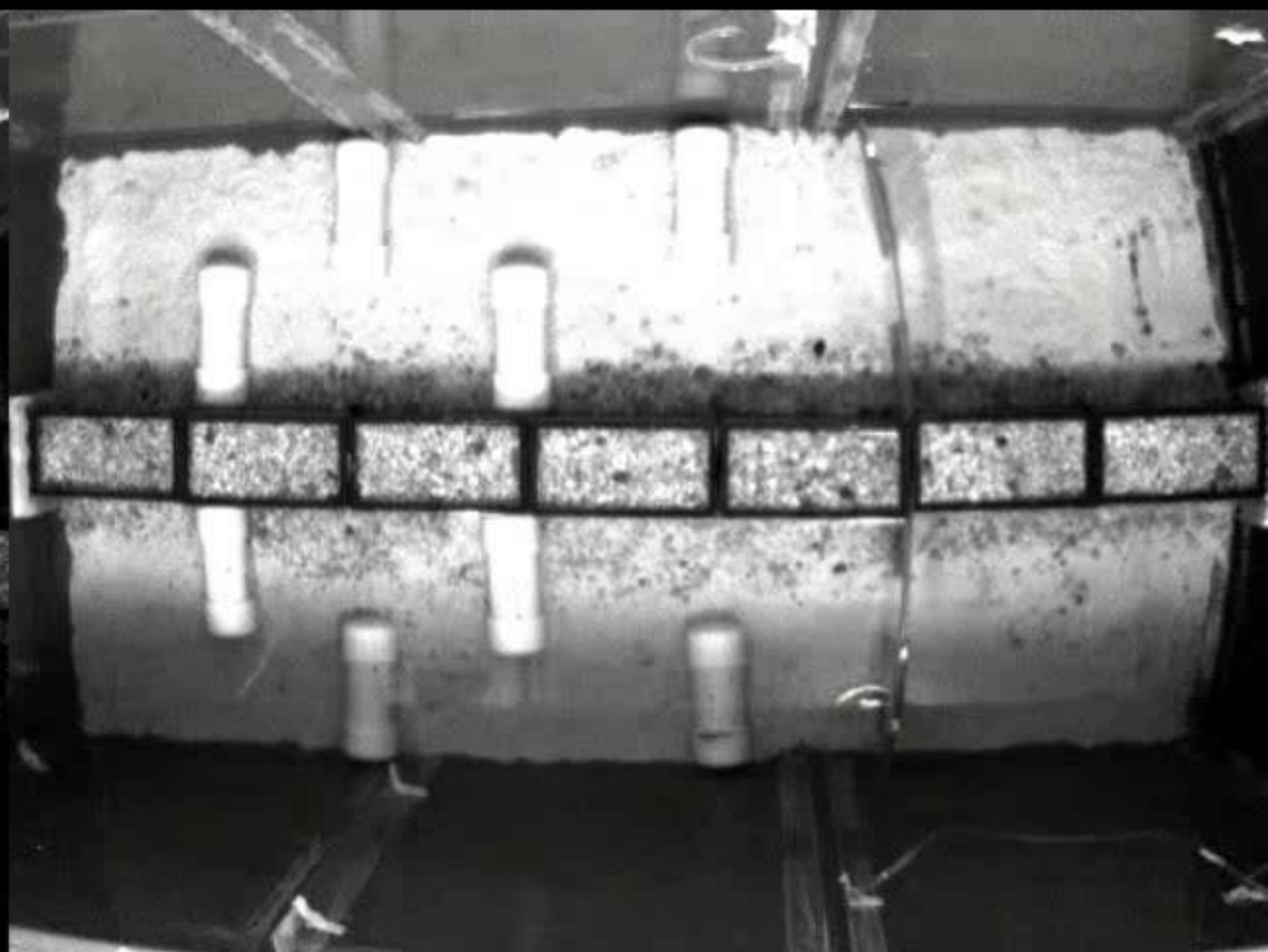
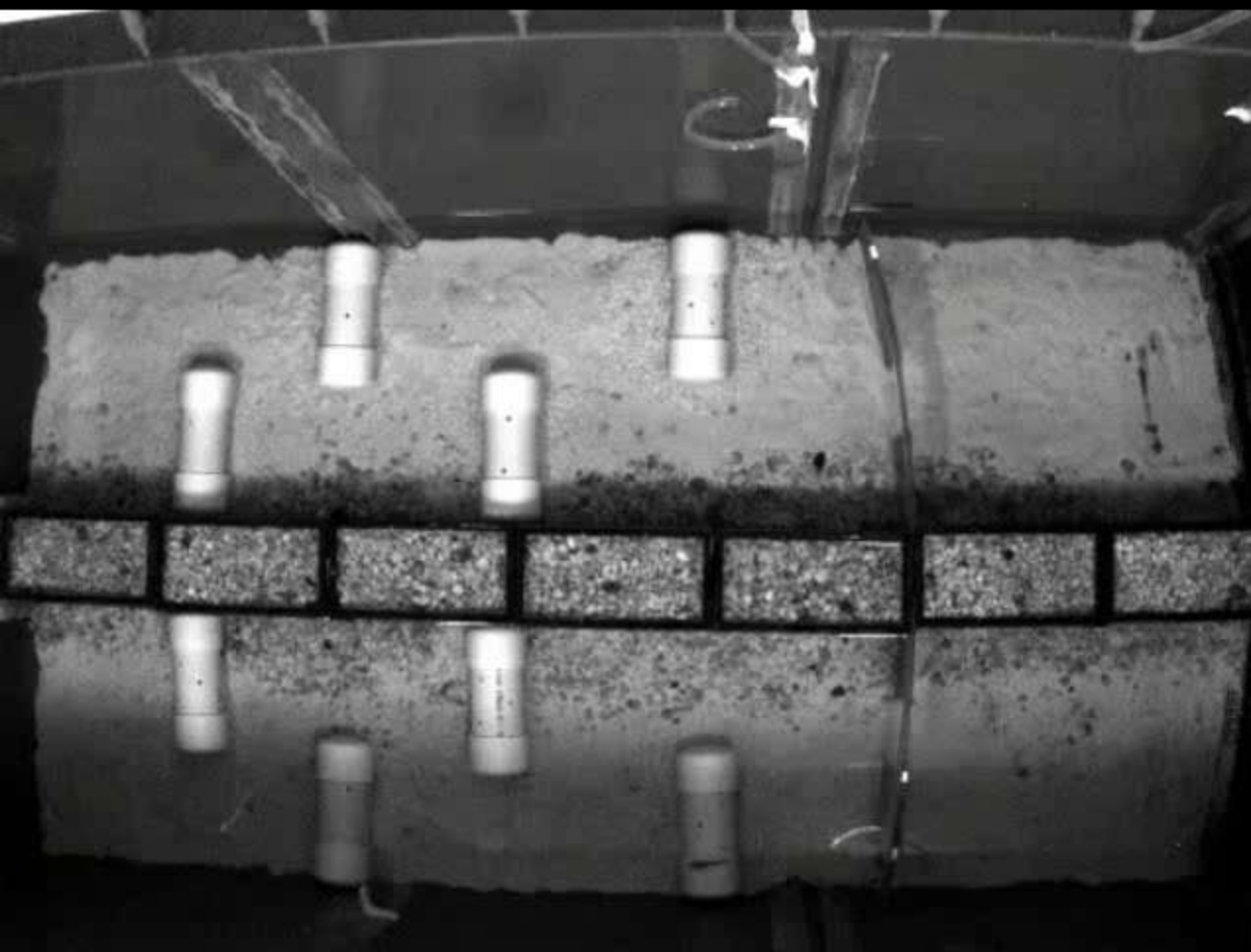
- Boldness
- **Sociability**
  - Mirror-image stimulus (MIS)
  - Shoaling or aggression

