TEMPORAL STABILITY OF OTOLITH CHEMISTRY IN THE EMBRYONIC REGION OF RECENTLY HATCHED LARVAL CAPELIN (MALLOTUS VILLOSUS) IN NEWFOUNDLAND, CANADA

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Small Pelagic Fish Conference

La Paz, Mexico

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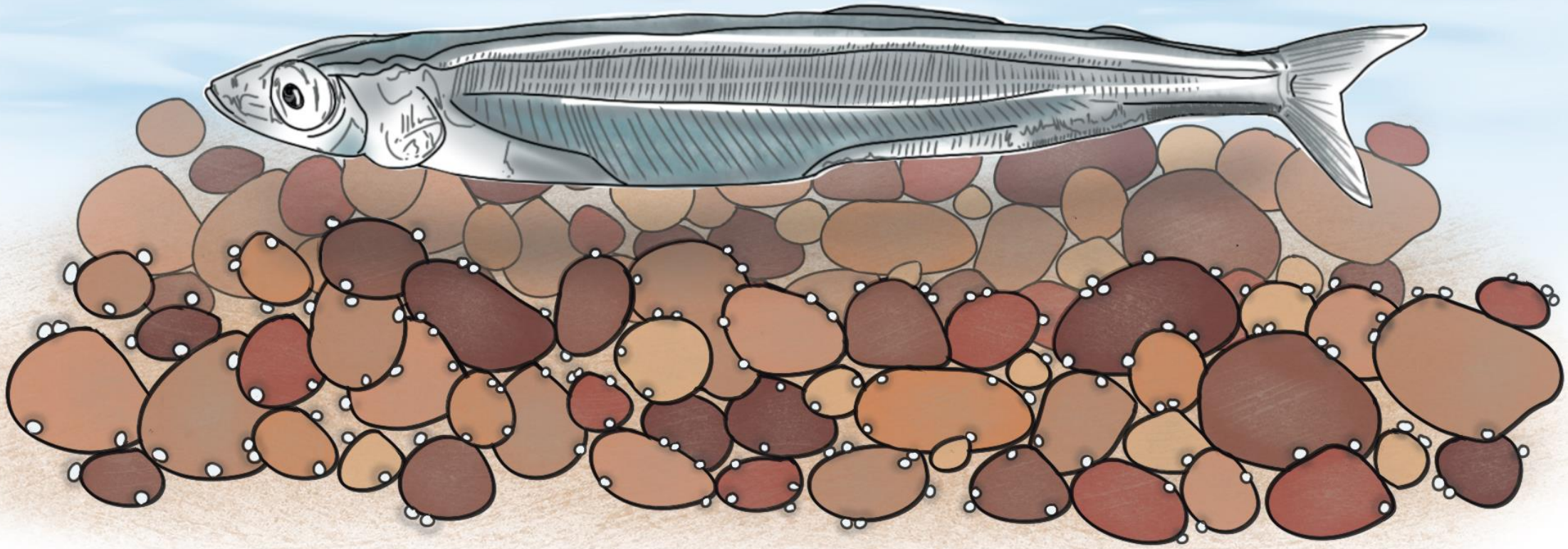
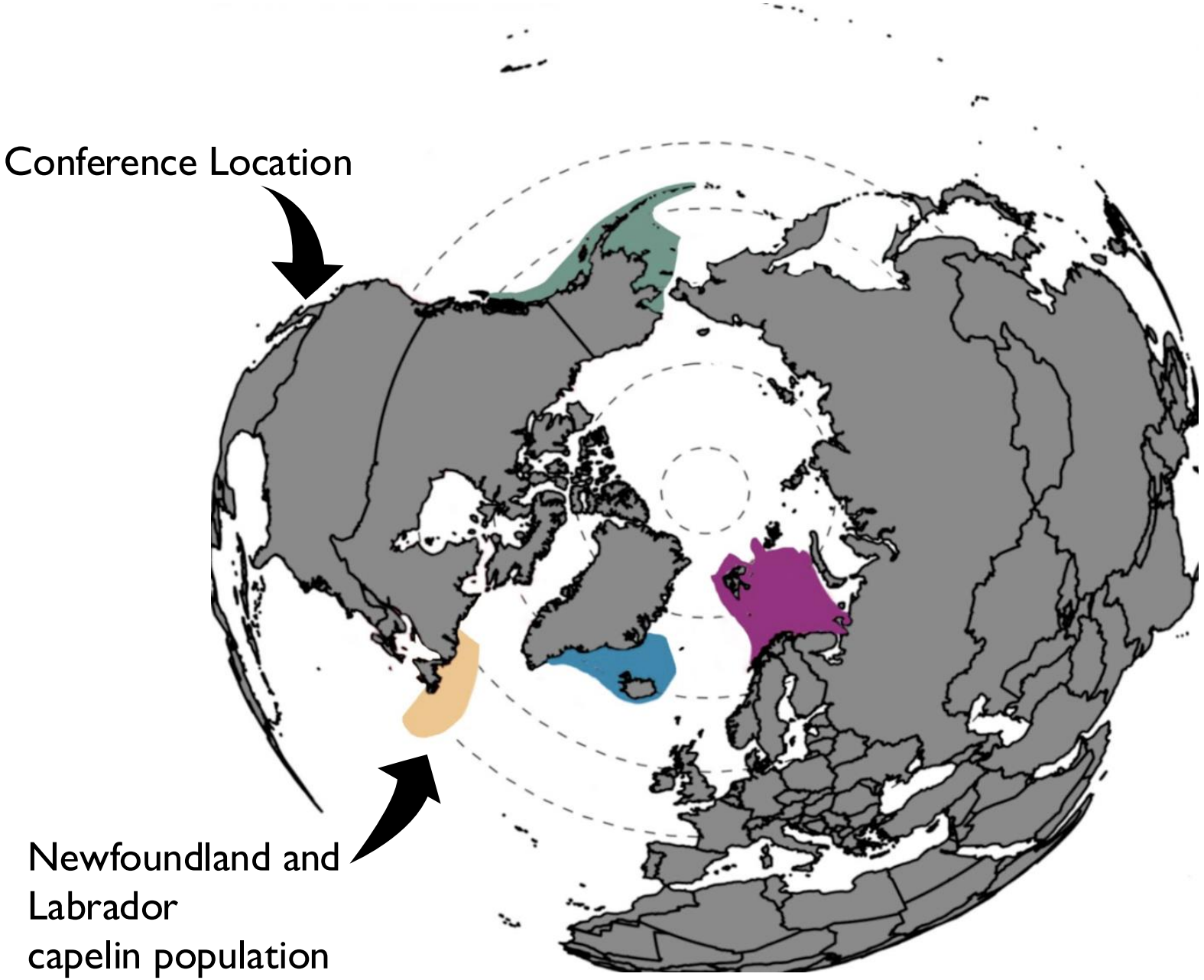


Capelin (*Mallotus villosus*)

- Forage fish
- Circumpolar distribution
- Middle trophic position
- Ecologically, economically, + culturally important

