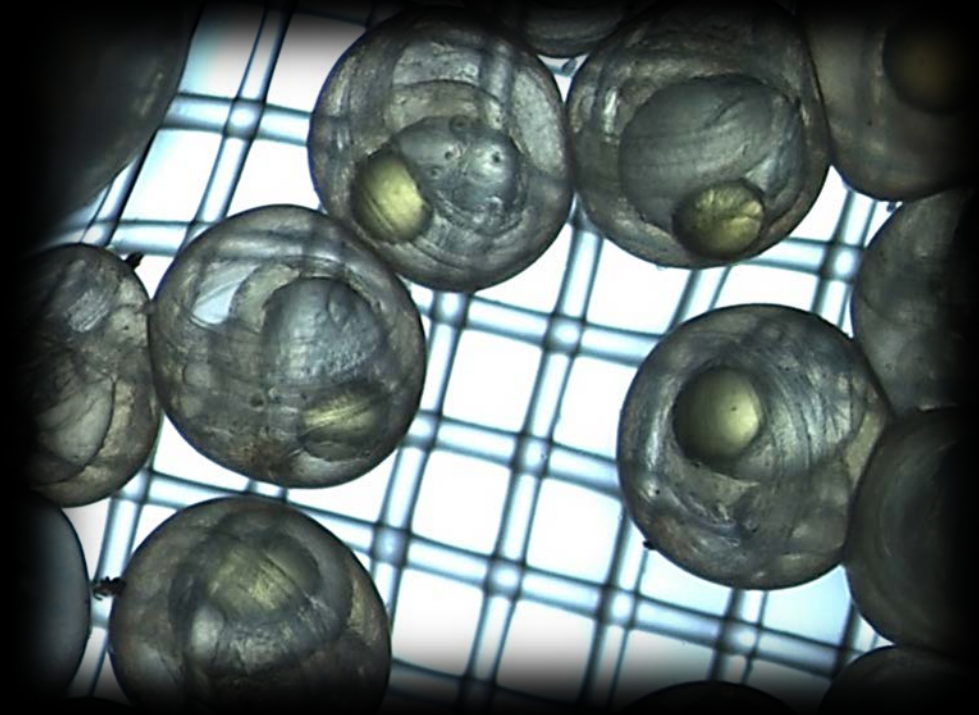


Pacific sand lance: an enigmatic forage fish with an uncertain sensitivity to climate change



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Why study sand lance?



Ammodytes personatus

©Scott Stevenson

- A quintessential forage fish
 - Nutrition at the right size



Ammodytes dubius

Why study sand lance?



- A quintessential forage fish
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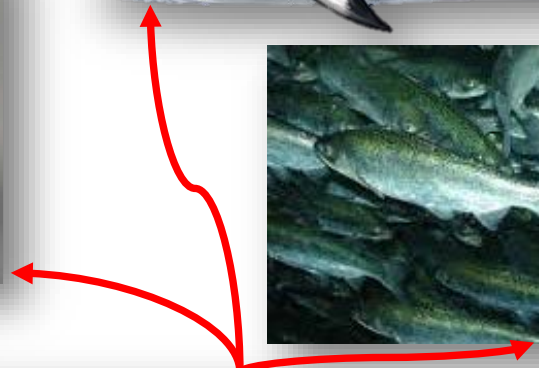
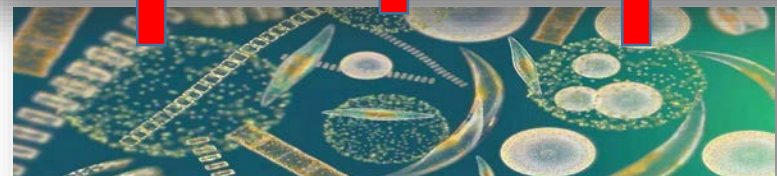
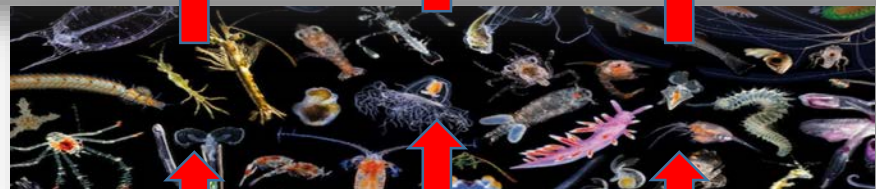