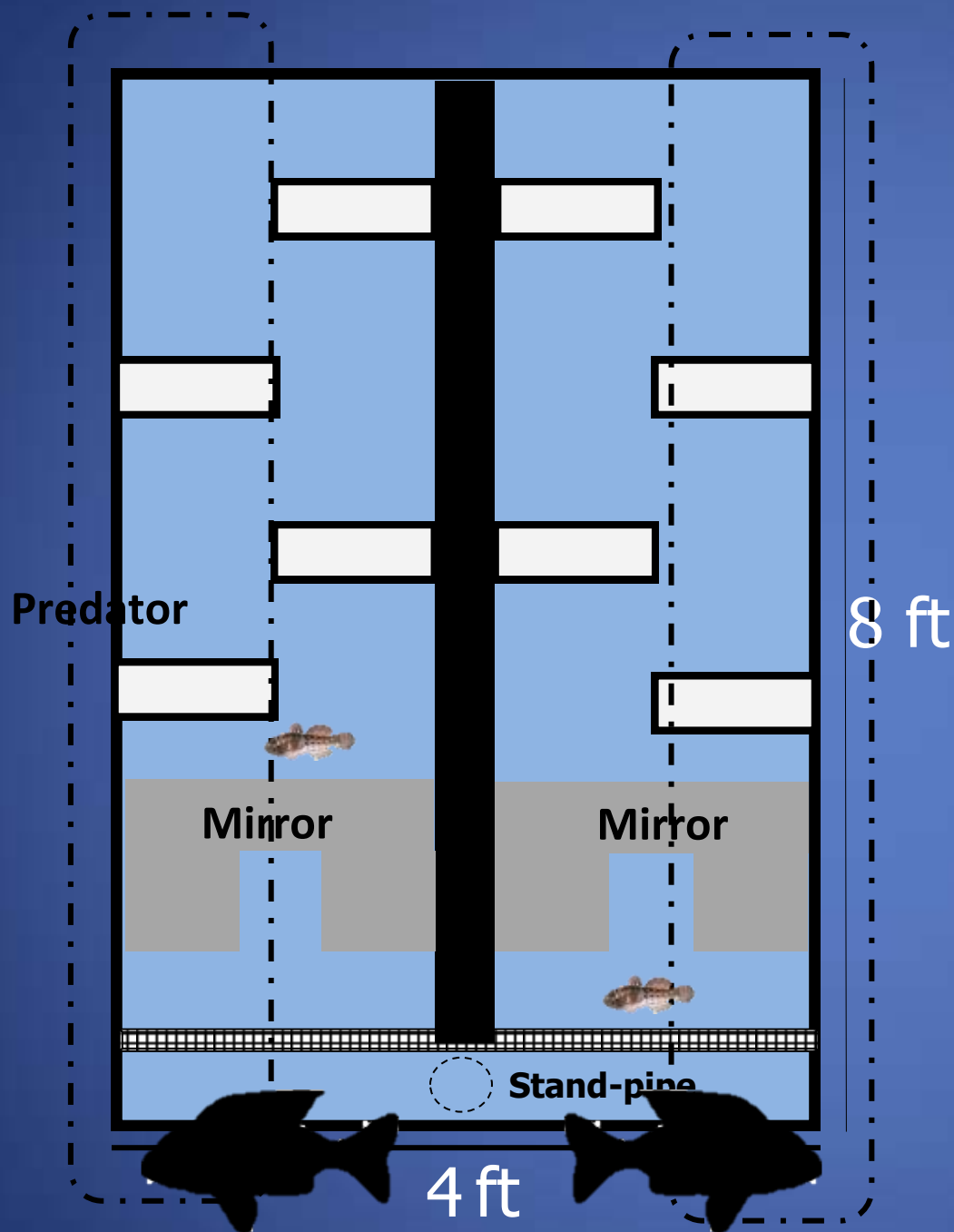




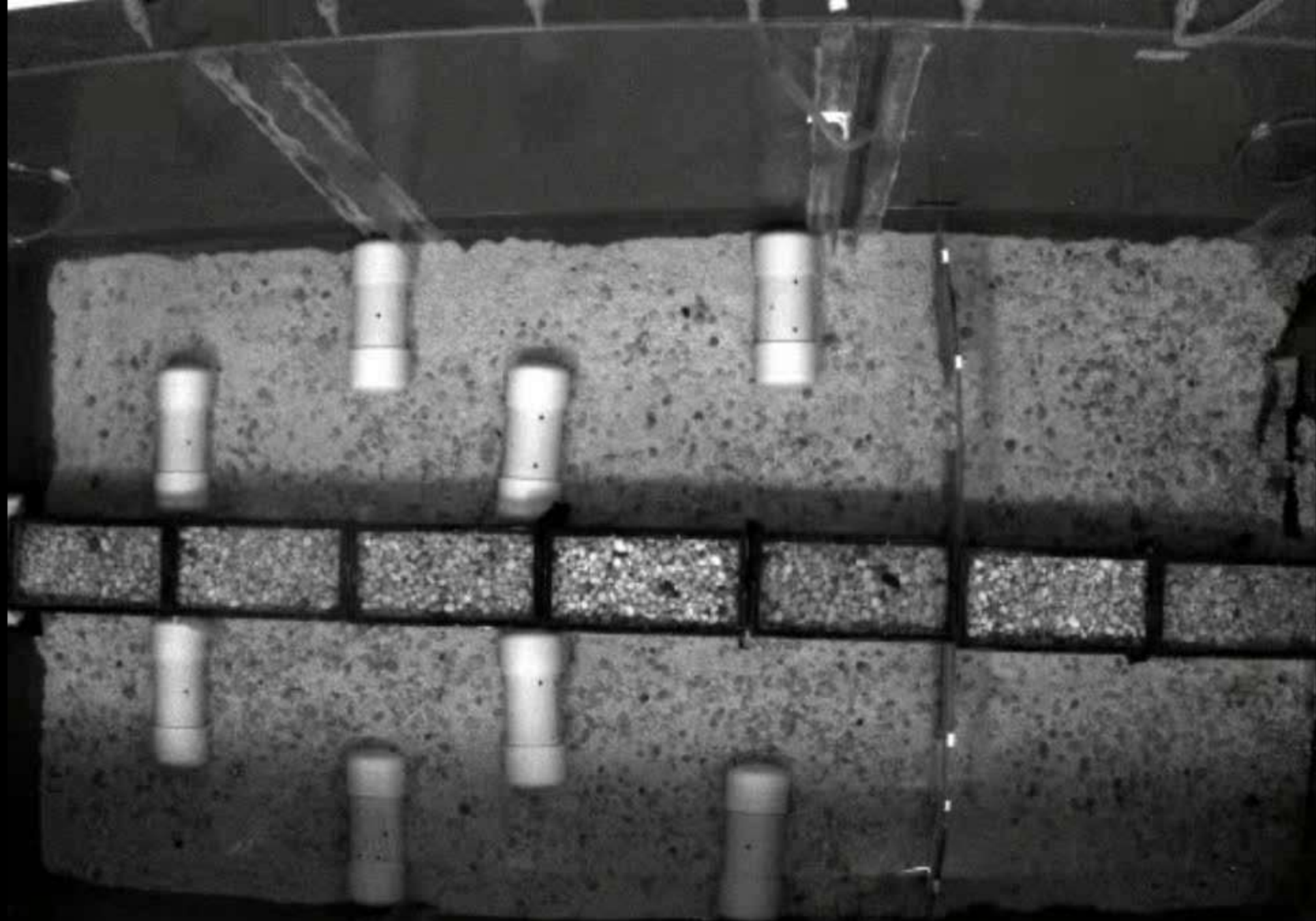


- Boldness
  - Sociability
  - **Exploration and dispersal distance**
- Gauge willingness to explore further and maneuver through the maze