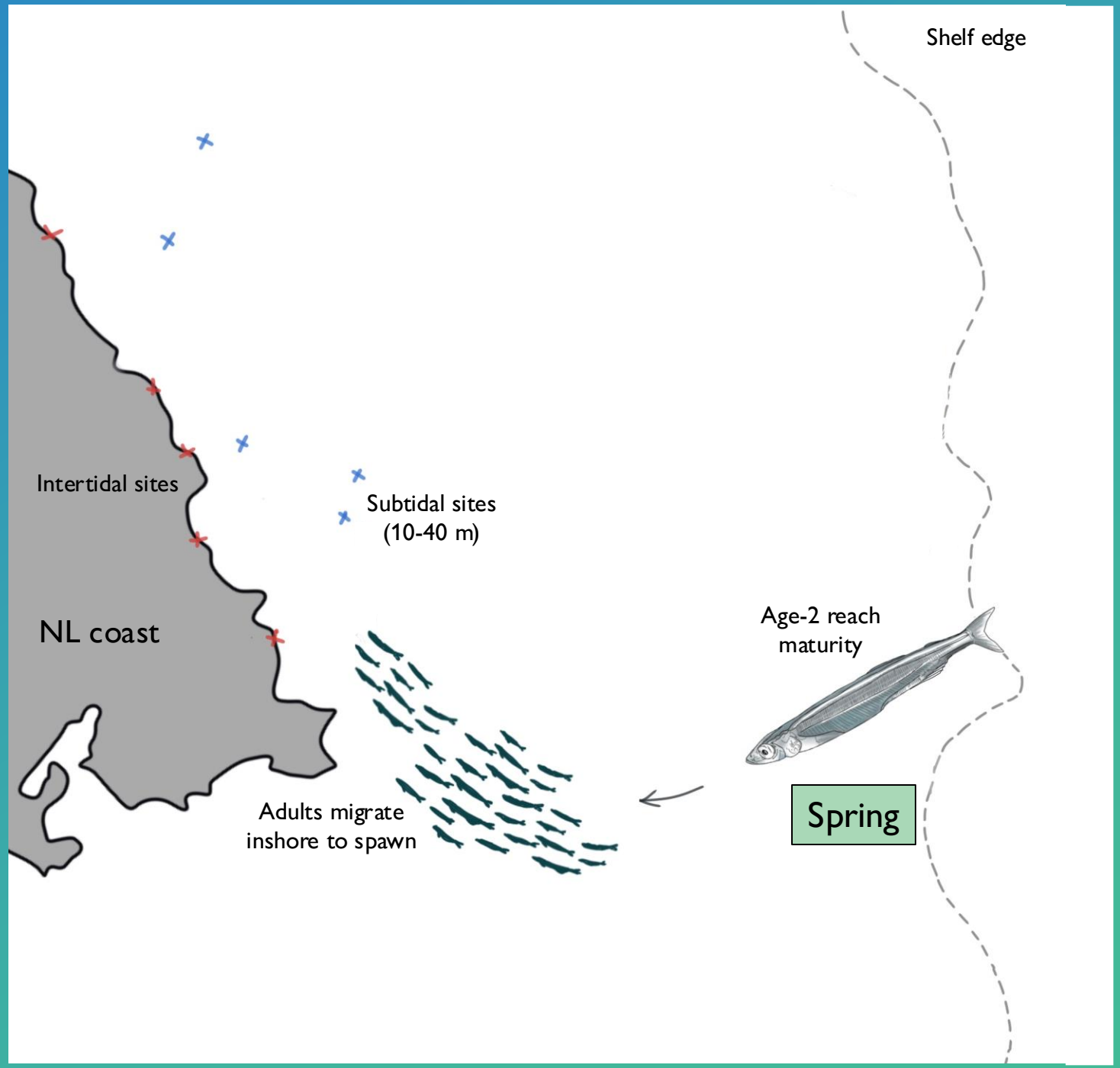


Map from Singh et al., 2025

Capelin Life History in Newfoundland

Spring

- Mature adults migrate from the shelf edge inshore



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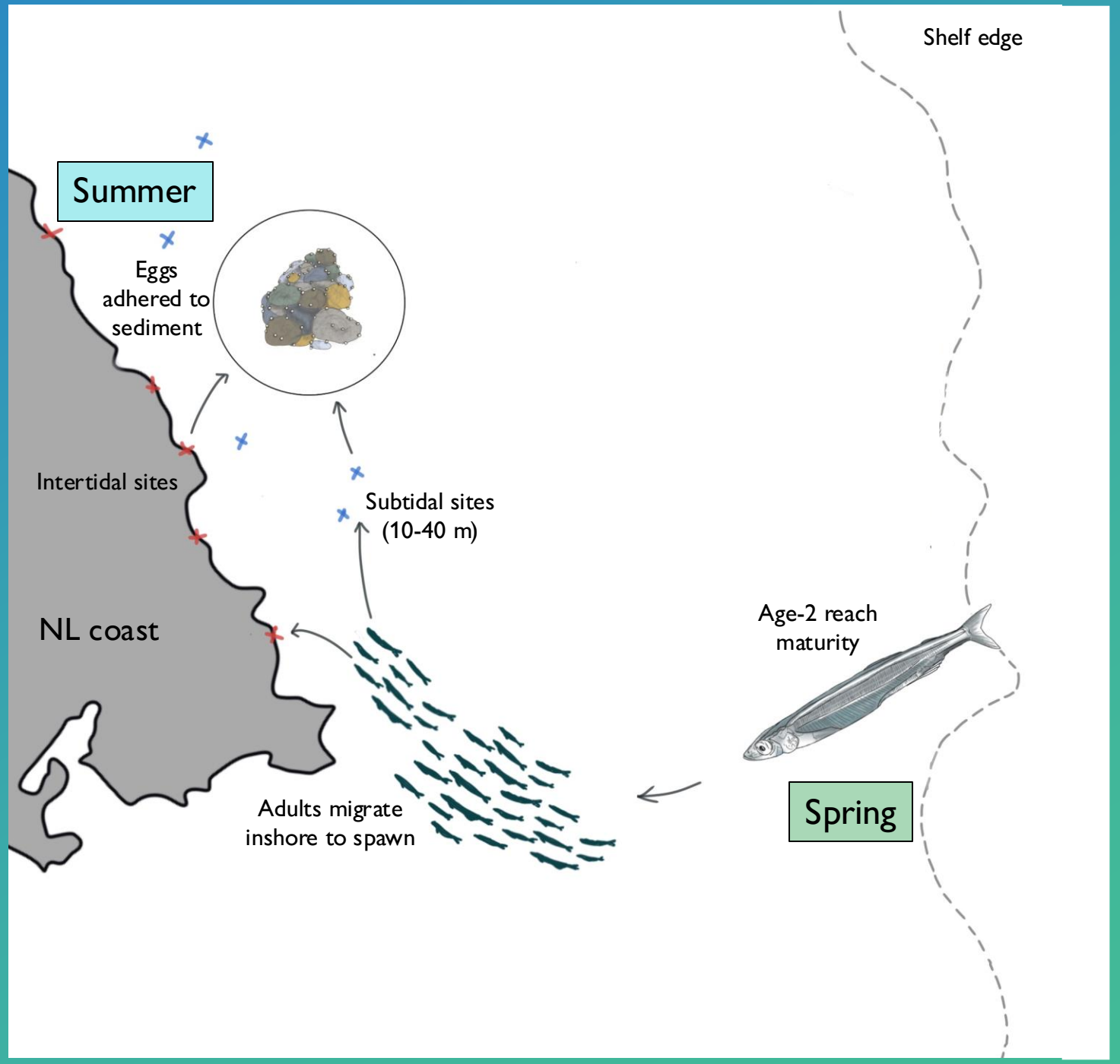
Summer

- Arrive and spawn at subtidal and intertidal sites along the coast



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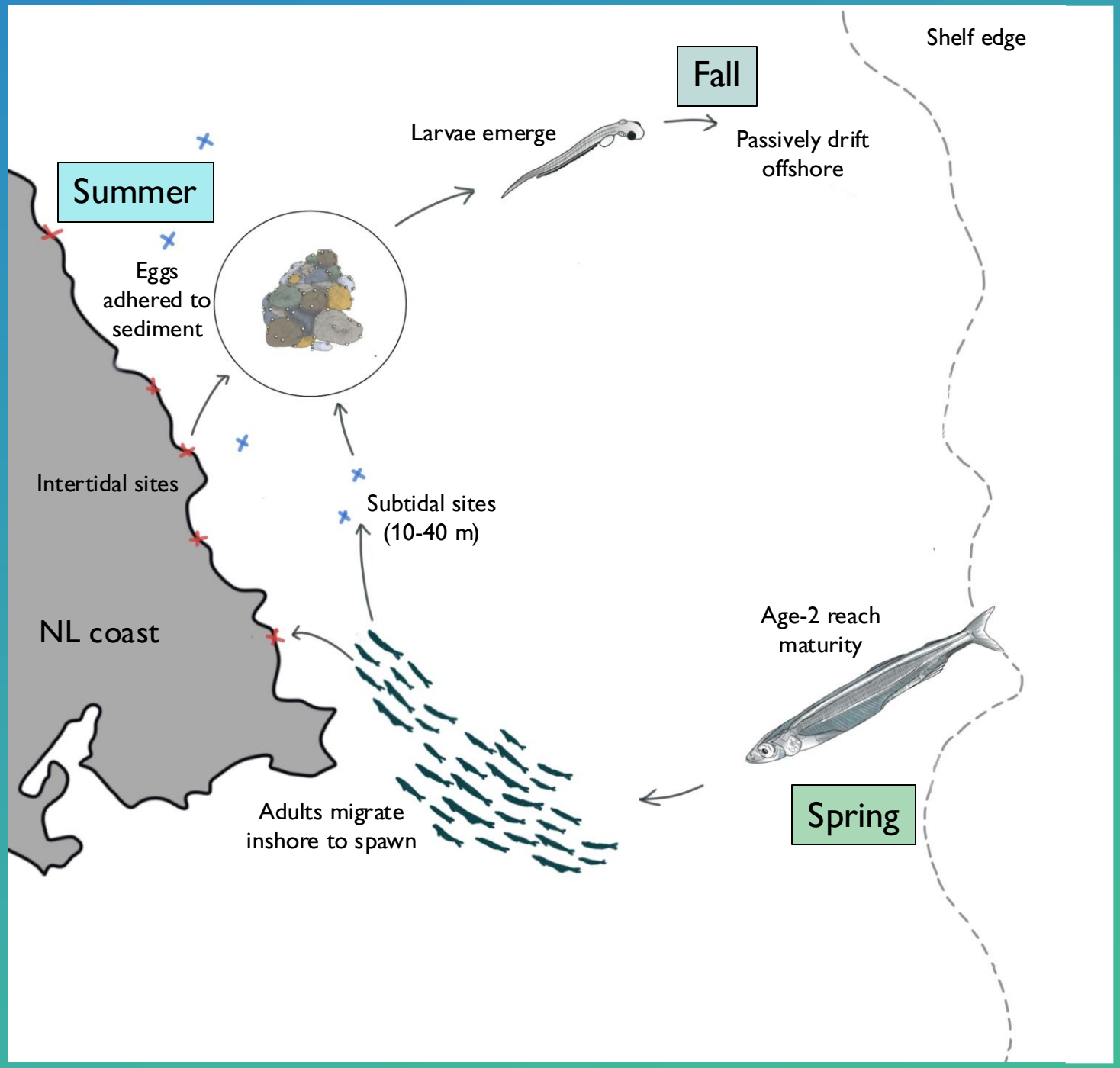

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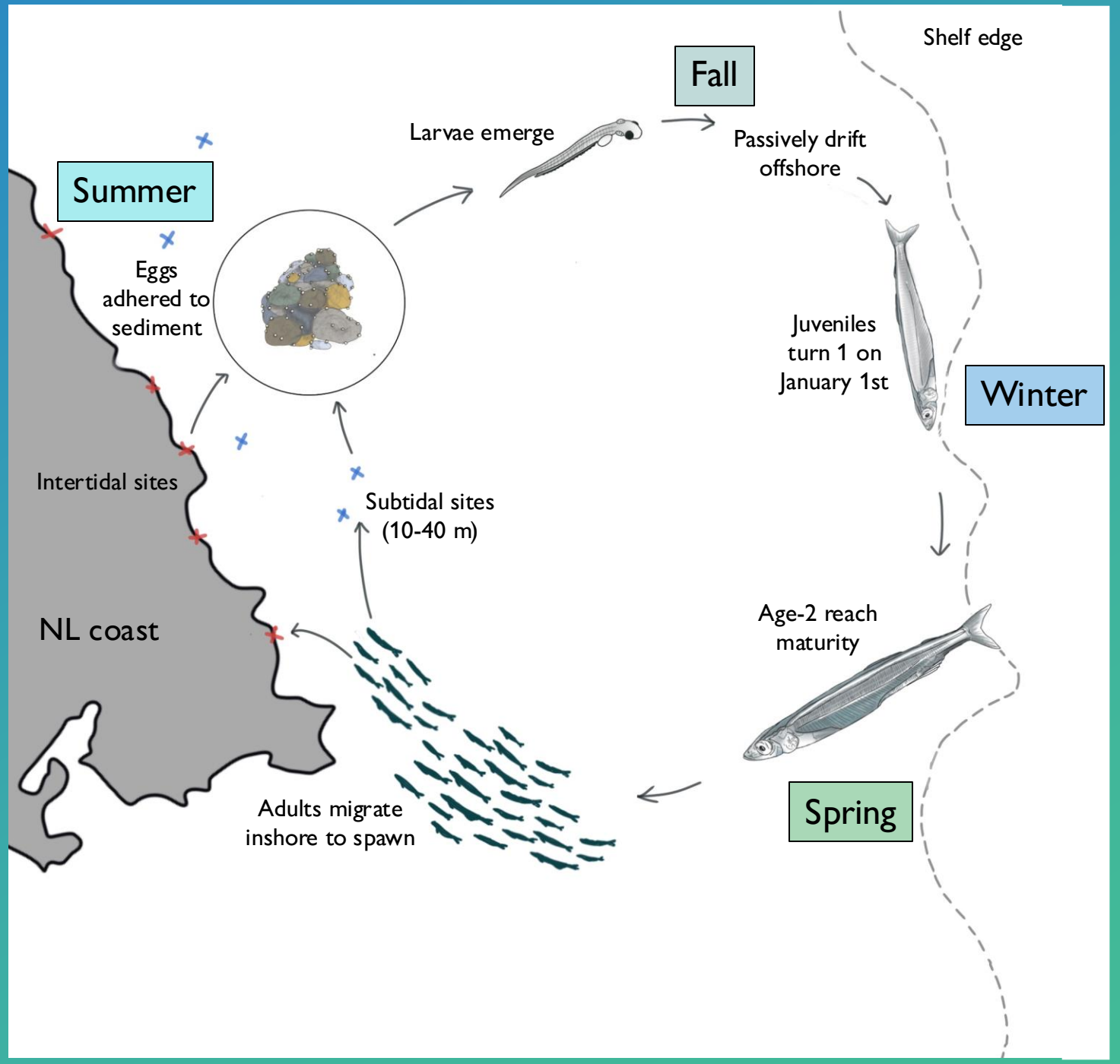
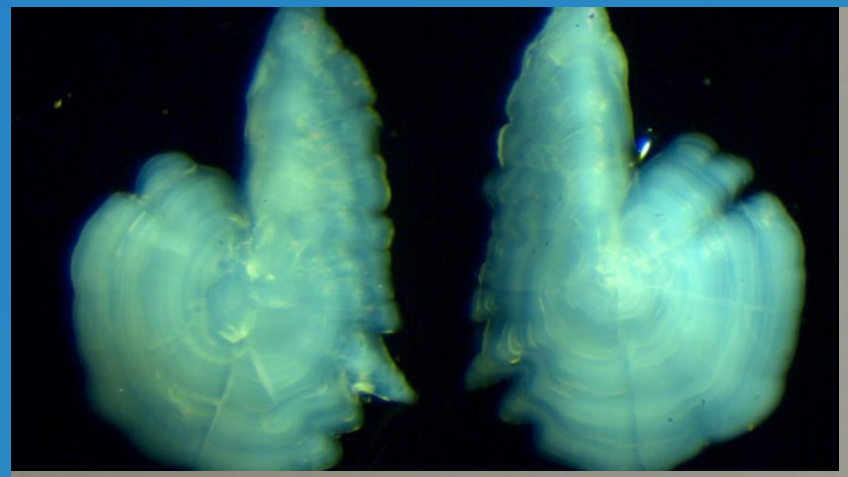
Winter

