Multistressor global change drivers reduce hatch and viability of Lingcod embryos

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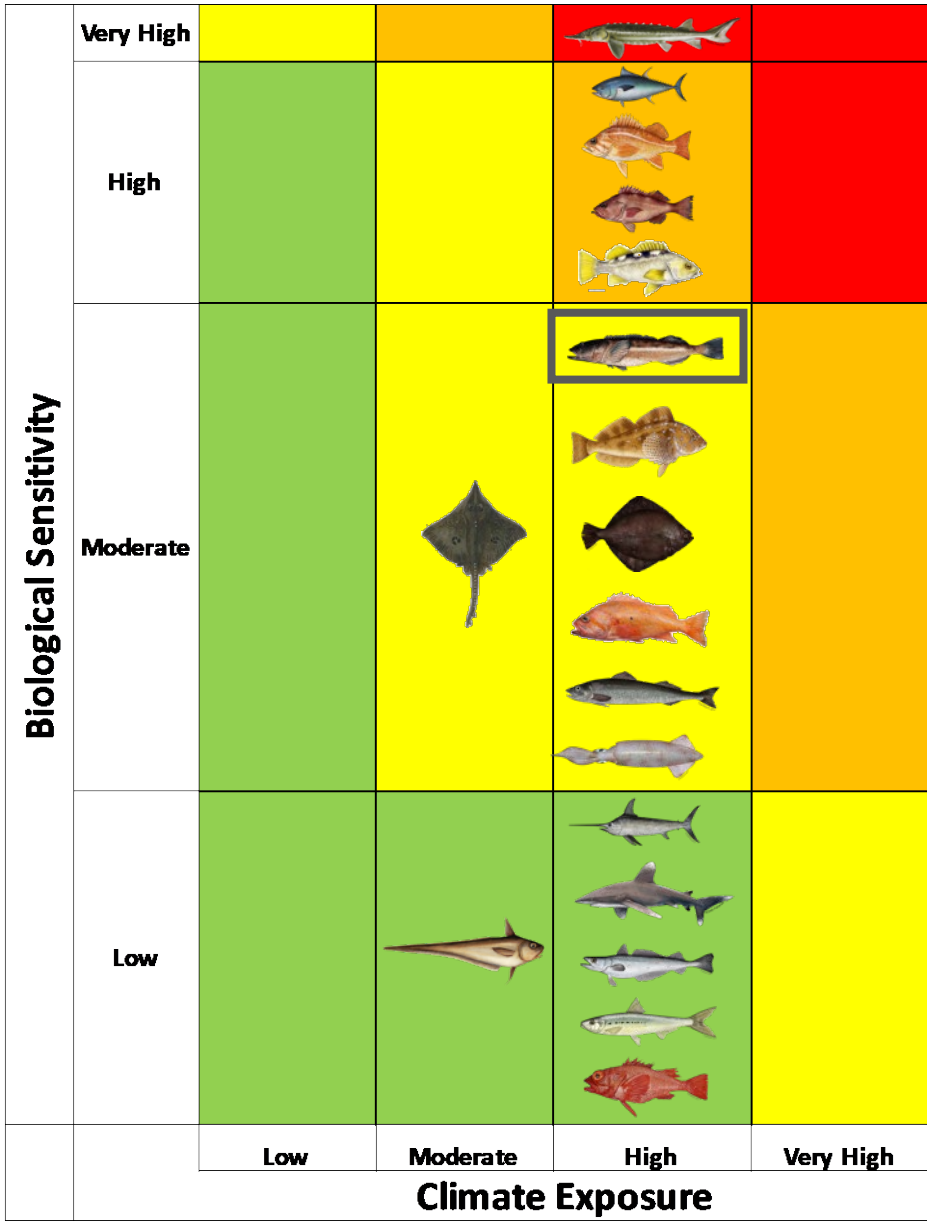
Lingcod are ecologically and economically important fish