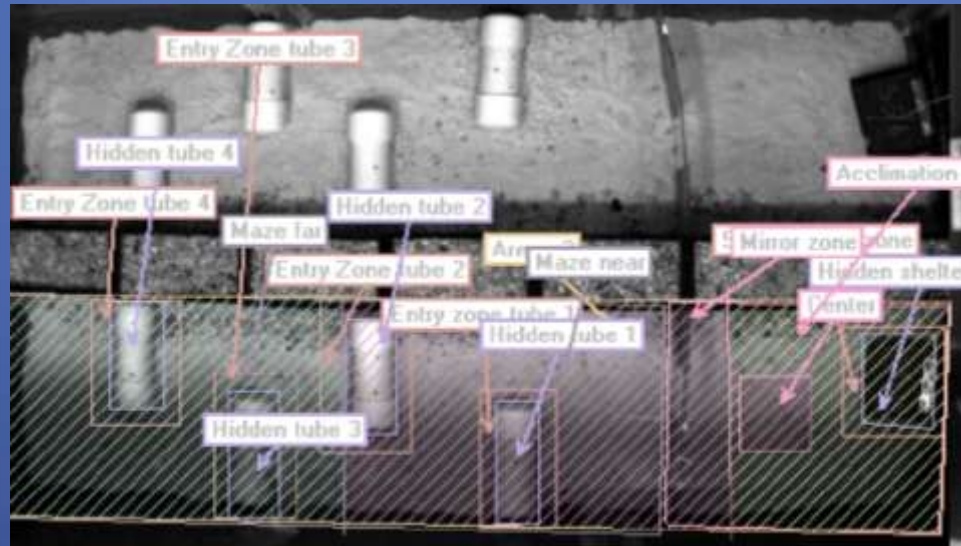


- Boldness
- Sociability
- Exploration and dispersal
- **Habituation (learning)**
  - Time to resume activity
  - Habituate to predator