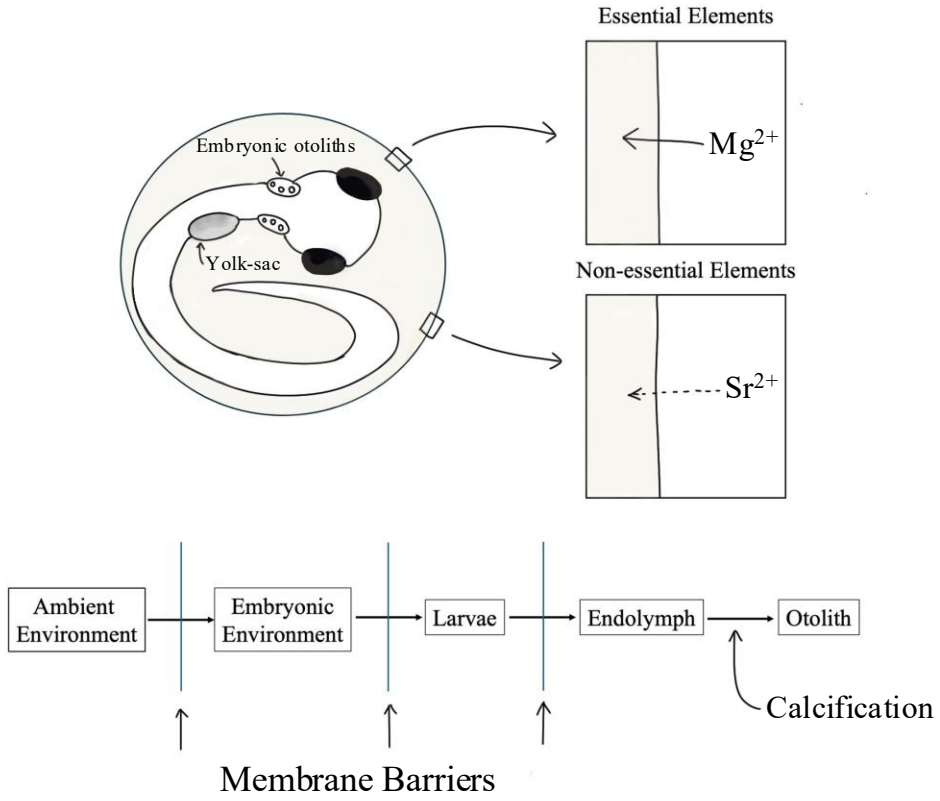
- Juveniles mature in nursery habitat at the shelf edge





Larval capelin otoliths

Adult capelin otoliths

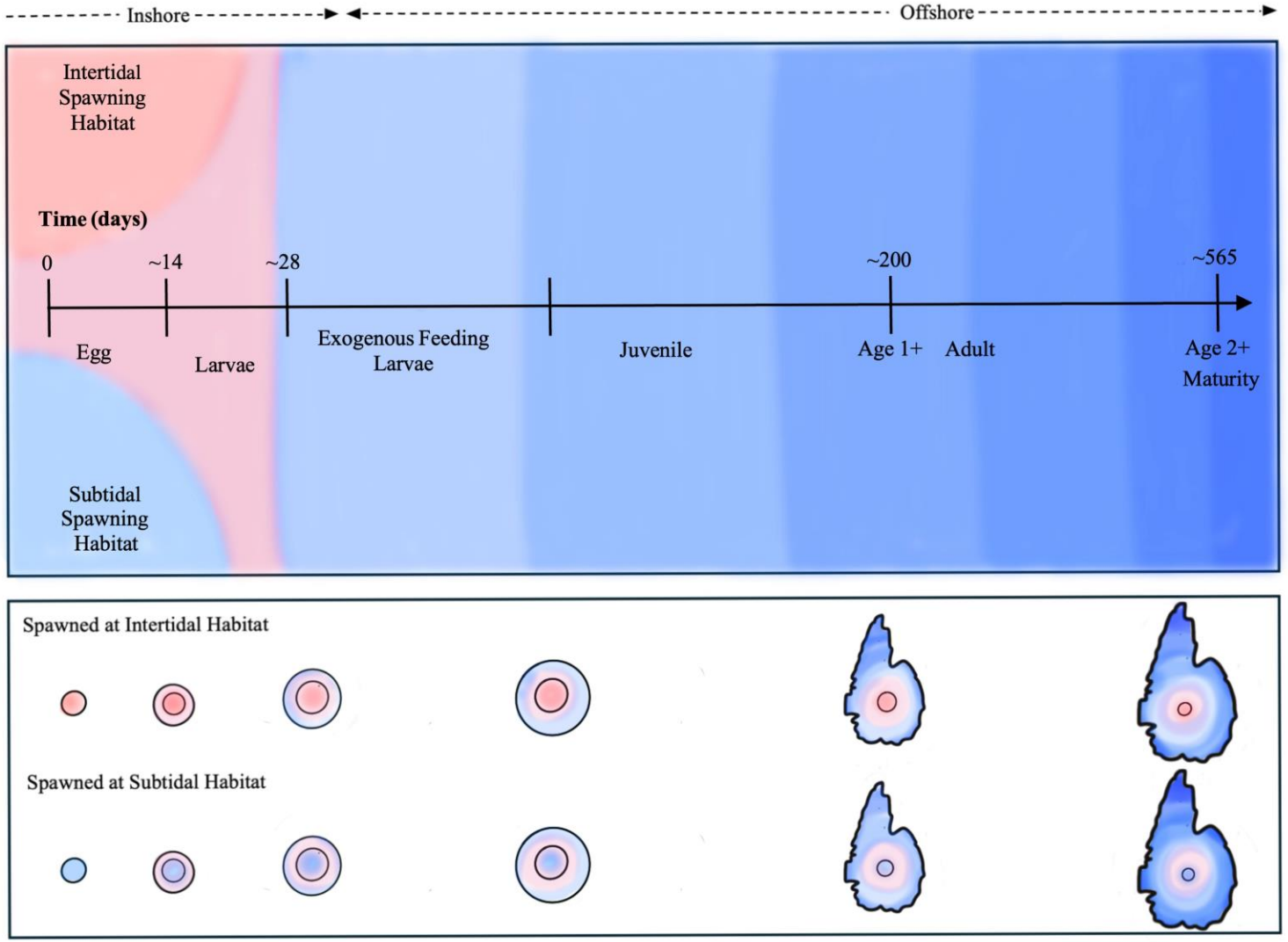


Reviewed in Tripp and Davoren 2025
Reviews in Fish Biology and Fisheries
Special Issue: Capelin in a changing environment

- The developing embryo is not a closed environment
  - Elements outside the membrane are transported in and can ultimately end up on the pre-hatch region of the larval otolith
  - Creating an environmental signature formed during incubation at the spawning site
    (Loeppky et al., 2018)

Temperature is a driver of differences in these early formed signatures

- Has allowed for differentiation of capelin larvae from intertidal and subtidal spawning habitat (Loeppky and Davoren, 2018)



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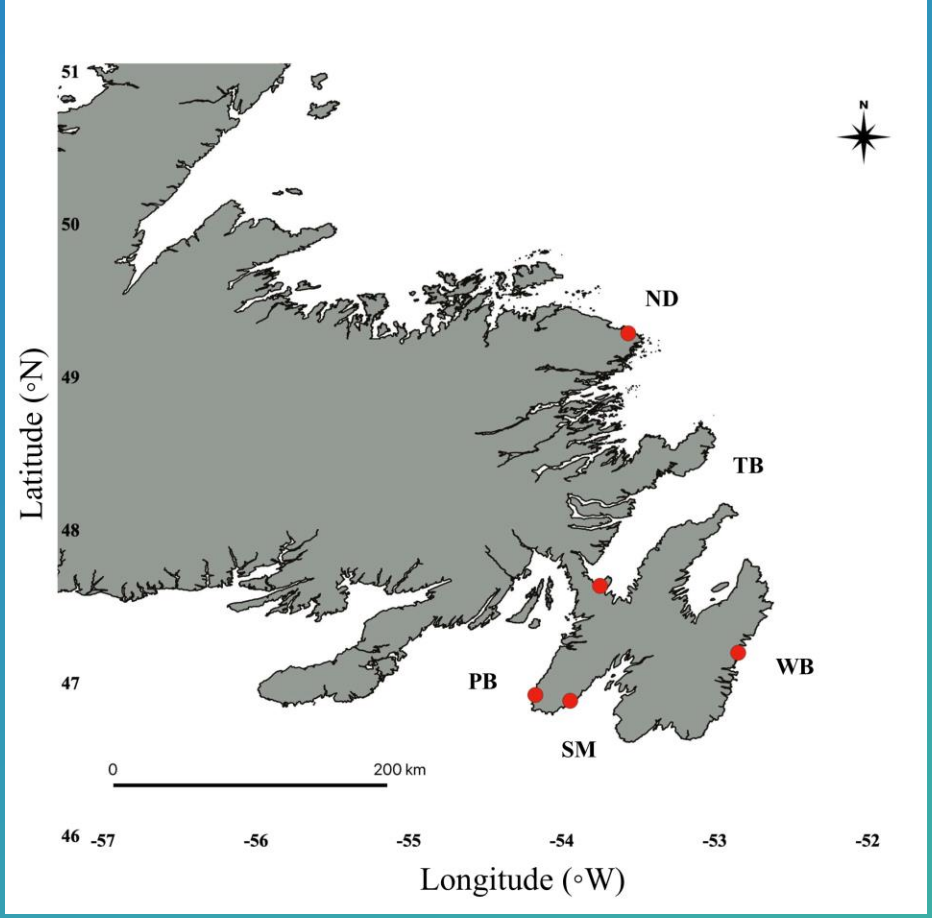
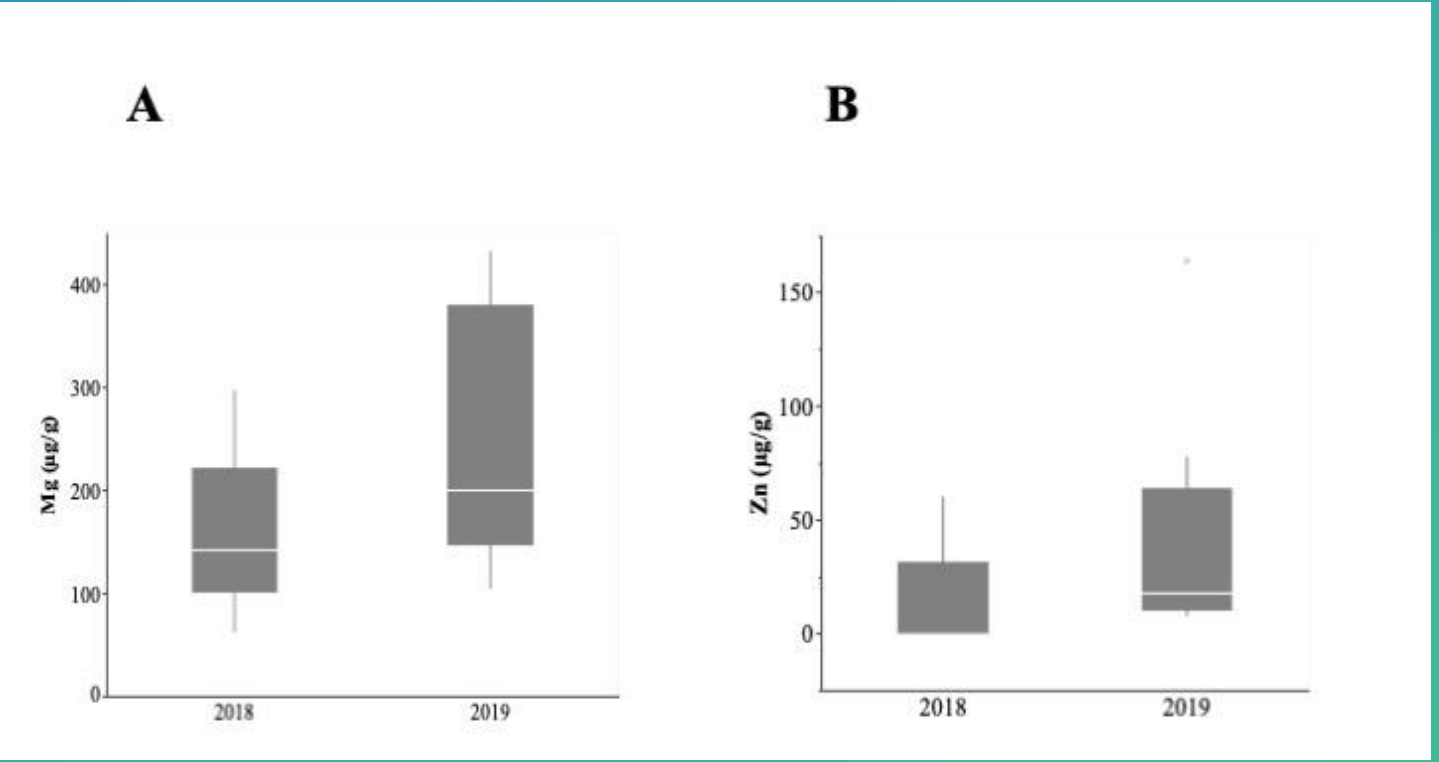
Otolith chemical signatures in larval capelin differ across