Ammodytes dubius



Ammodytes personatus

©Scott Stevenson

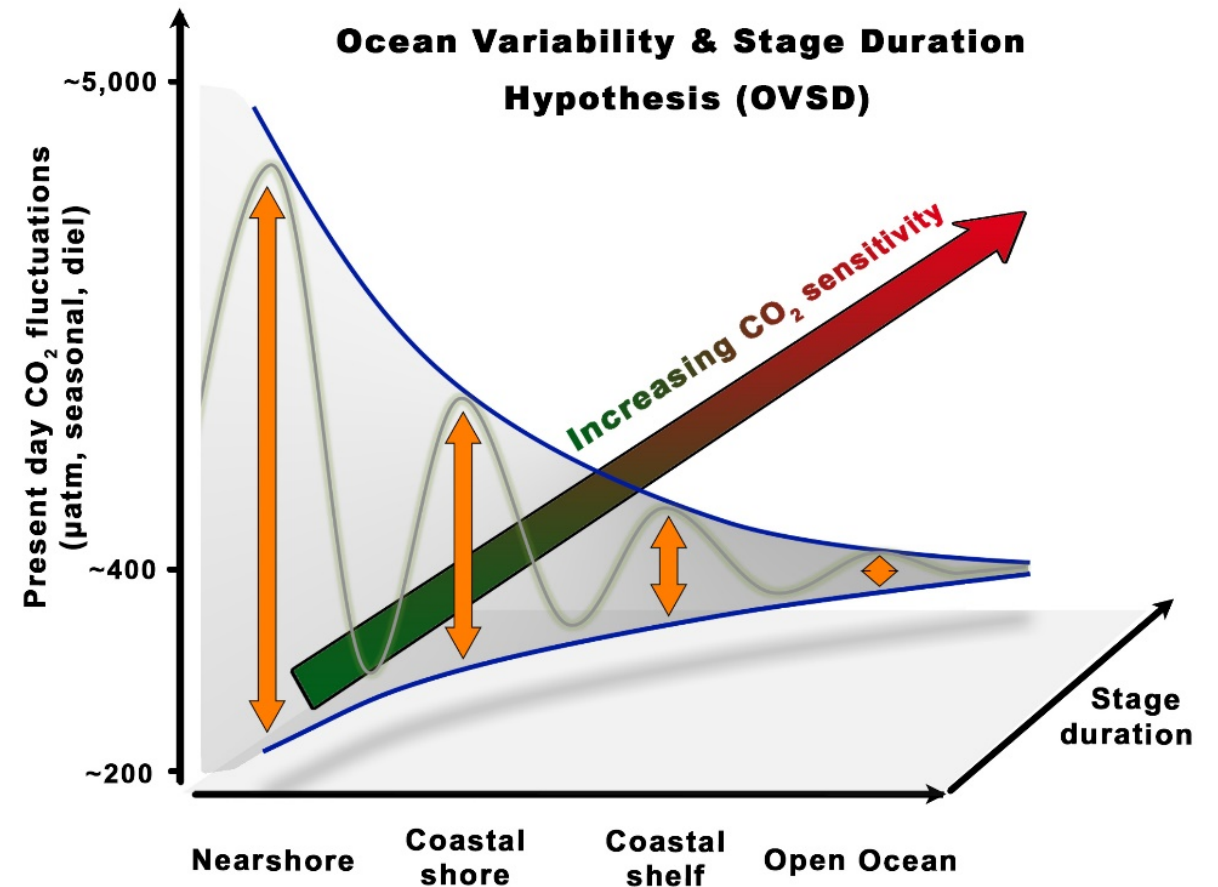


Why study sand lance?



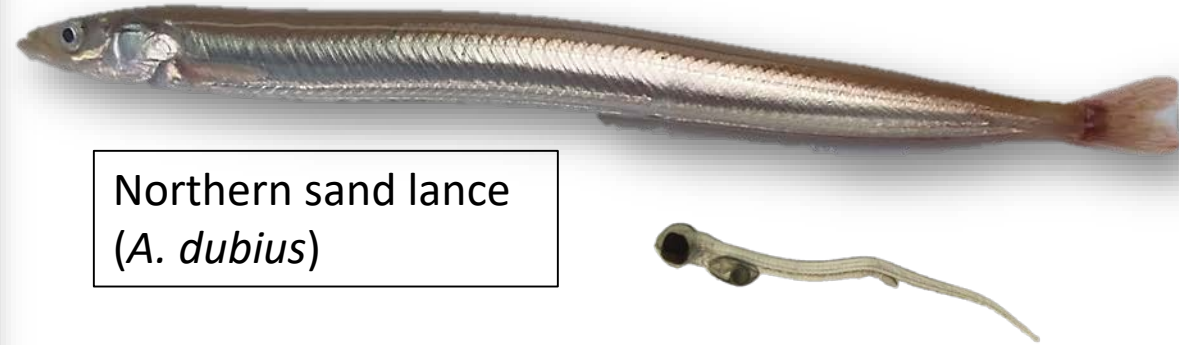
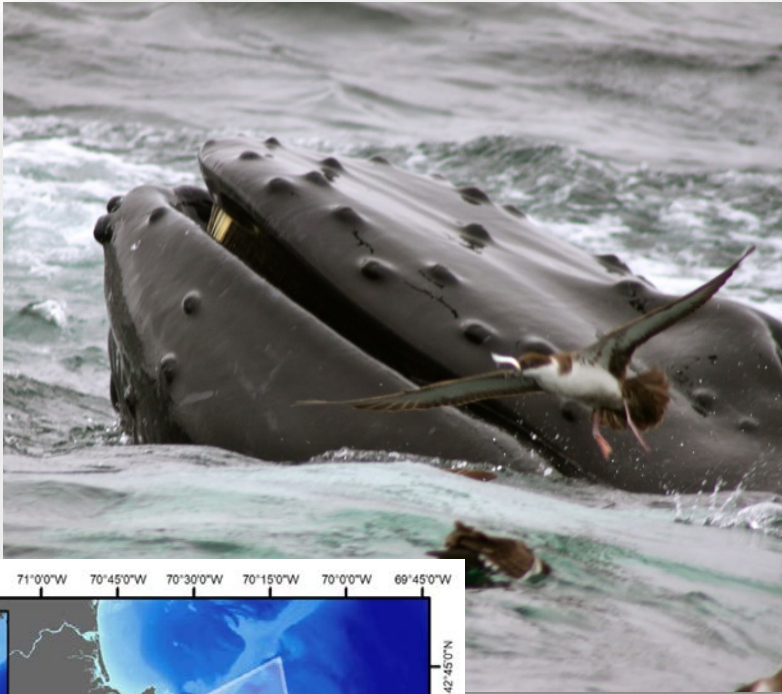
- Generally understudied
- Unknown sensitivity to climate related stressors
- ...But potentially a useful model organism!