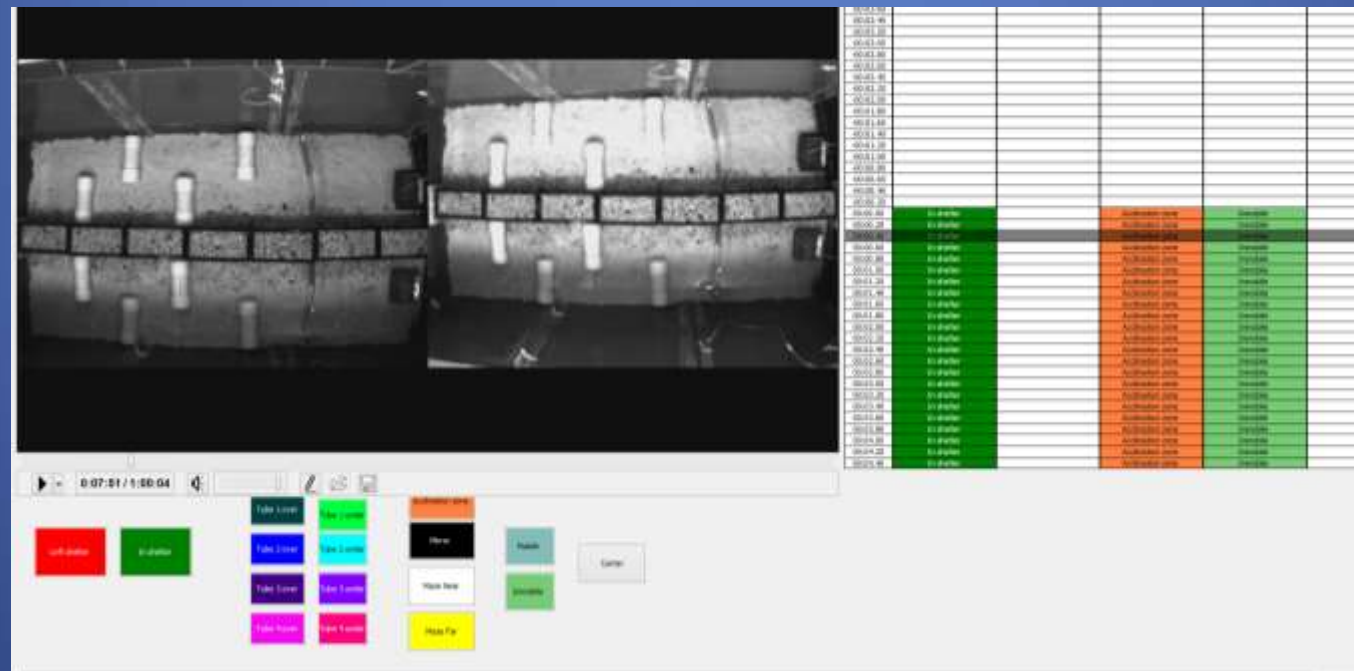
# Behavioural Analysis

- Ethovision- automated video tracking software
- Measure activity, overall distance moved, max velocity, time spent in centre vs side,



# Behavioural Analysis

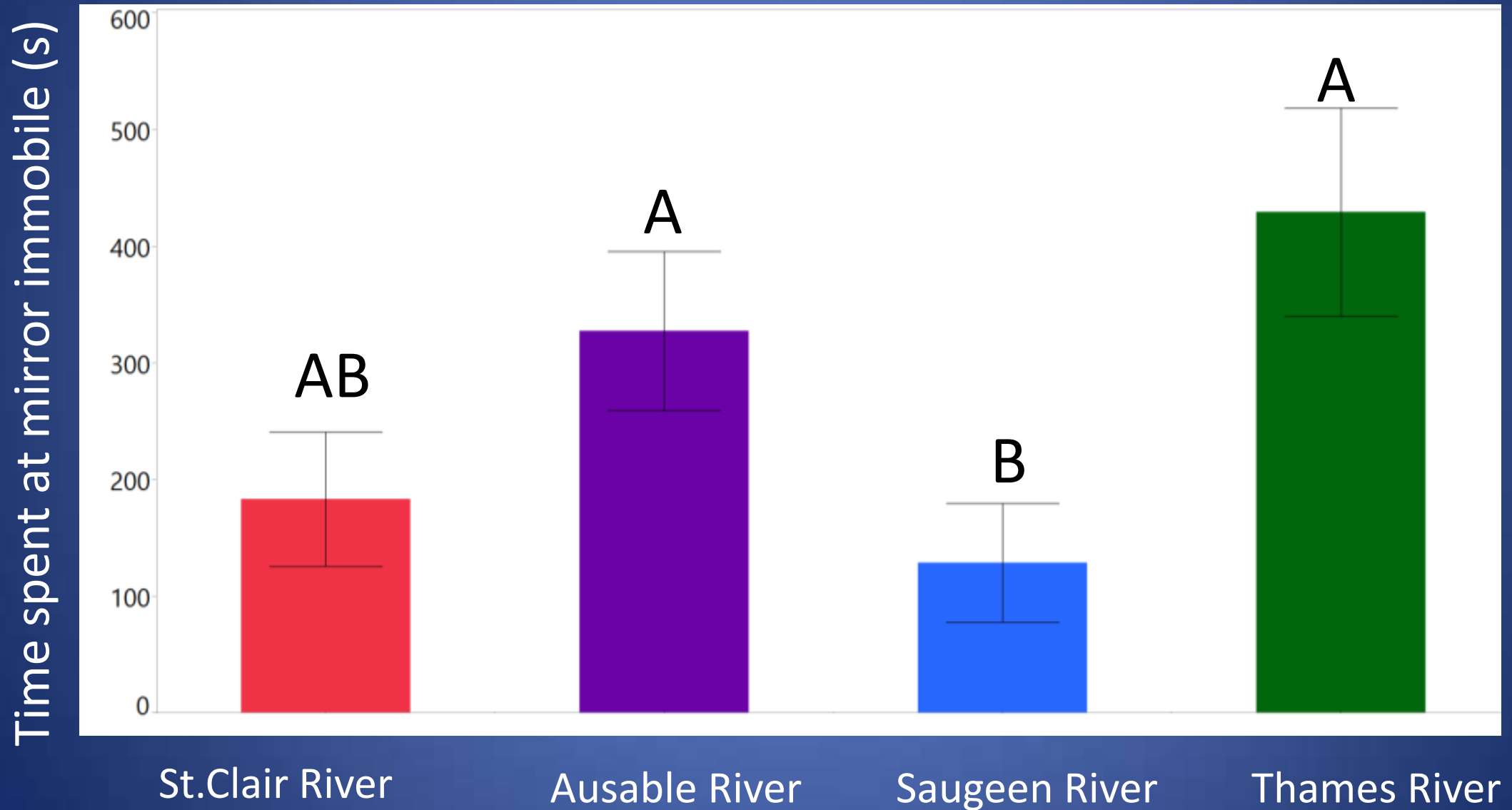
- Solomon coder- manual scoring
- Frequency, duration in specific zones and latency to leave shelter, and other zones