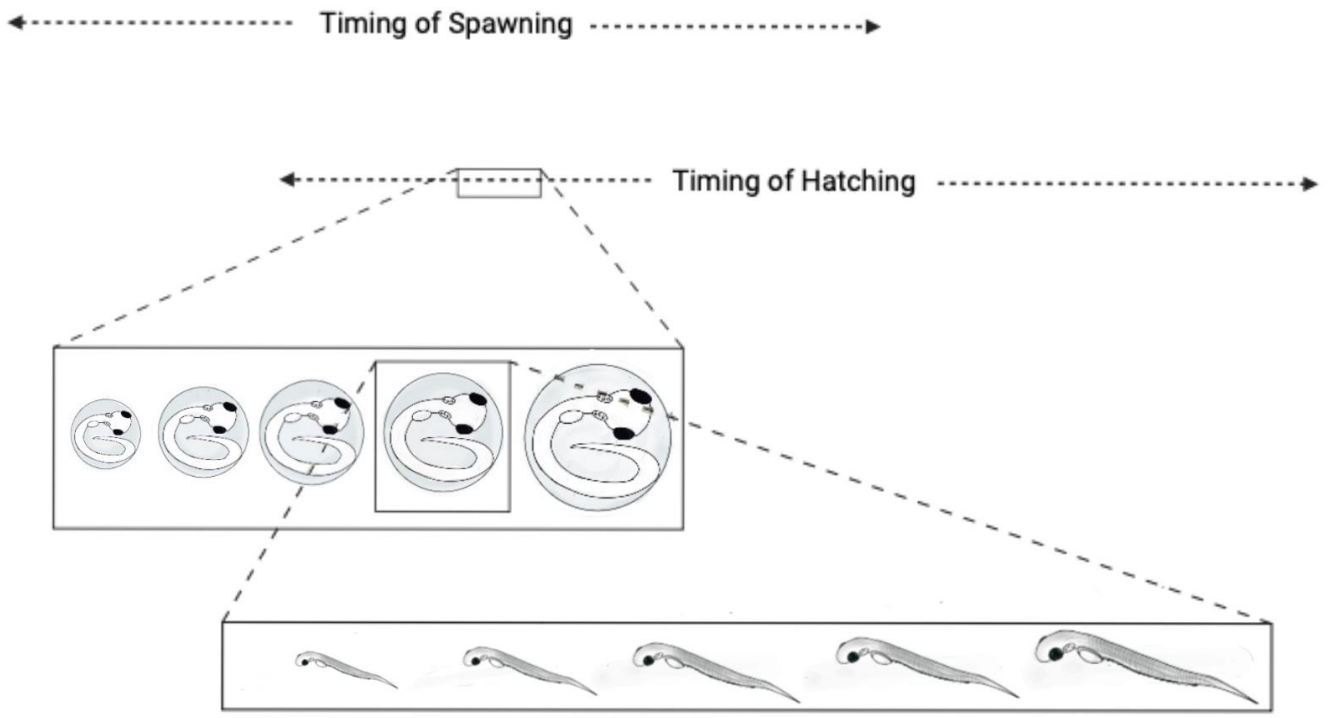
- Space
- Time*

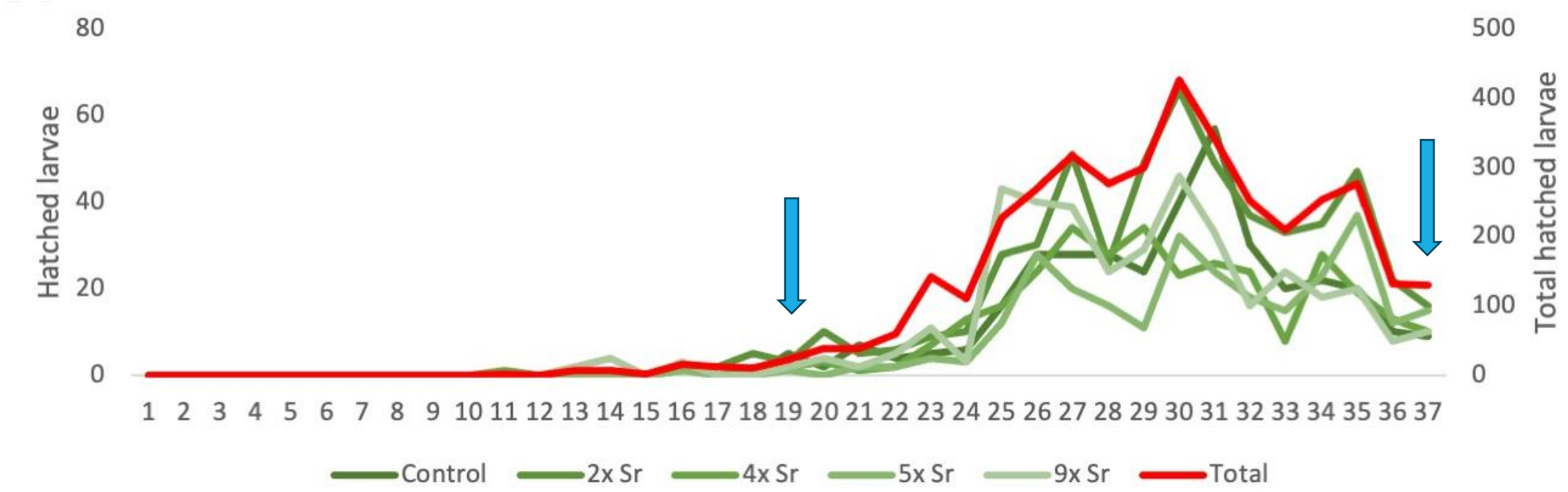




Tripp et al., 2020

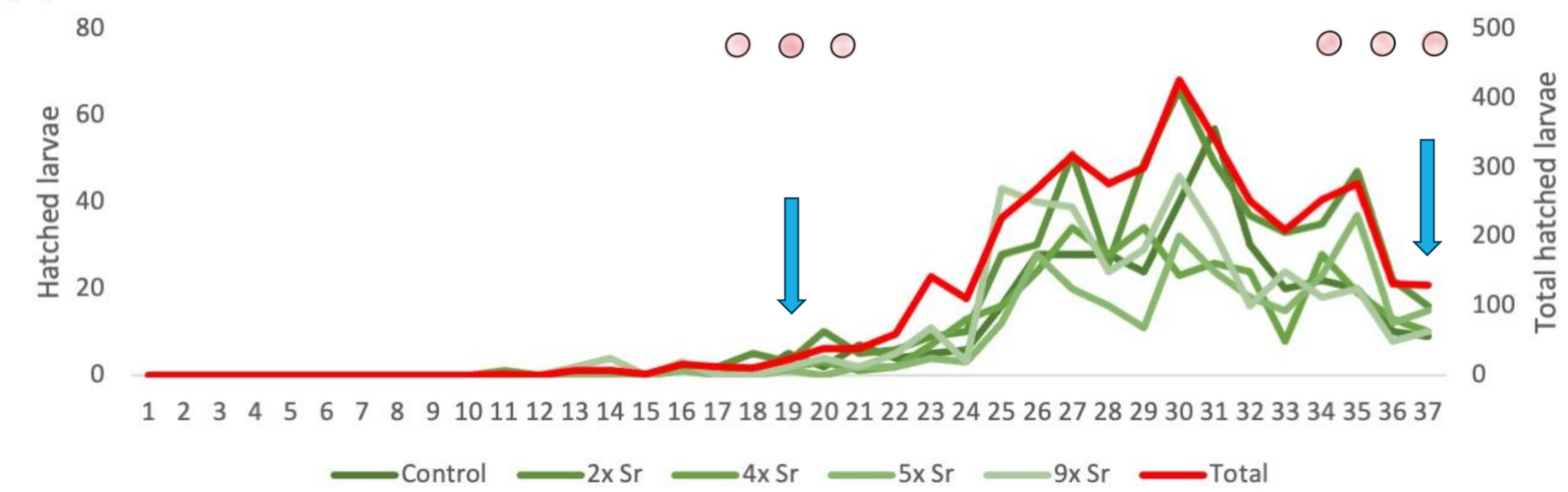
- Capelin demonstrate protracted spawning and hatching periods
  - Spawning duration in coastal Newfoundland lasts for a median of 11 days at intertidal spawning sites (Murphy, 2022)





Tripp et al., 2021

- Eggs collected from a single spawning event and raised under controlled conditions
- Protracted hatching lasting nearly 20 days



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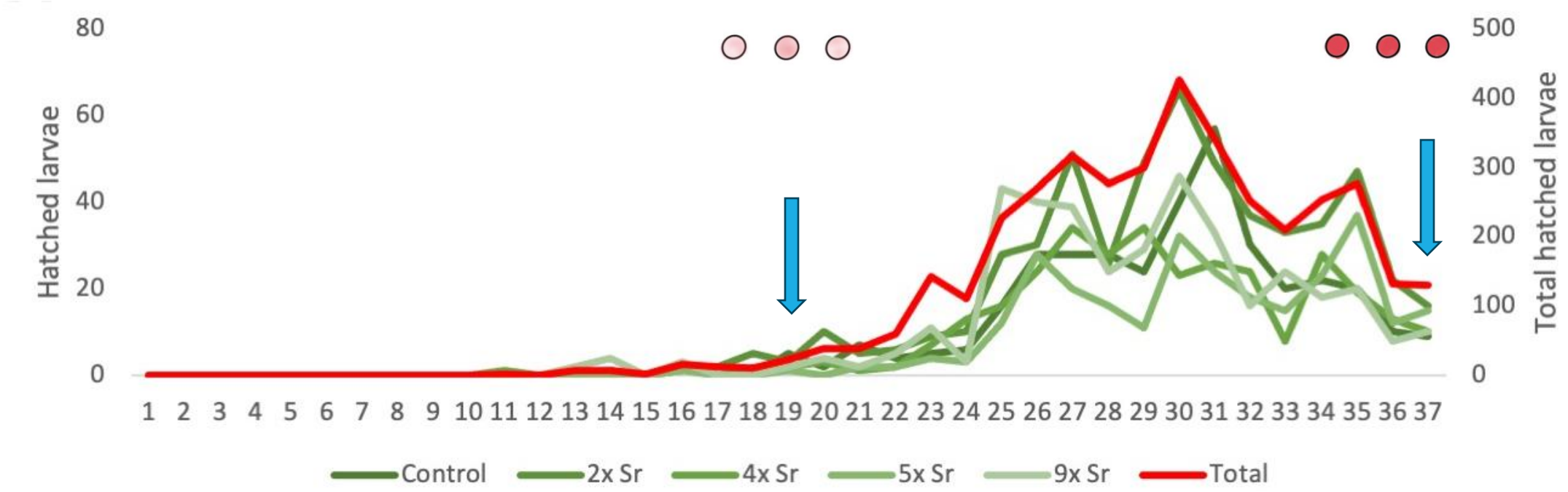