Why are CO₂ responses among fish early life-stages so variable?



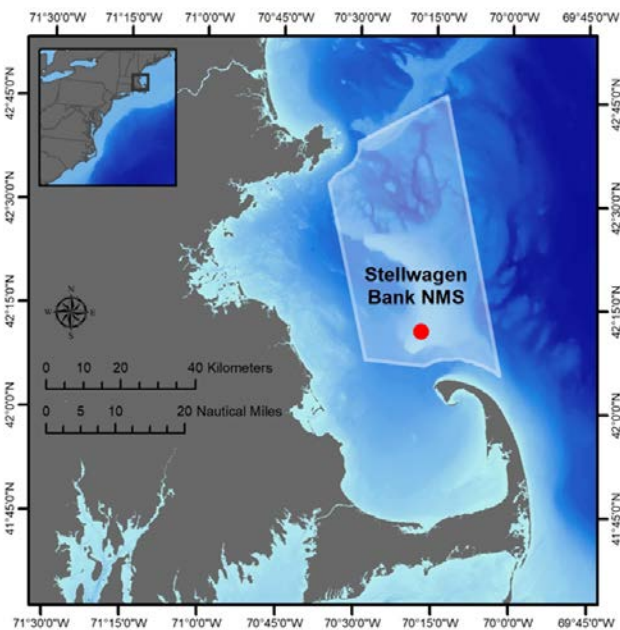
Low pCO₂ variability + slow development ↑ OA sensitivity

Study species: Northern sand lance



Northern sand lance
(*A. dubius*)

- Widely distributed on the northwest Atlantic shelf.
- Considered a foundational species, especially in Stellwagen Bank National Marine Sanctuary.
- Spawn in late-fall (cooling temperatures and low $p\text{CO}_2$ conditions).



Experimental design

Hypothesis

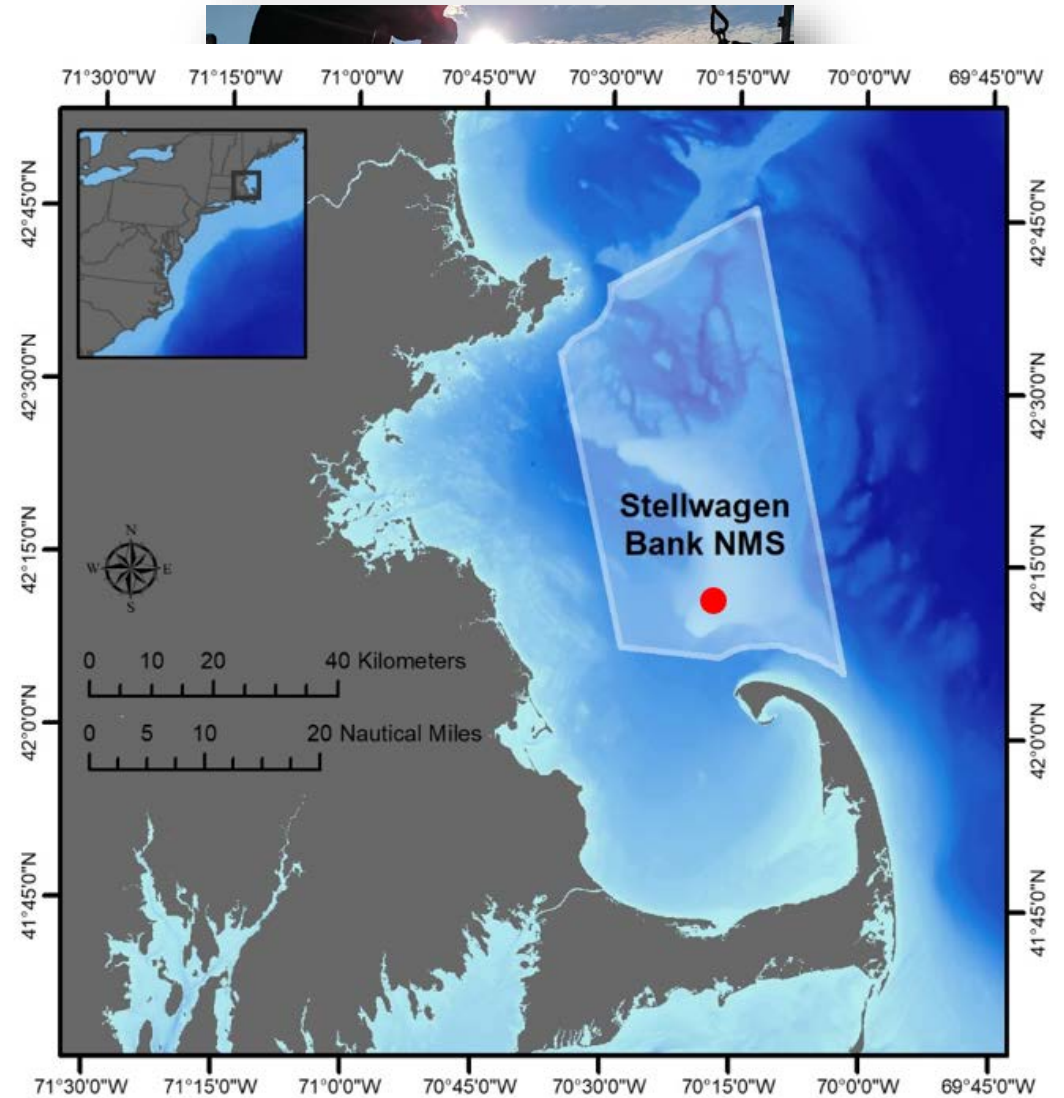
- The offshore/winter spawning *A. dubius* will be more CO₂-sensitive than nearshore/warm-water spawners (e.g., the Atlantic silverside).