# Statistical Analysis

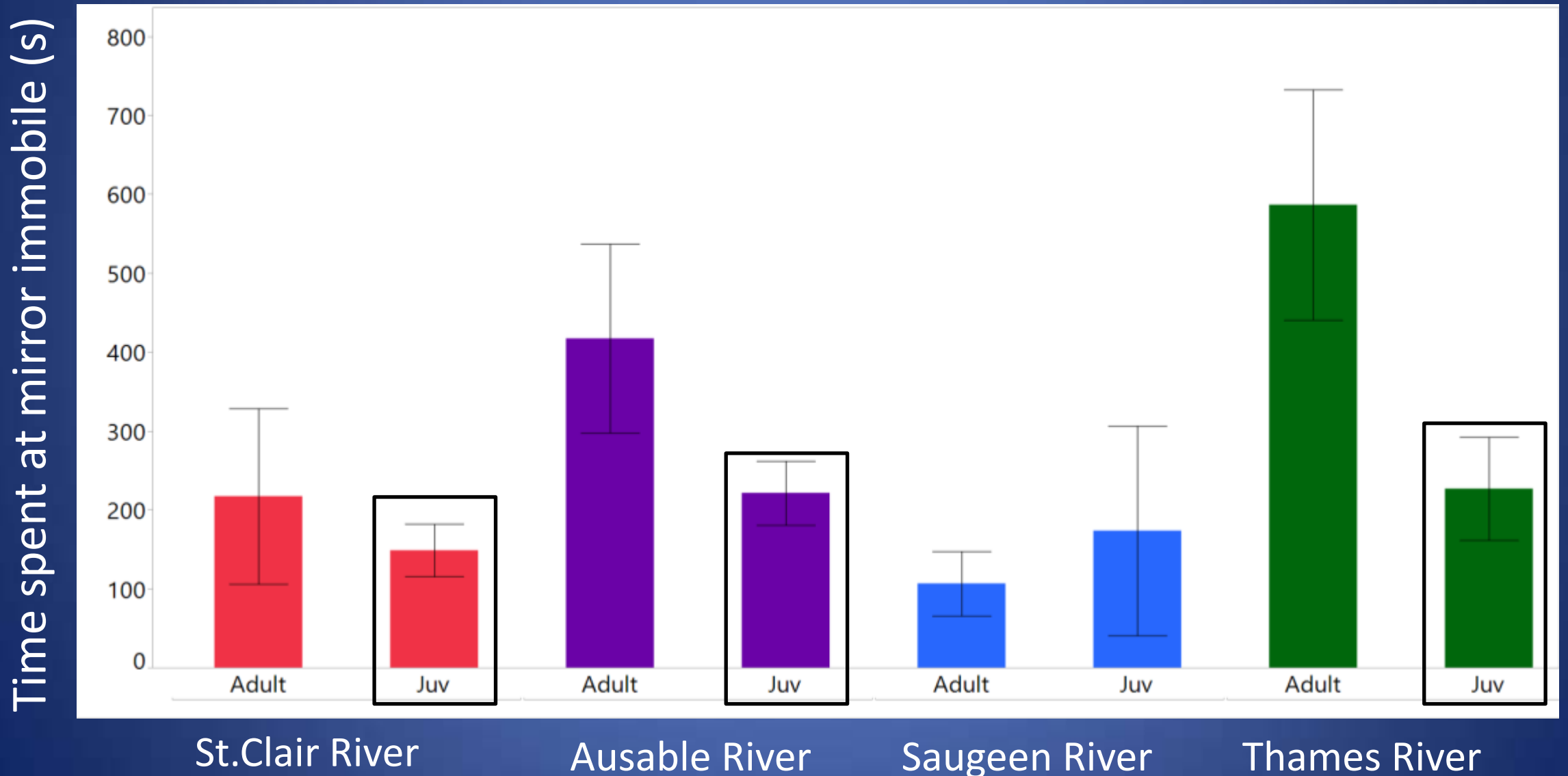
- Non-parametric test
  - Kruskal-wallis test
    - Multiple comparisons corrected by using Bonferroni sequential method