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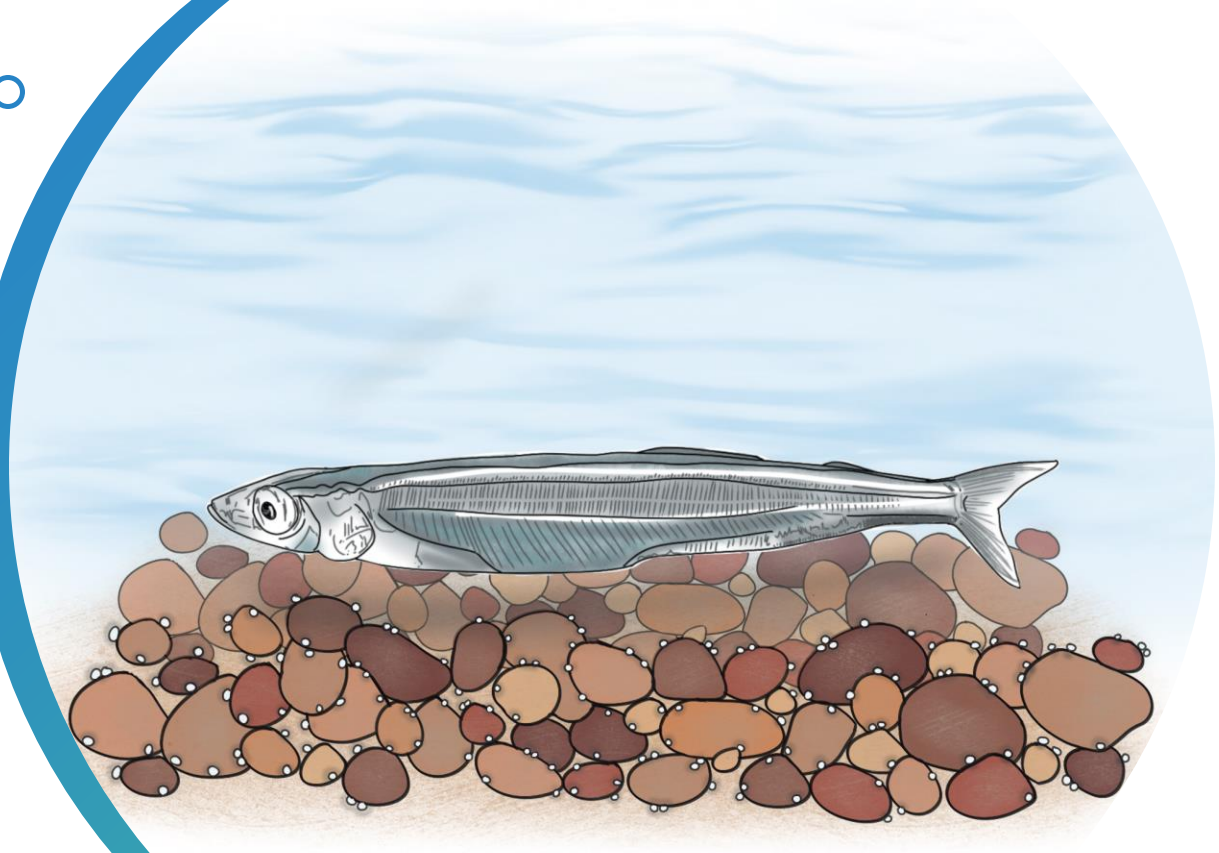

Objective

- Investigate temporal stability of larval otolith chemistry

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Early Intertidal

Late Intertidal

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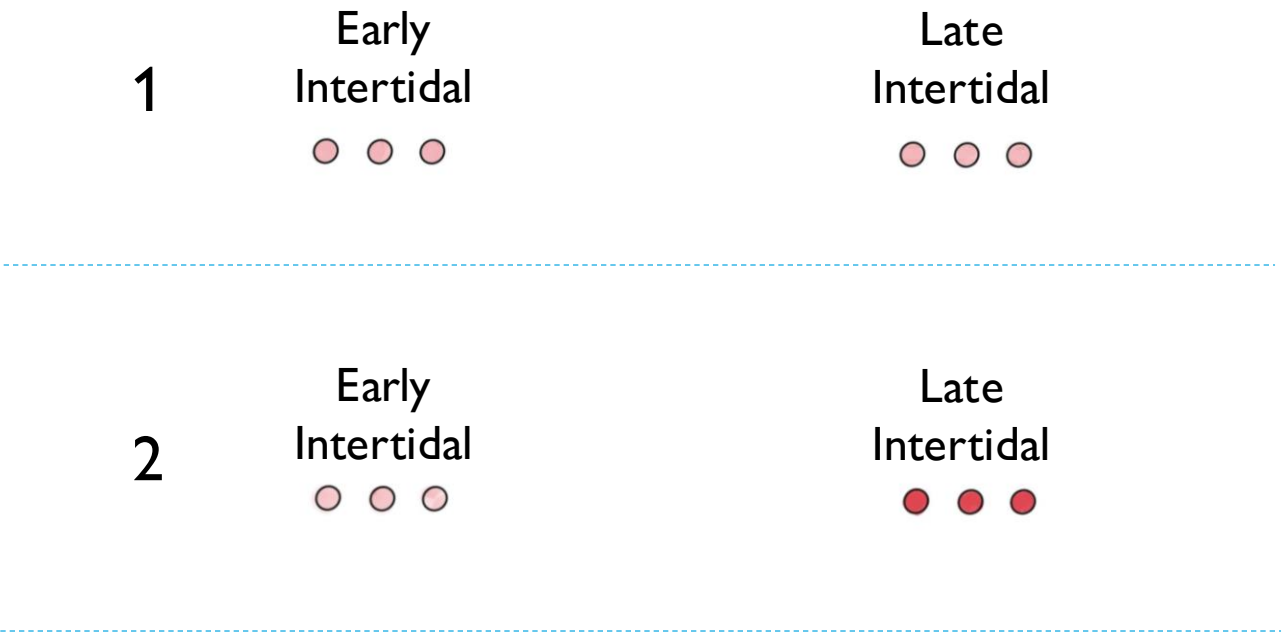
- Investigate temporal stability of larval otolith chemistry
- Trying to determine relative recruitment/contributions from the two habitats
- First need to make sure that the variability in otolith chemistry in the pre-hatch region from extended larval emergence is smaller than the variation between habitats



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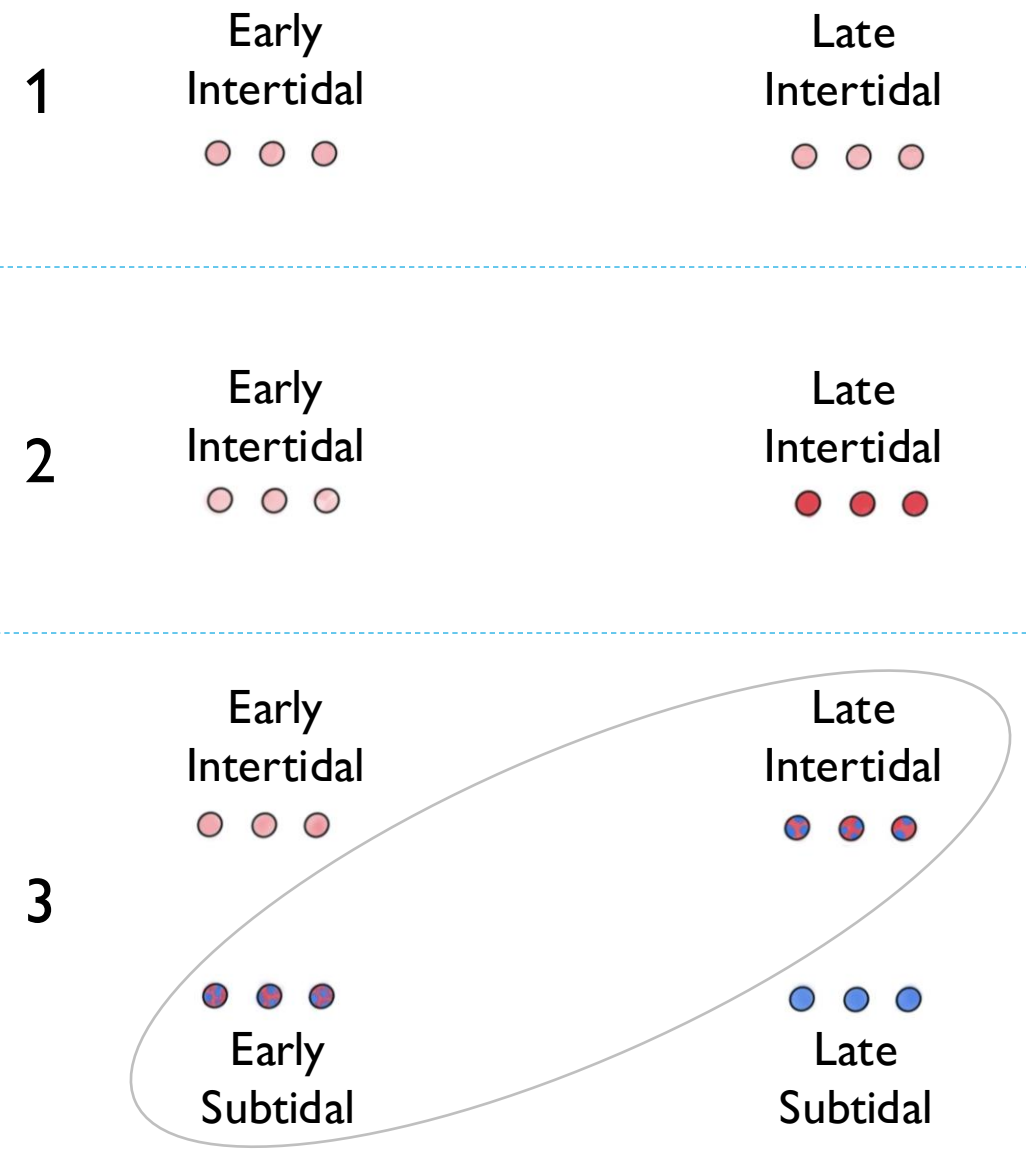

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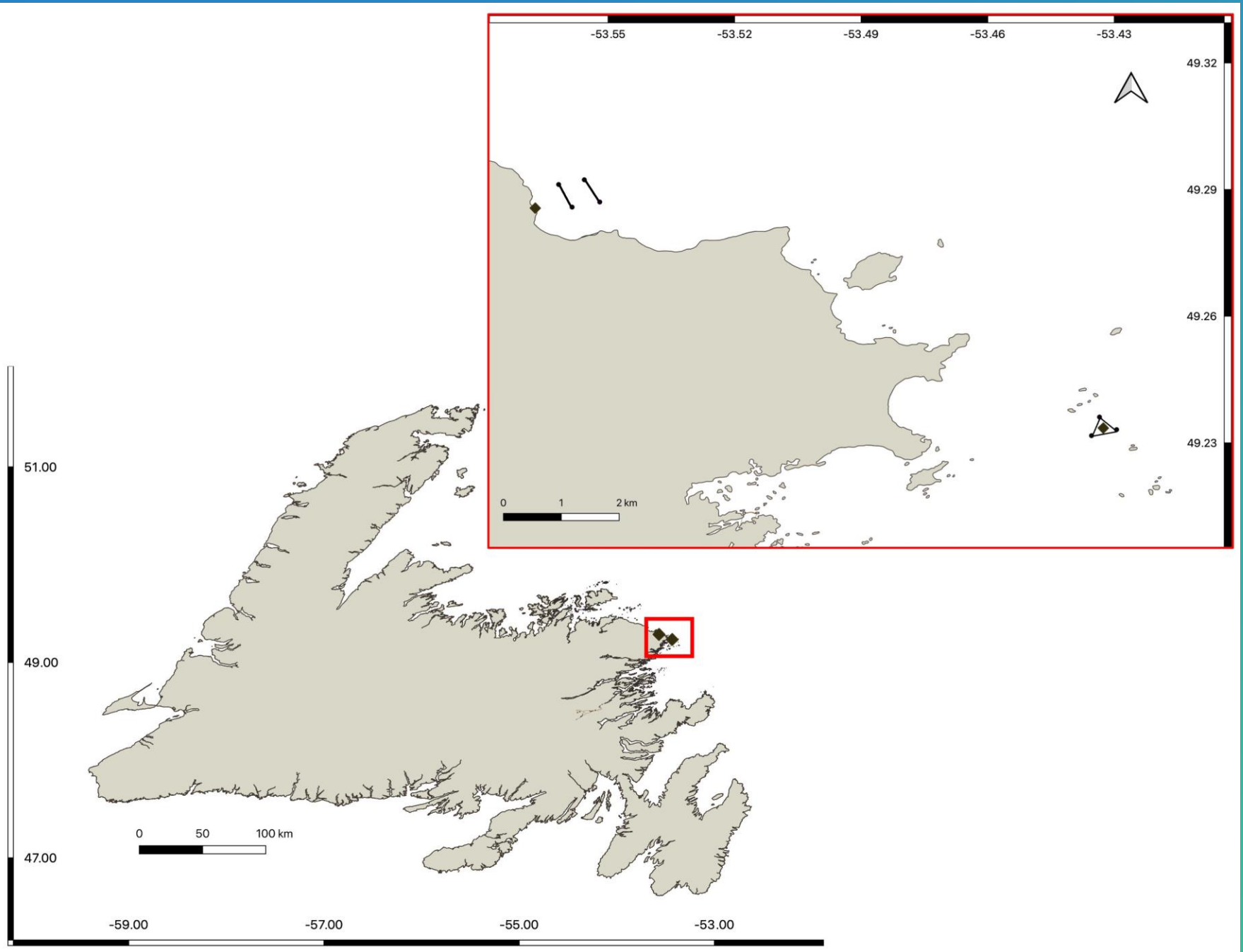