Objective

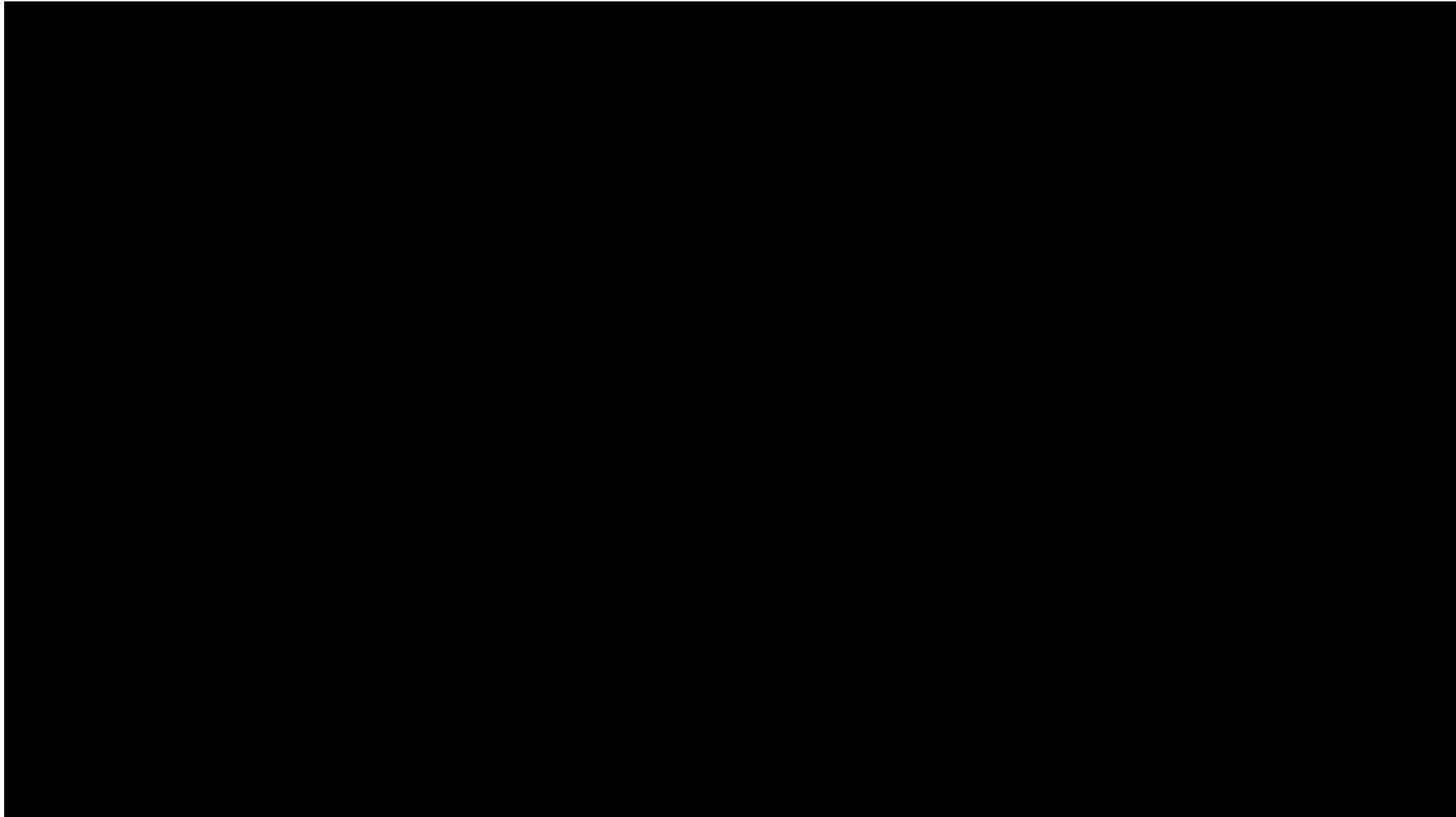
- Quantify CO₂ × temperature effects on survival and development of wild embryos.