# Preliminary Results: Round goby from Thames spent more time at the mirror immobile

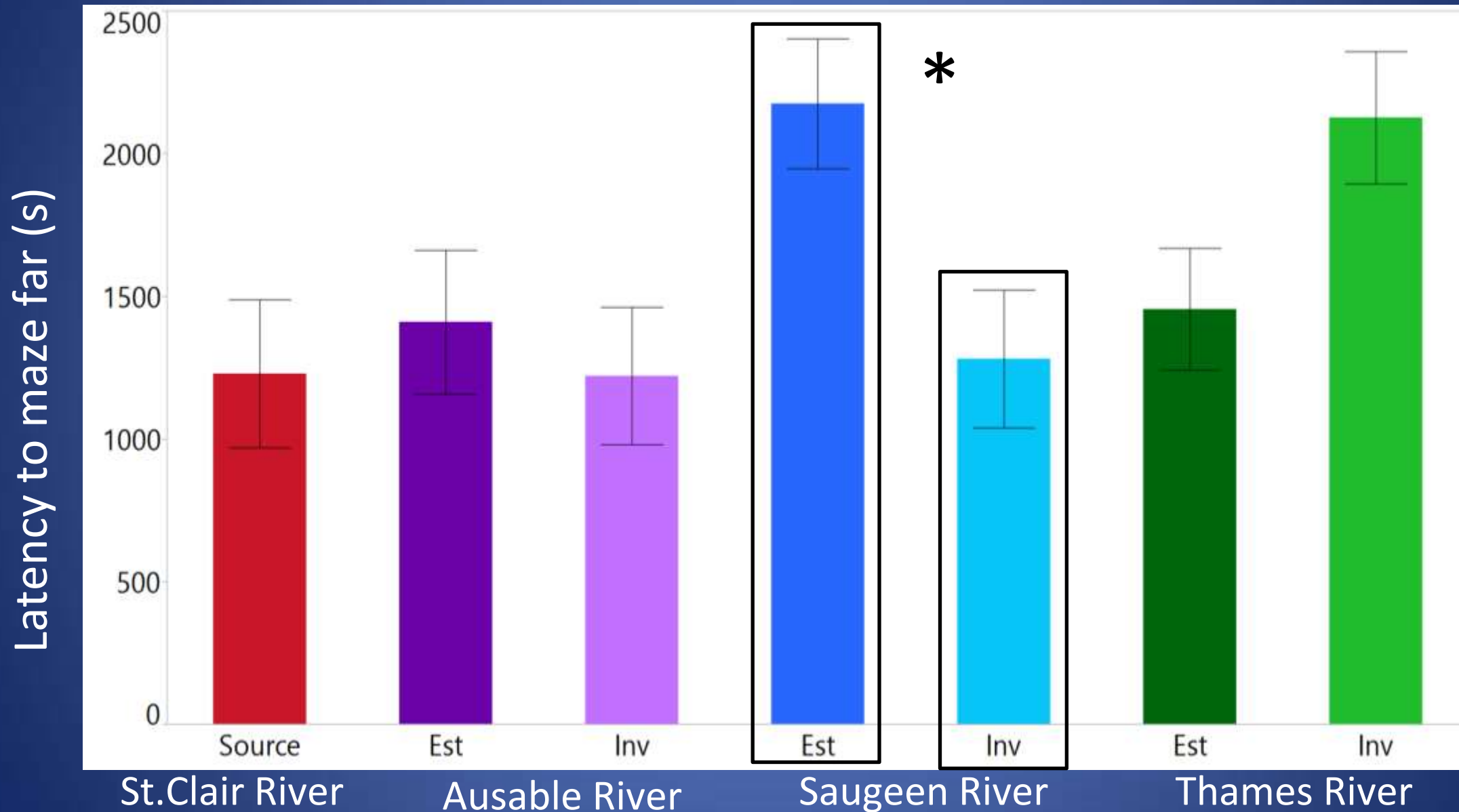




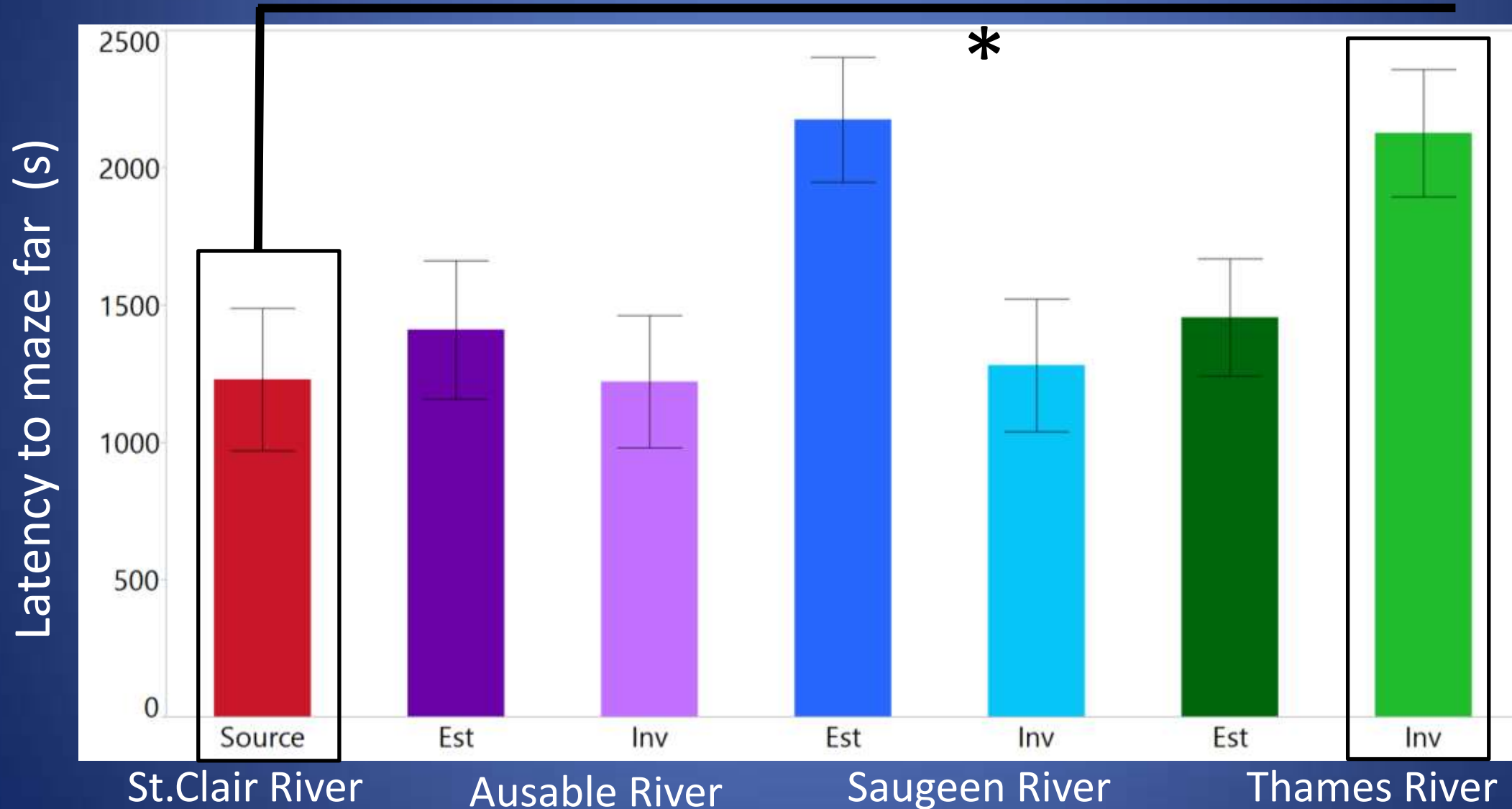