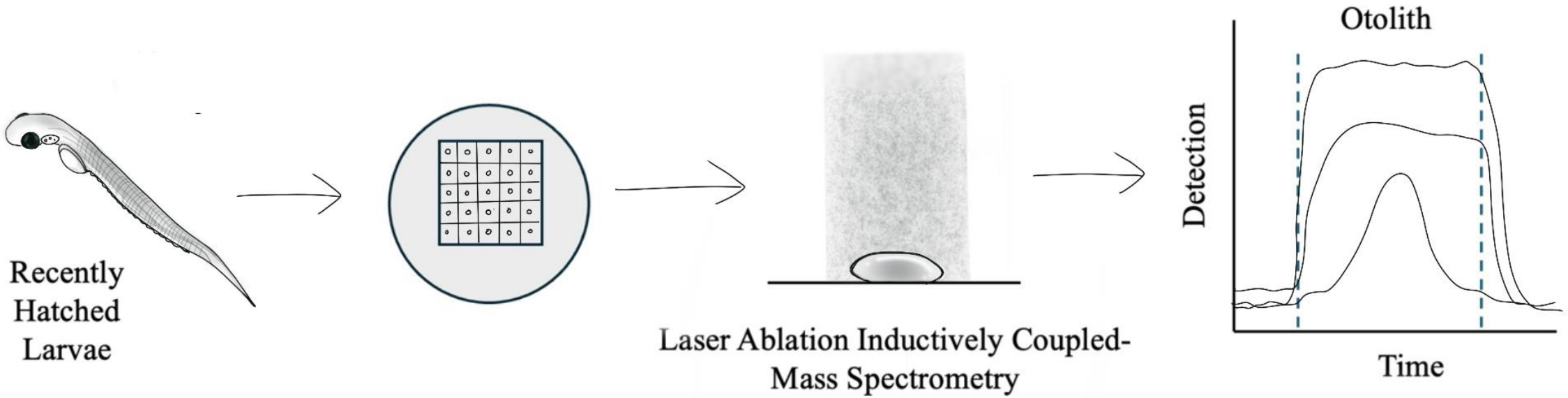
Study Site

- Northeastern coast of Newfoundland
- Capelin spawning sites in both habitats
- Survey lines designed following methods used by Department of Fisheries and Oceans (DFO) to cover all direction of larval emergence

Conduct larval tows every 48 hrs starting from estimated hatching

Sample larvae that emerged 'early' and 'late' from both habitats

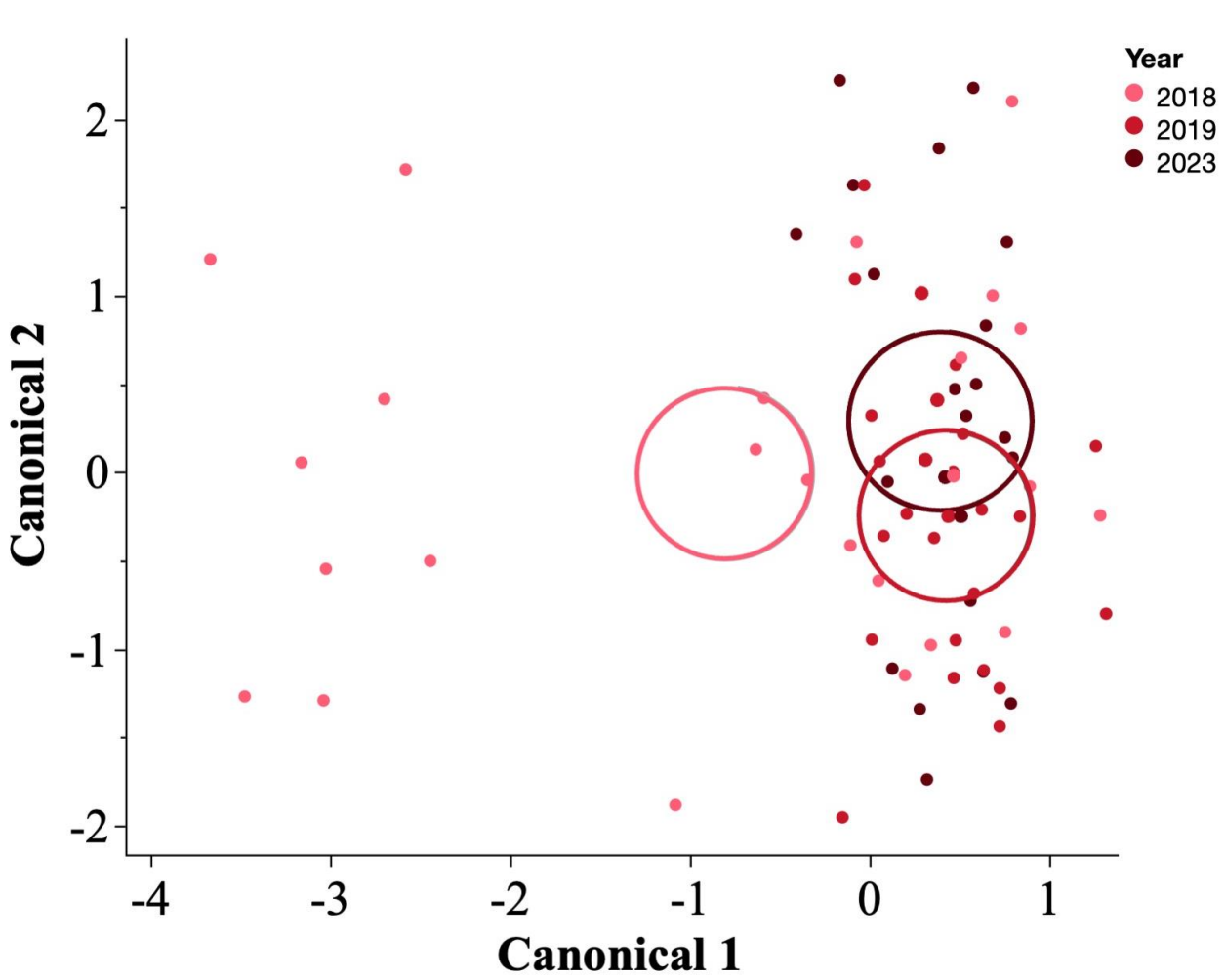
Habitat	Year
Intertidal	2018
Intertidal	**2019***
Intertidal	2023
Subtidal	**2019***
Subtidal	2021
Subtidal	2022