Methods

- Factorial combinations of pCO₂ (**400, 1000, 2200 μatm**) and temperature (**5°, 7°, 10°C**).
- Response traits: hatch frequency, embryo survival, hatch morphometries.

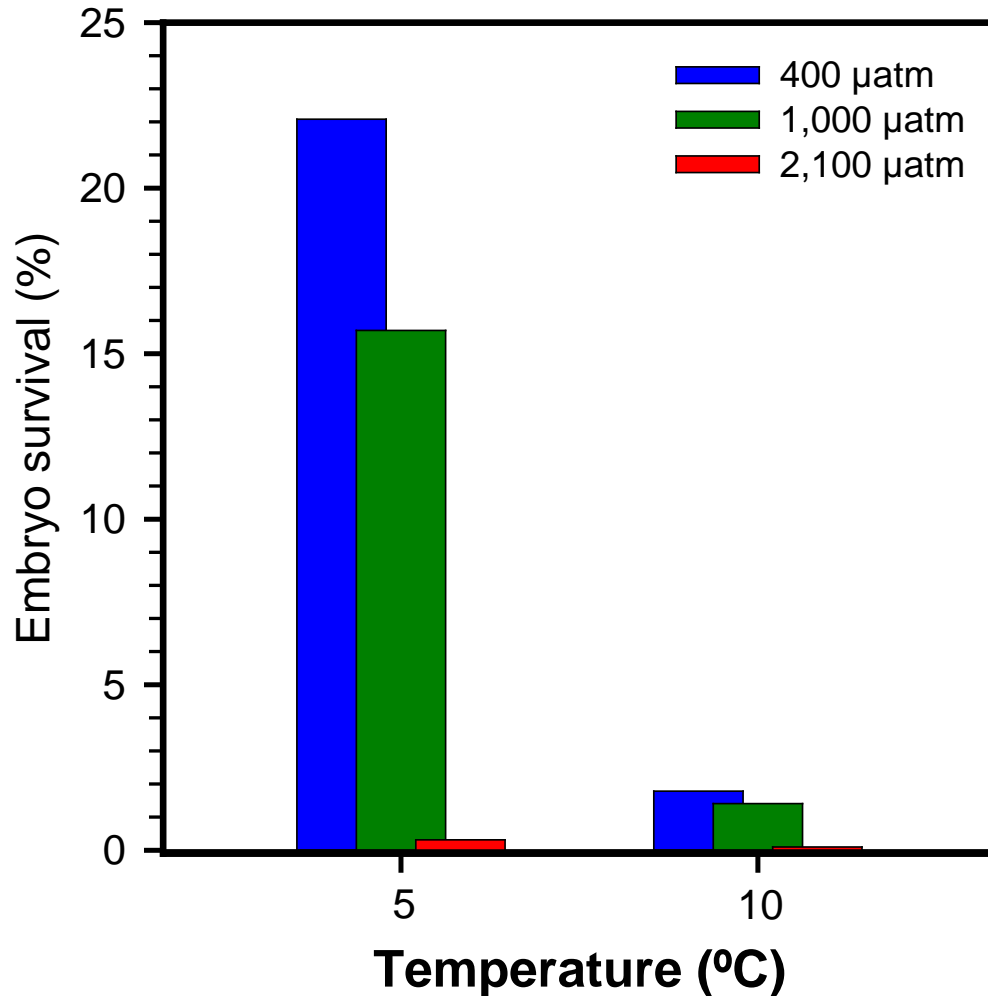


Collecting spawning sand lance from SBNMS



Results: CO₂ × temperature effects in *A. dubius* ELS

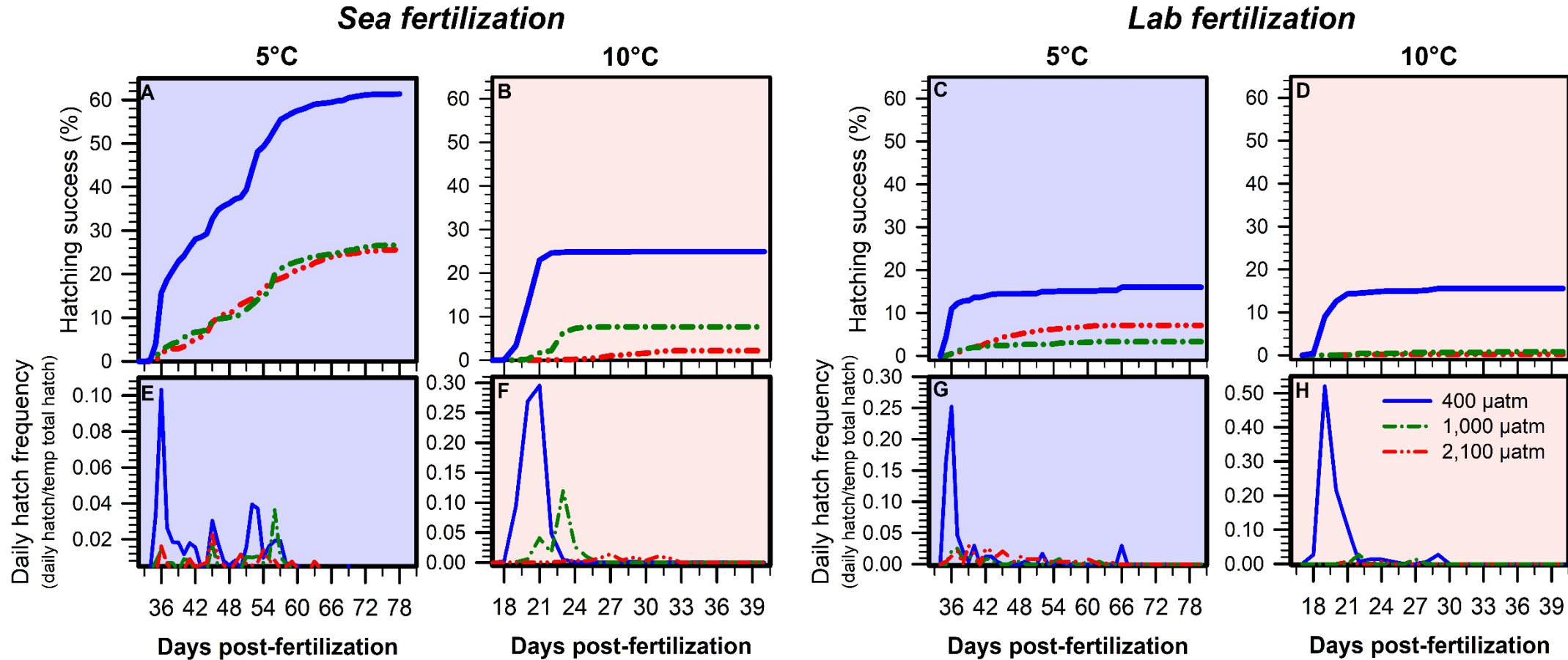
2016 pilot trial



- 2016 pilot study found strong effects of elevated $p\text{CO}_2$ and temperature.
- Experiment repeated in fall 2017 with embryos from two fertilizations (at sea and in the lab).