# Juveniles overall are less sociable



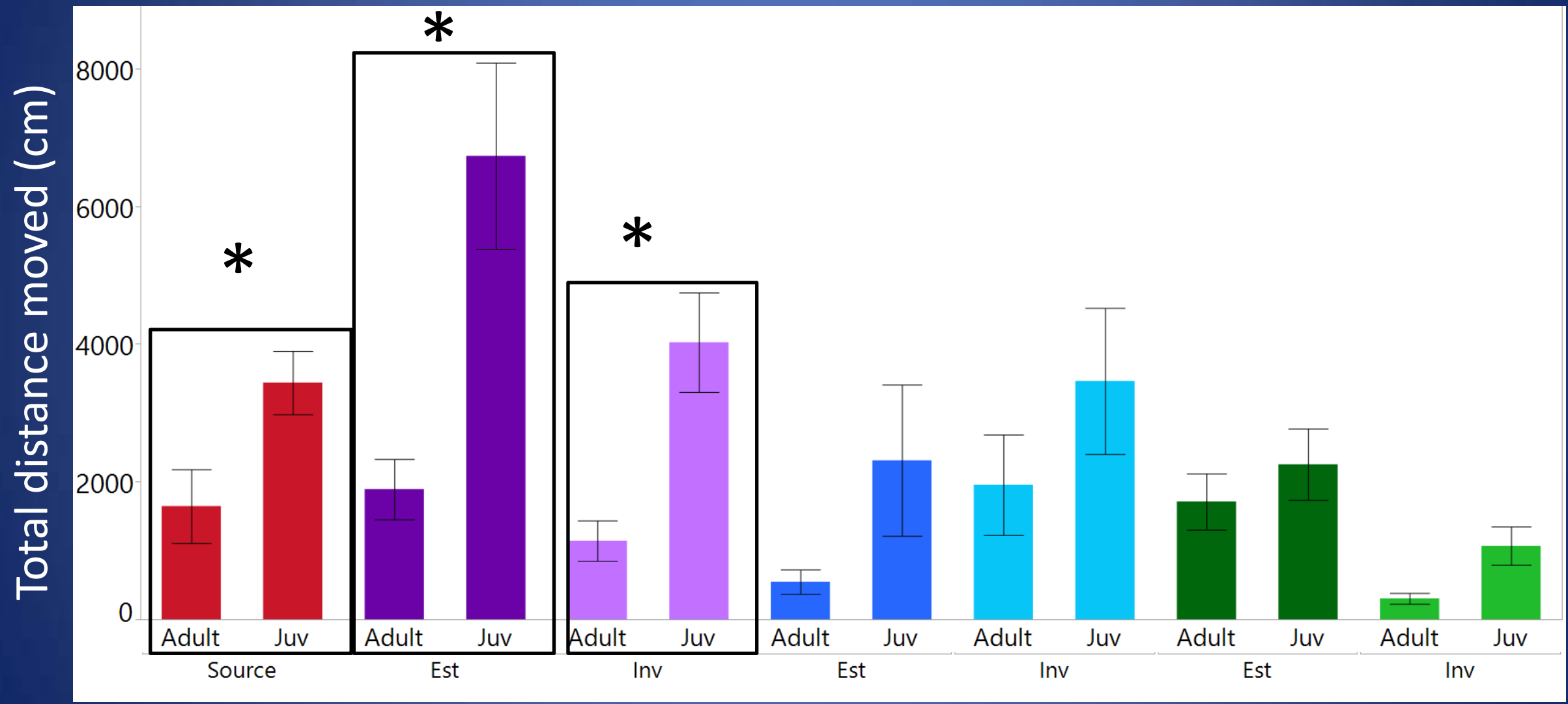
# Invasion stage gobies get to maze far quicker