- Used a suite of elements including magnesium, manganese, strontium, and barium

A

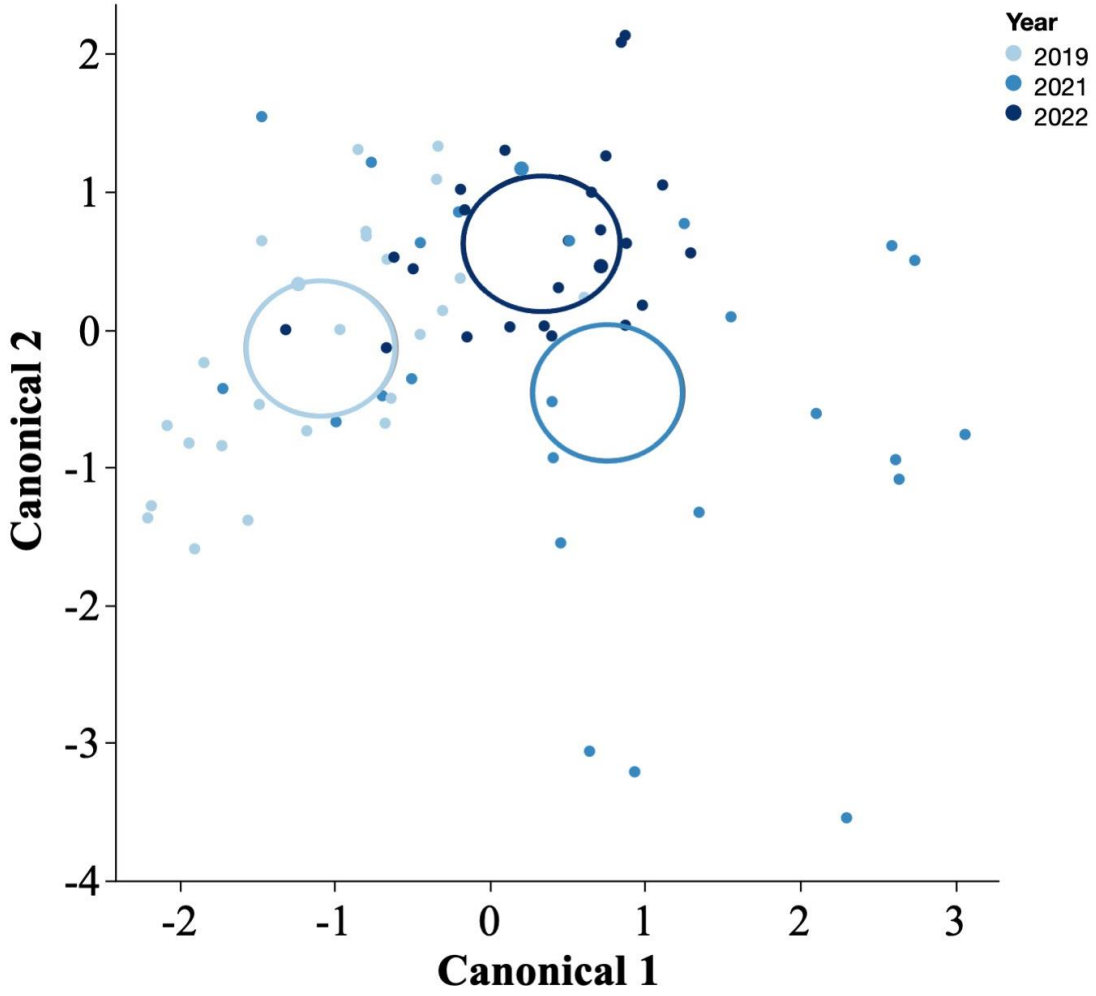
INTERTIDAL



Approx $F_{8,136}$= 3.17, P-value =0.002

B

SUBTIDAL

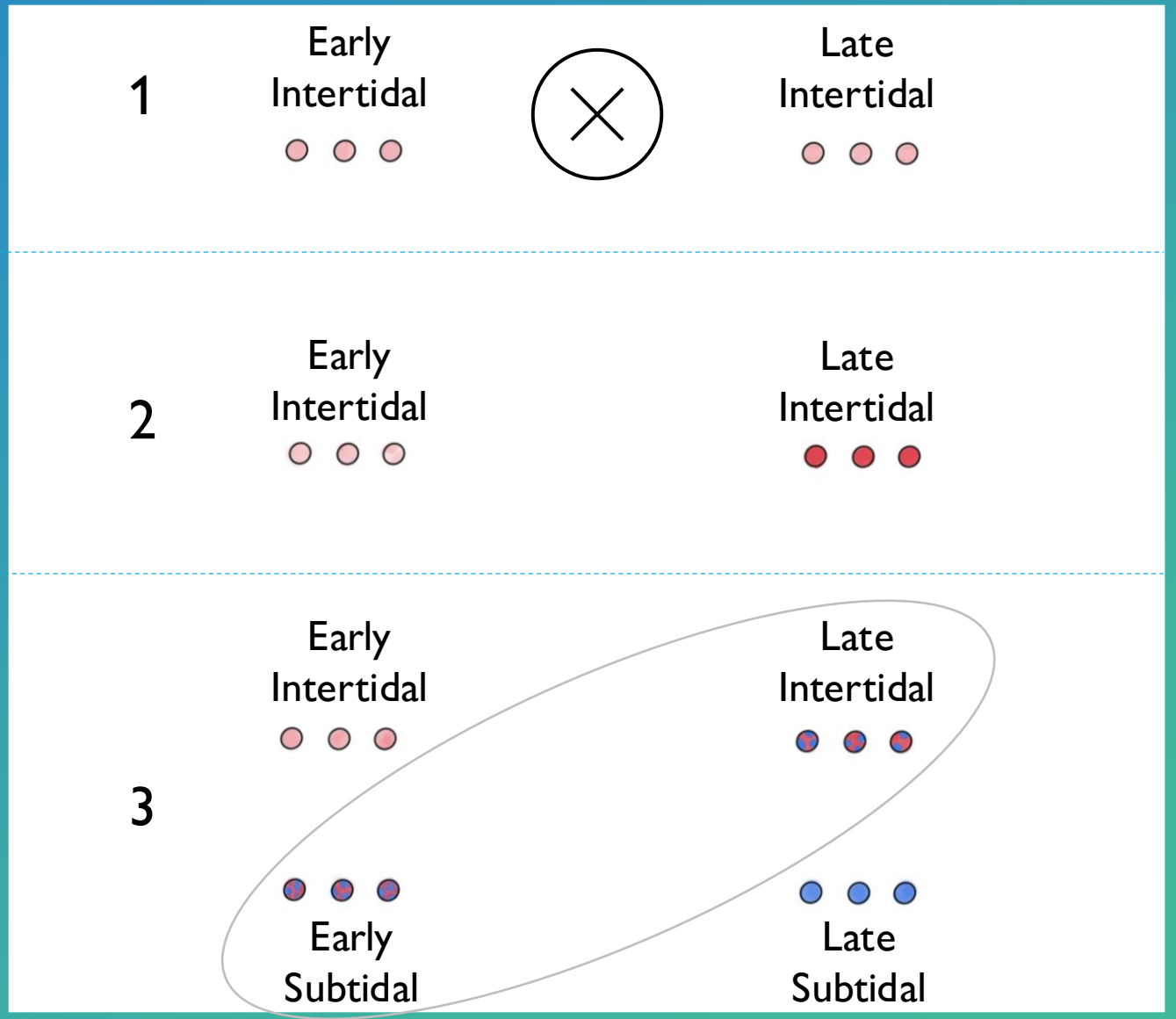


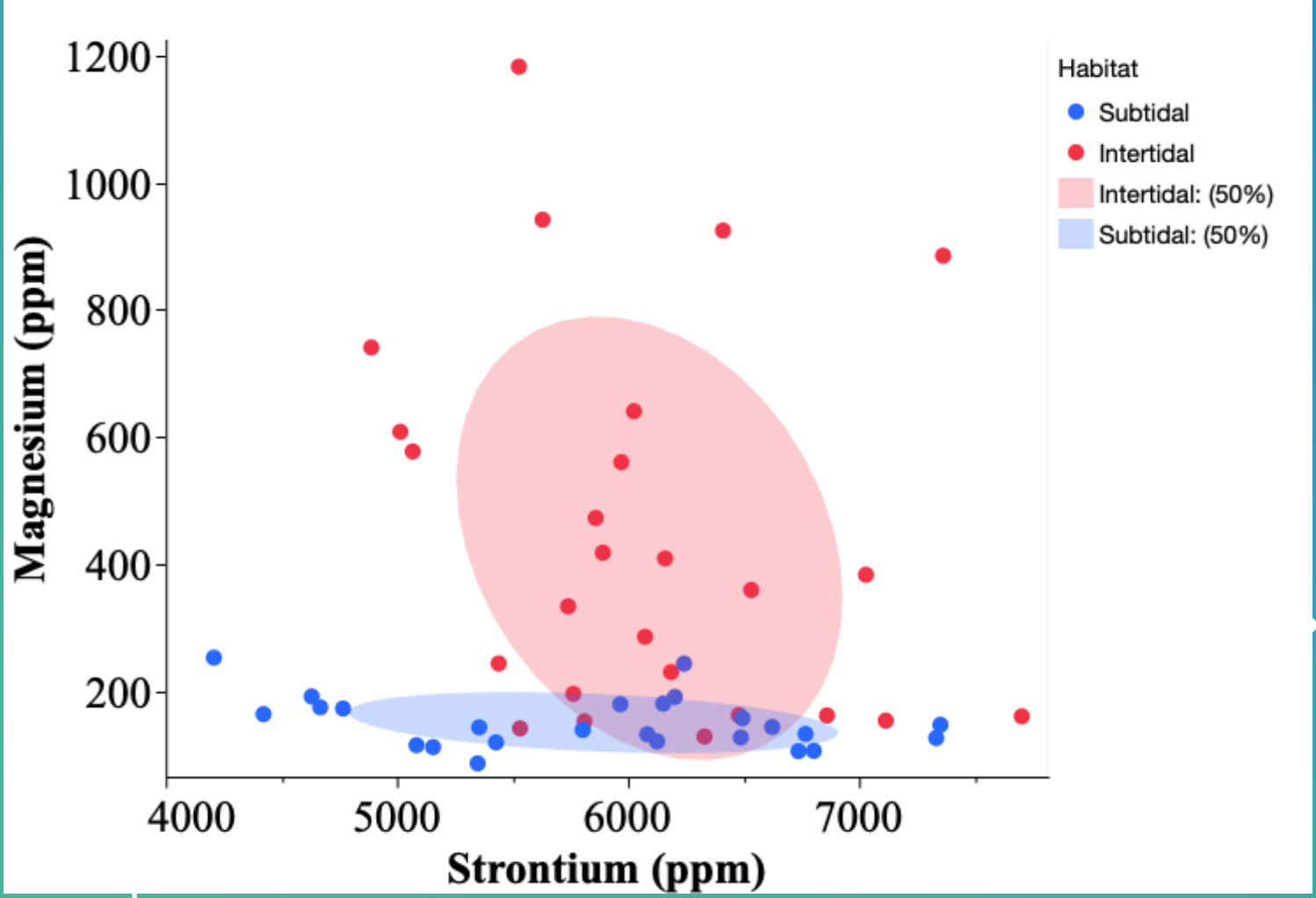
Approx $F_{8,136}$= 7.09, P-value <0.0001

Comparisons between ‘early’ and ‘late’ larvae in each year and habitat sampled

- Based on discriminant function analysis there were significant differences in the otolith chemistry signatures of ‘early’ and ‘late’ larvae in most years across both spawning habitats
- Successful classification ranged ~80-100%

Comparisons between ‘early’ and ‘late’ larvae in each year and habitat sampled



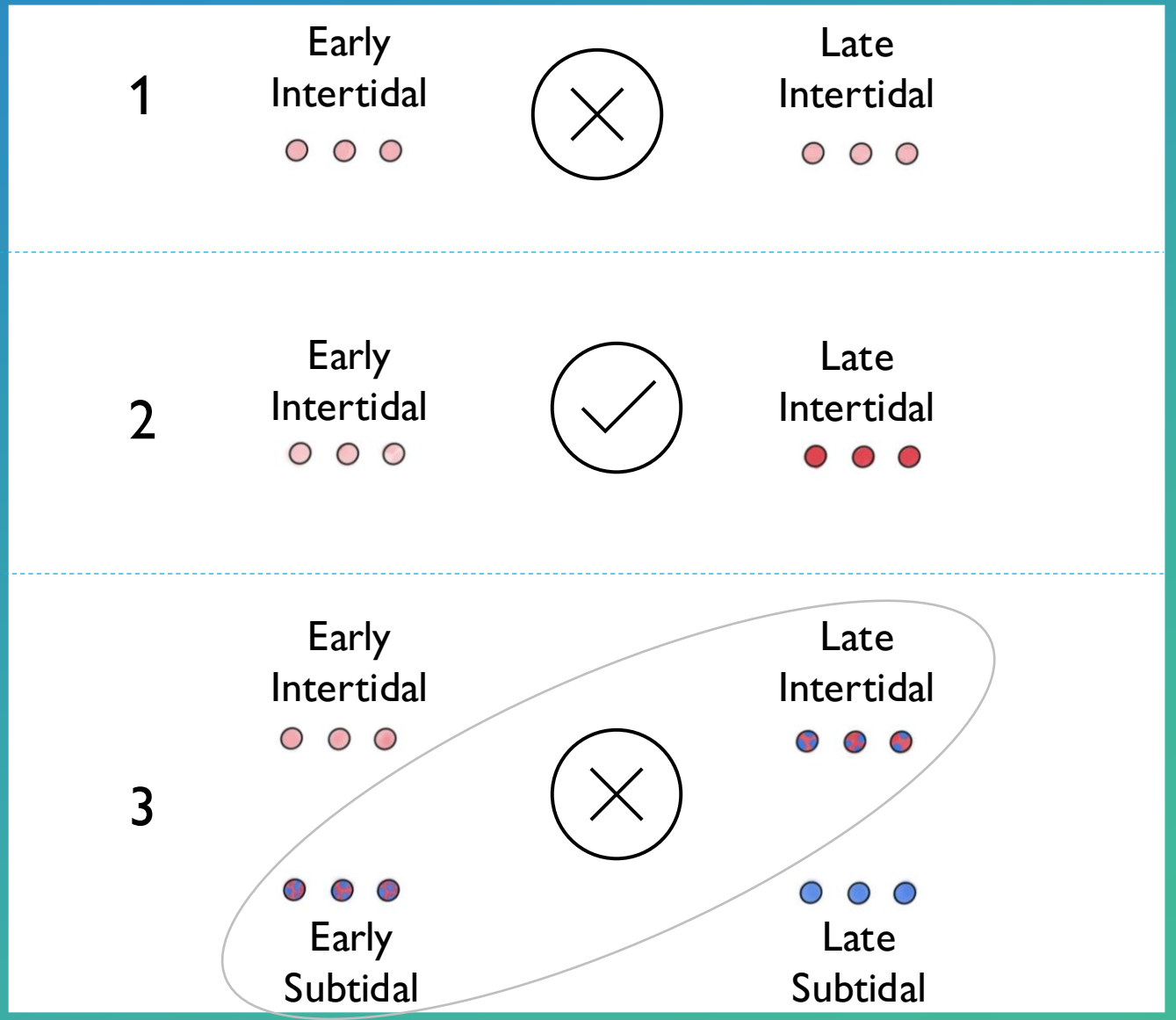


Comparisons between habitats with timing pooled in 2019

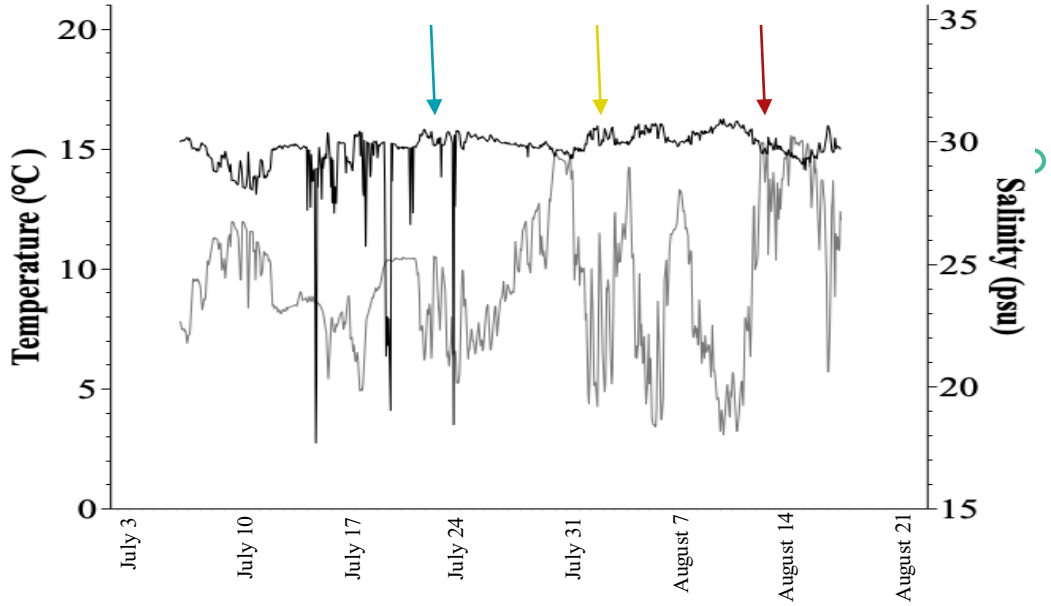
- Approx $F_{4,46}$= 11.12, P-value <0.001
  Successful Classification to Correct Habitat = 88.24%

Despite variability in the otolith chemistry between ‘early’ and ‘late’ larvae in 2019 we can determine the habitat of origin with high success