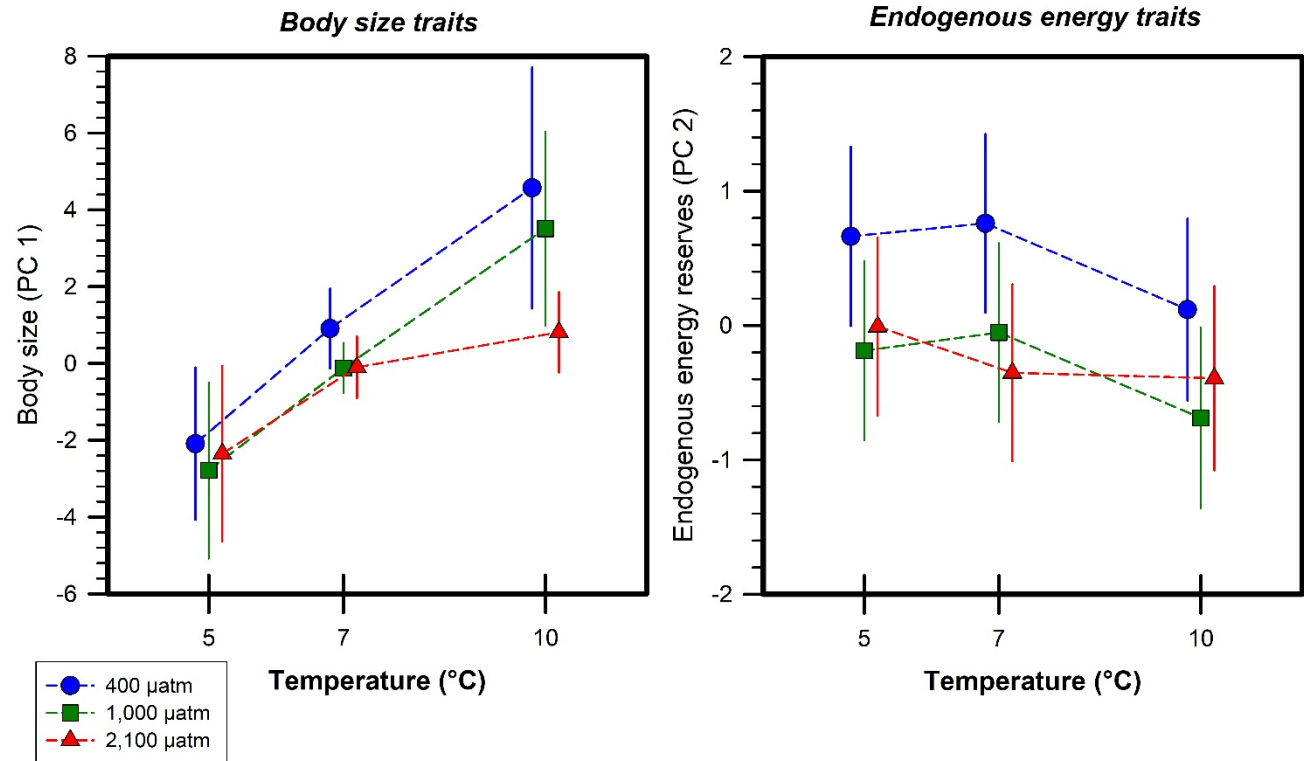


Results: CO₂ × temperature effects in *A. dubius* ELS

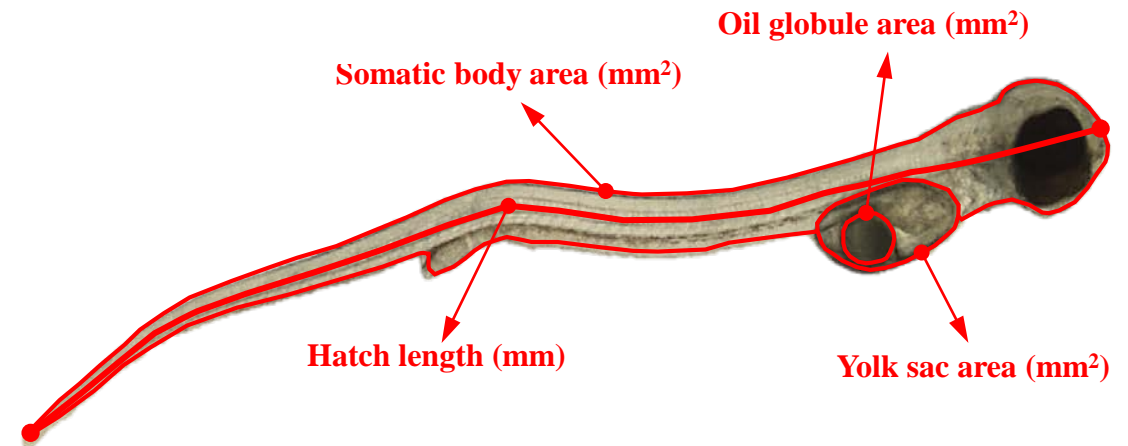


- Elevated pCO₂ reduced average %hatching by more than half.