# Invasion stage gobies at the Thames are slower to get to the furthest zone



# Juvenile round goby are more mobile at all populations



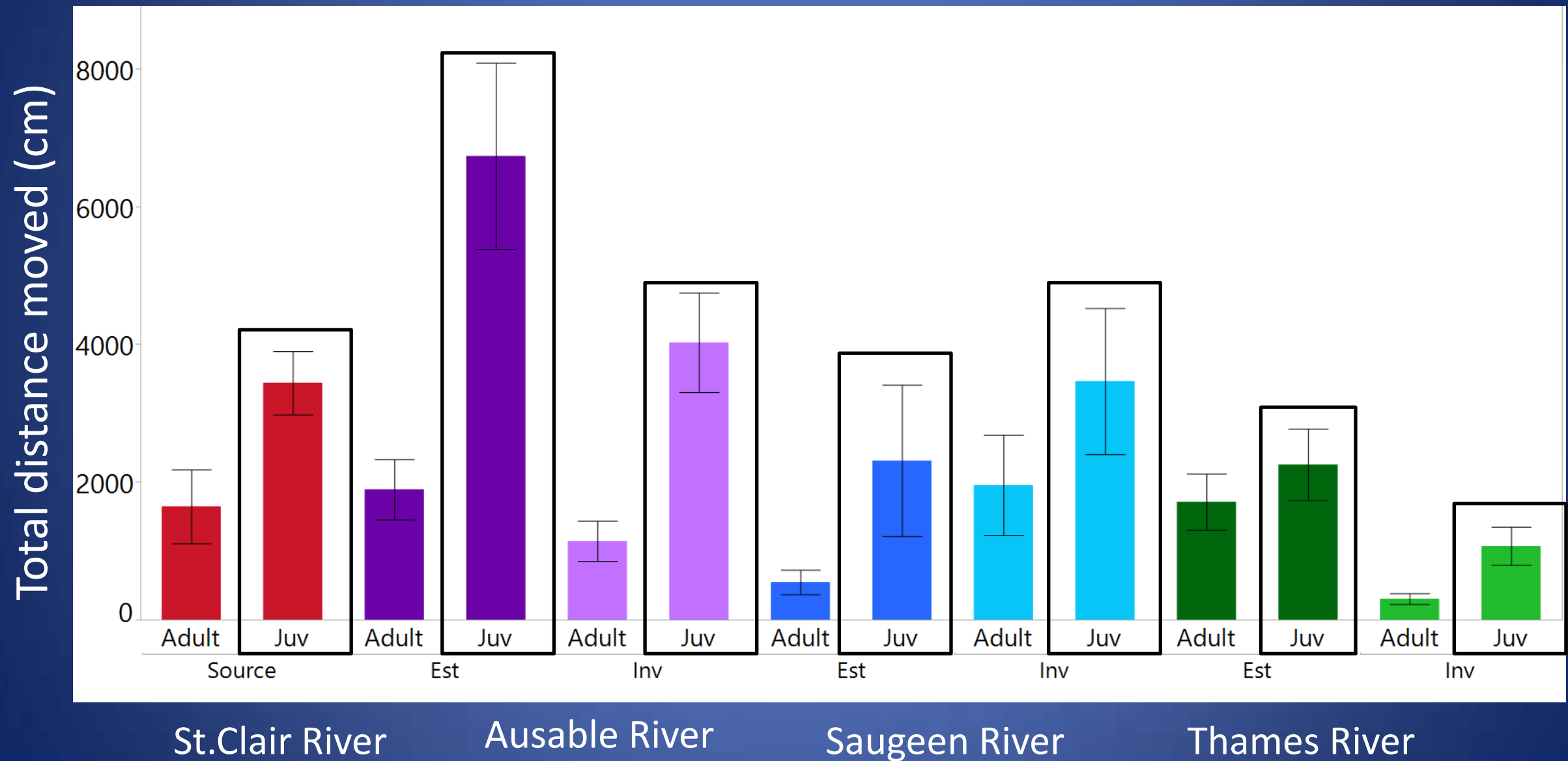
St. Clair River

Ausable River

Saugeen River

Thames River

# Juvenile round goby are more mobile at all populations



# Results Summary and Discussion

- Thames river invasion stage (newest invasion) is the least explorative → took the longest time to reach maze far
- St. Clair river (Source) was quicker to reach maze far → more explorative
  - Local adaptation
  - St. Clair river is a major shipping channel
- Juveniles are more mobile and spend less time at mirror compared to the adults
  - Swim bladder- less of a morphological constraint
  - Invasion syndrome?

# Significance and Future Directions

- Examination of invasive behavioural traits
  - Screening profile
  - Look at gene expression of genes associated with certain behaviours
- Assessment of invasive species impact
- Management practices
  - Ex. Lionfish culling



# Acknowledgements

- **Supervisors:** Dr. Christina Semeniuk & Dr. Daniel Heath
- **Committee members:** Dr. Dennis Higgs & Dr. Barbara Zielinski
- Todd Leadley
- Dr. Oliver Love
- Brendan Graham
- **Semeniuk members:** Kevyn Janisse, Mitch Dender, Jessica Mayrand, Meagan McCloskey, Pauline Capelle, Natalie Sopinka
- **Heath members:** Felicia Vincelli, Kyle Wellband, Calvin and Clare Venney
- **Sources of funding:**