Comparisons between habitats with timing pooled in 2019



INTERTIDAL 2019



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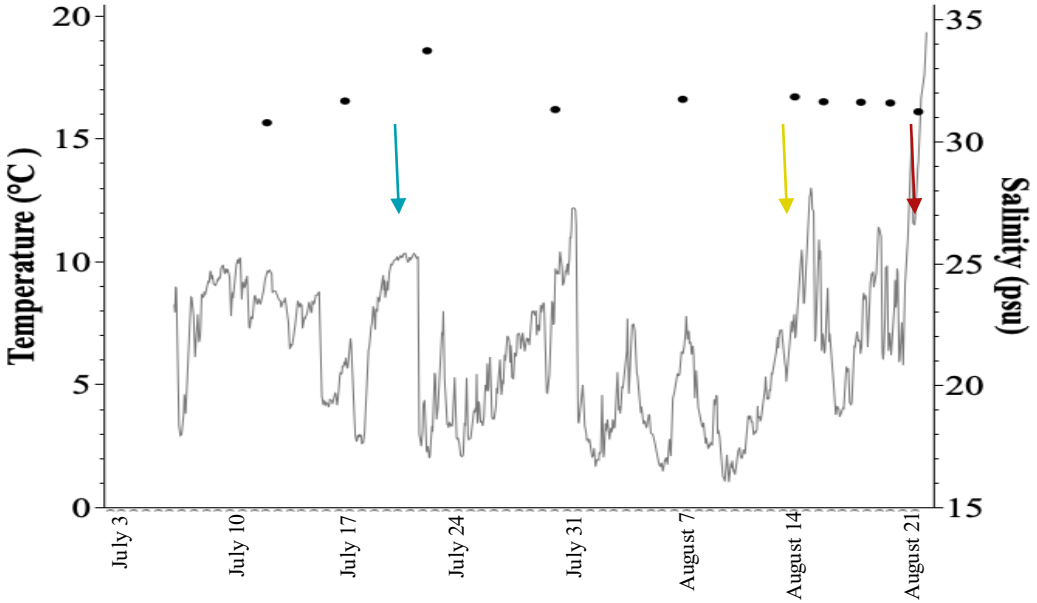
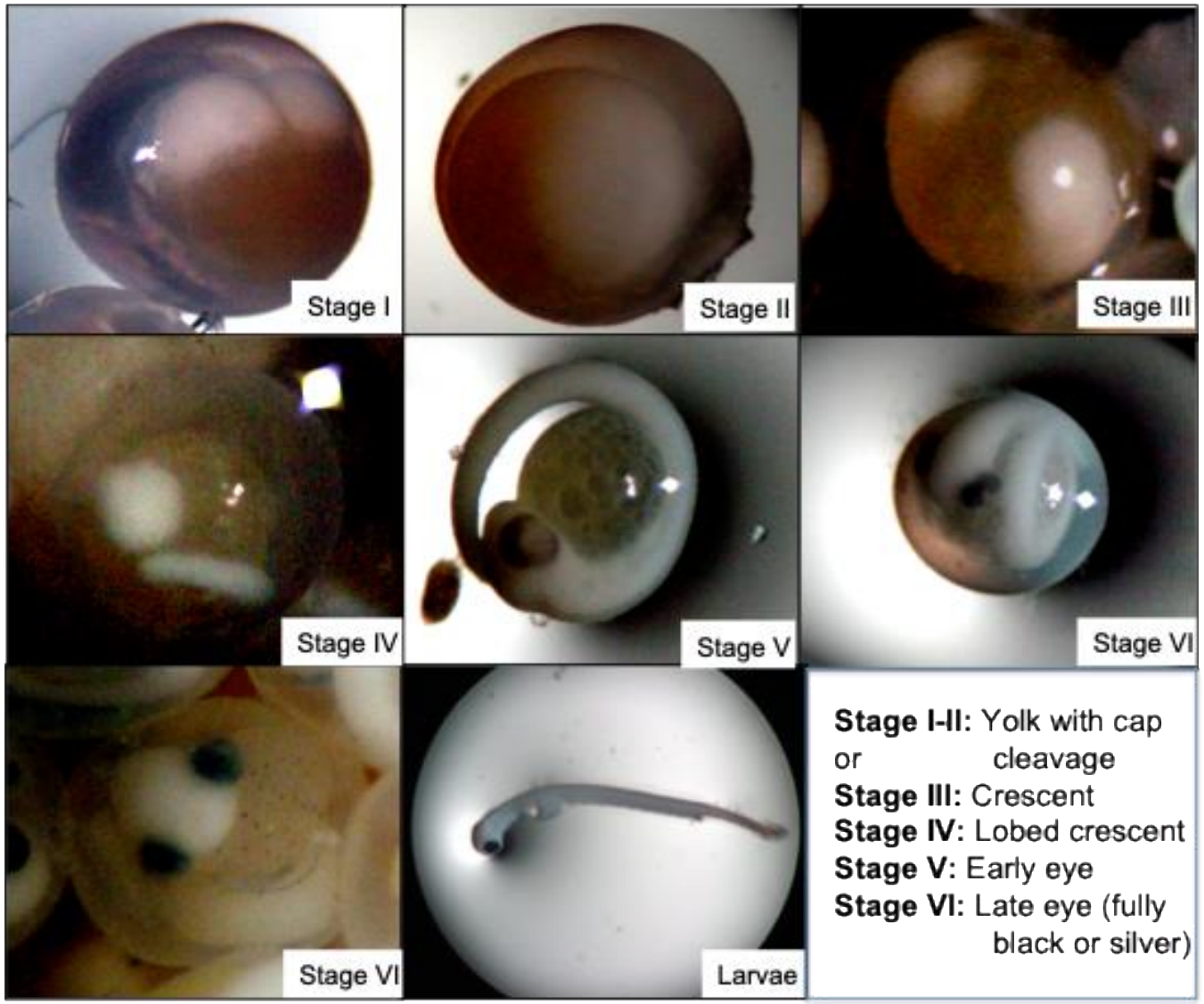


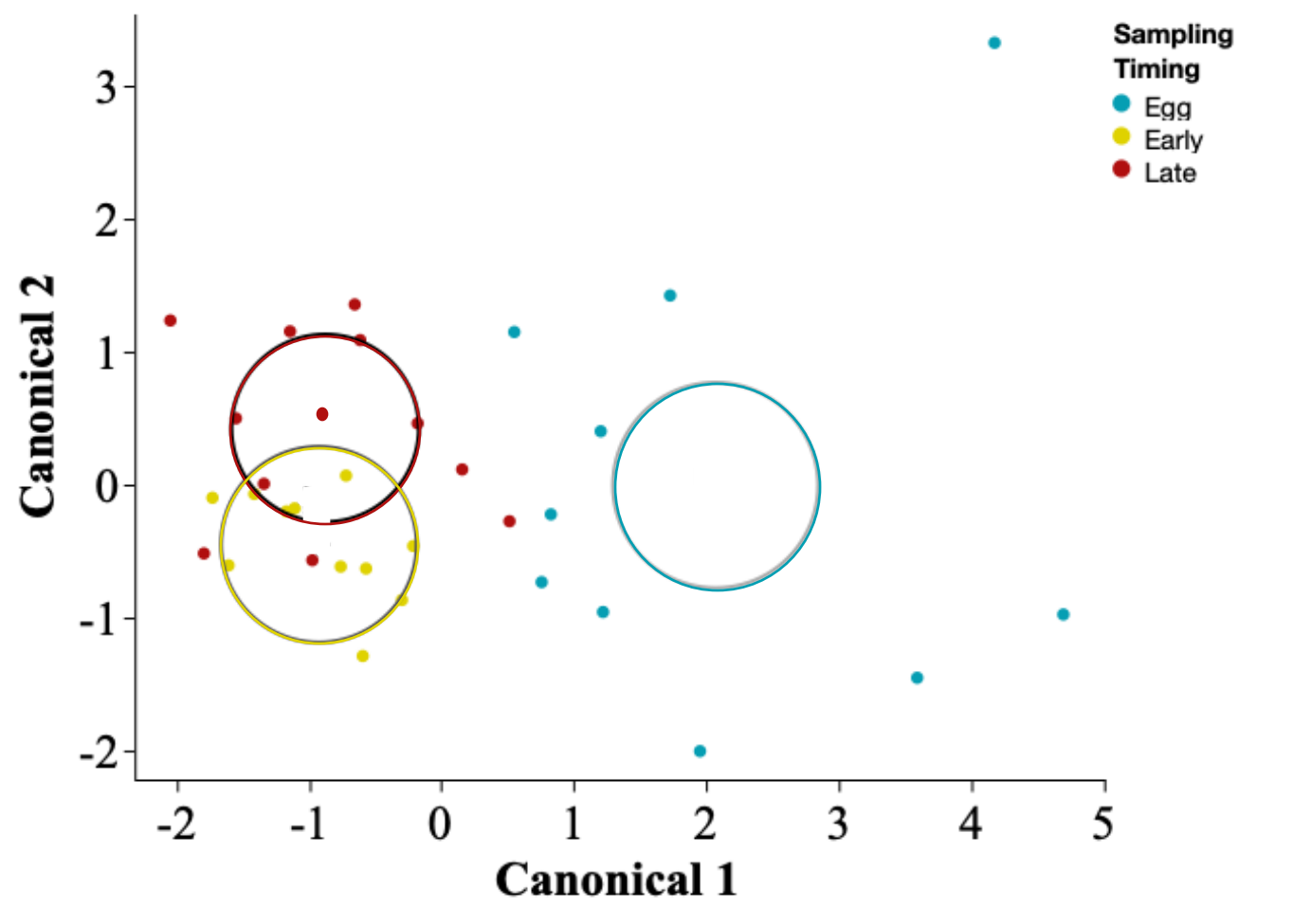
Environmental conditions

- Hourly temperature logger
- Hourly salinity logger
- Point salinity measurement
- Date of first spawning
- 'Early' sampling
- 'Late' sampling

- Temperature showed similar general trends between both habitats with lower magnitudes in the subtidal habitat
- Salinity was more variable at intertidal habitats

- Investigated the timing of otolith formation in the developing capelin embryo
- Collected fertilized capelin eggs from the intertidal spawning site every day in 2023
- Otoliths were only detected in the last stage of development (Stage VI) prior to hatch





Intertidal 2023.

- Otoliths removed from capelin eggs incubated at the same intertidal site in the same year as recently emerged capelin larvae were significantly different in otolith chemistry
- Driven by higher element concentrations (Mg, Sr) in the egg

Approx $F_{8,54}$= 5.86, P-value <0.001
Successful Classification to Correct Habitat = 81.82%

Conclusions

There were significant differences in the otolith chemistry signatures of capelin larvae that emerged from both intertidal and subtidal spawning sites ‘early’ versus ‘late’

There differences did not preclude the distinction of spawning habitat for larvae when emergence timing was pooled

Best practices will depend on the specifics of the species and question but for species with protracted spawning/hatching the timing of sampling may matter

Conclusions

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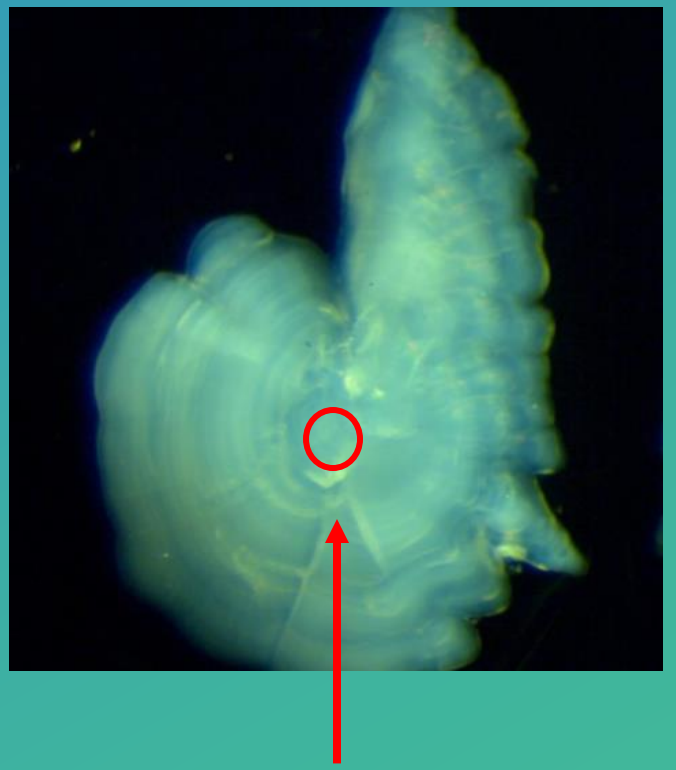

Came from a highly productive bay and habitat that needs to be conserved

Acknowledgements

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Pêches et Océans Canada

Davoren Lab
University of Manitoba

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PICES

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Food and Agriculture Organization of the United Nations

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