- Hatching was prolonged and intermittent under OA conditions.

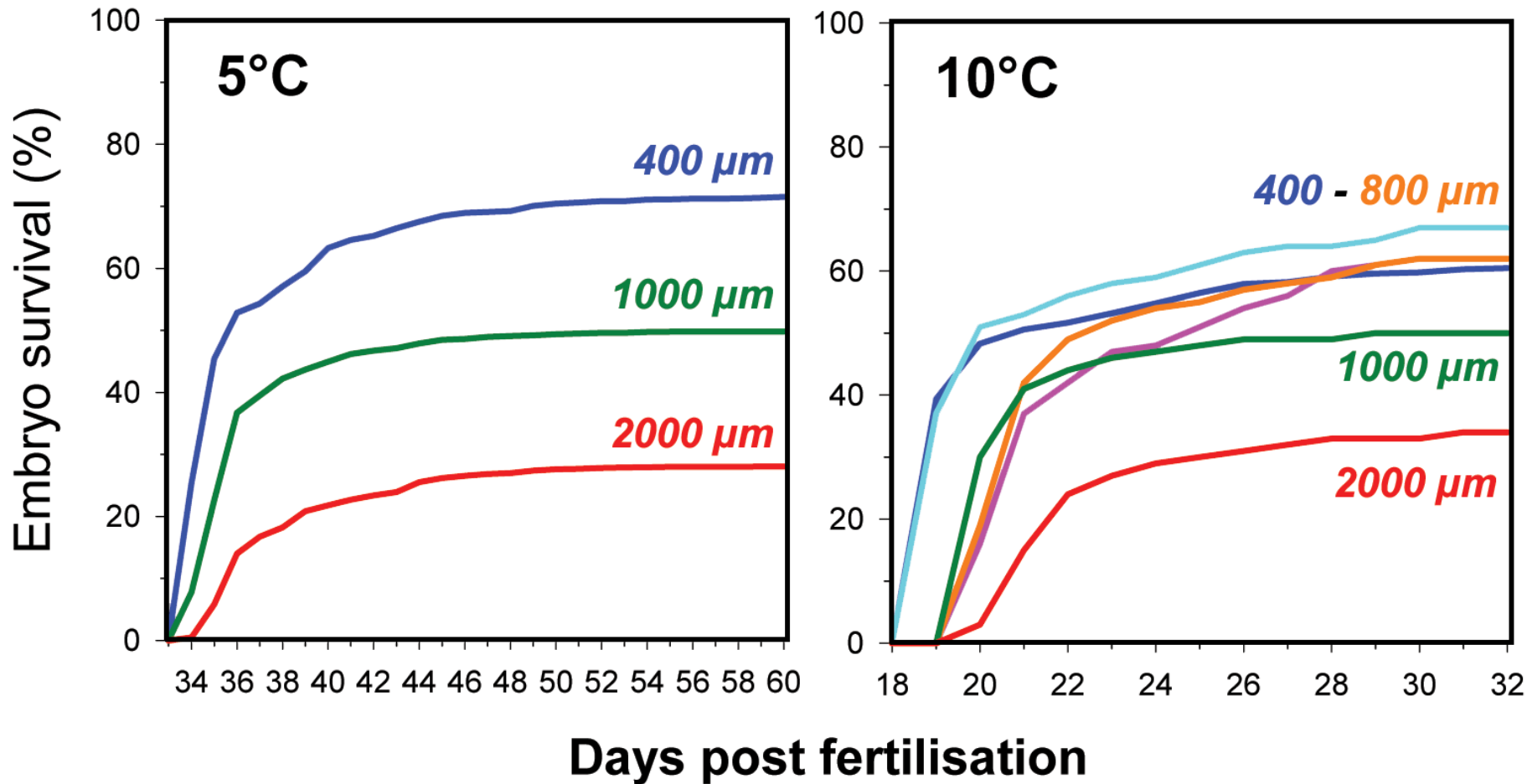
Results: CO₂ × temperature effects in *A. dubius* ELS



- Hatch size was reduced under combined elevated $p\text{CO}_2$ and warm conditions.
- Elevated $p\text{CO}_2$ significantly reduced endogenous energy at hatch.



Results: CO₂ × temperature effects in *A. dubius* ELS



Emma Cross



Lucas Jones

- Northern sand lance among the most CO₂-sensitive fish documented to date.

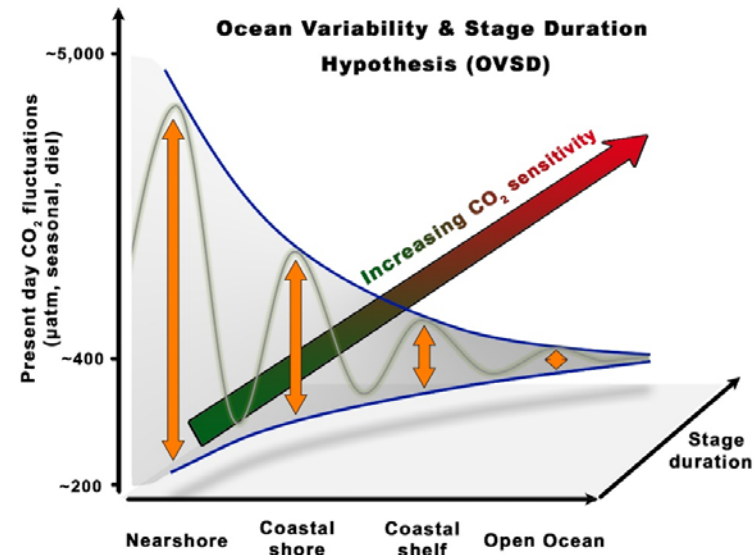
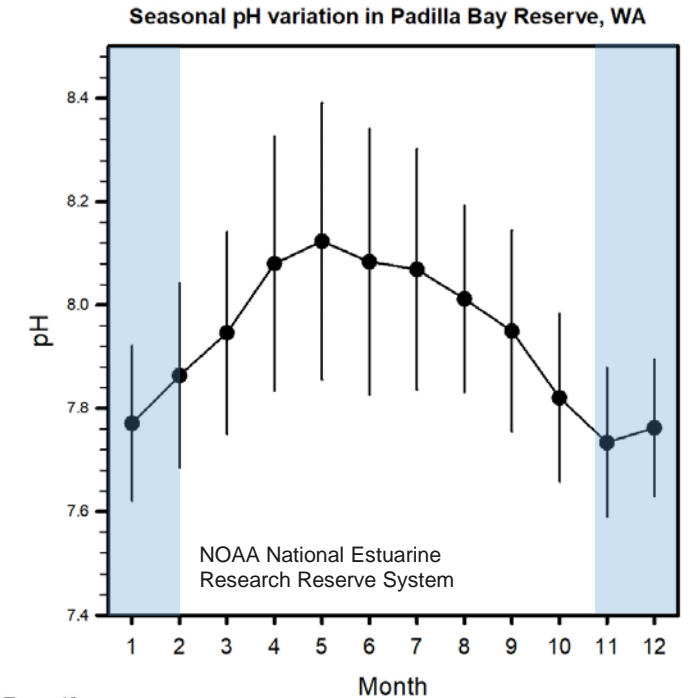
Pacific sand lance

Northern Hemisphere coastal marine systems could be more vulnerable to climate change than previously understood.

- But what about Pacific sand lance?
- **Important life-history differences:**
 1. Spawn intertidally
 2. Puget Sound naturally acidifies during winter.

Fall 2019 Experimental Objectives

1. Quantify the CO₂-reaction norm of *A. personatus* offspring.
2. Test for CO₂ × temperature interactions.
3. Elucidate underlying physiological mechanisms.



Questions?

UCONN
AVERY POINT

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Sea Grant

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STELLWAGEN BANK
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