PC: Monterey Bay Aquarium

California Current Climate Vulnerability Assessment



McClure et al. 2023

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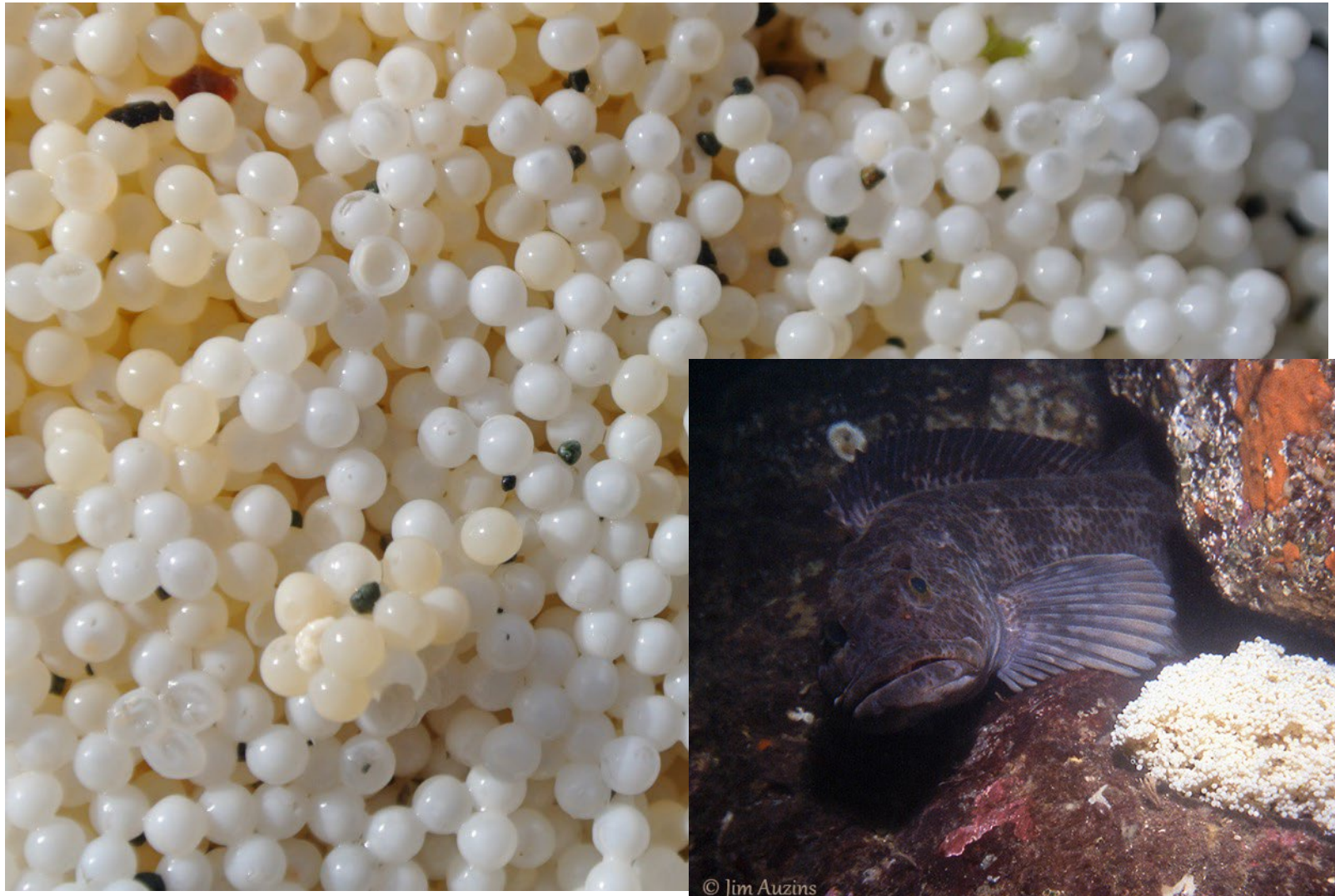
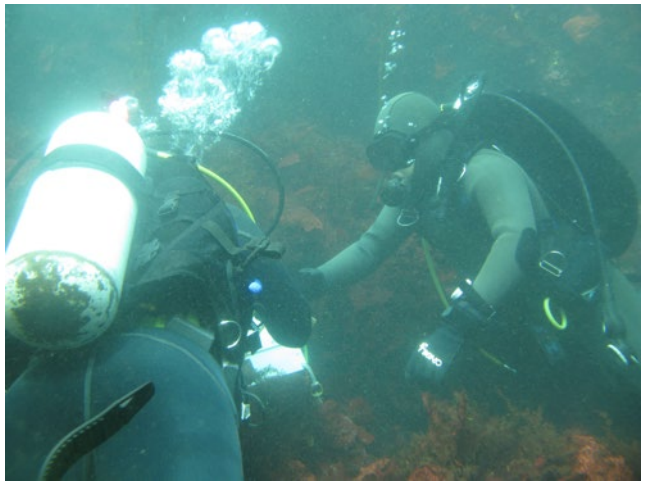
Lingcod are benthic egg layers



This study is the first to expose marine benthic eggs to future temperature, pH, and DO conditions in concert (RCP 8.5)

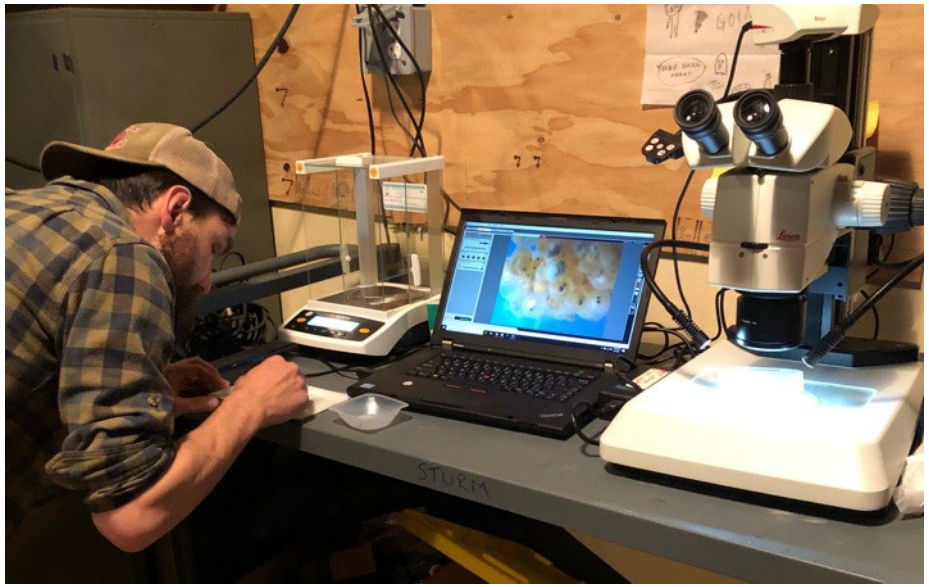
Overarching Question: How will Lingcod larval survival and condition be impacted by global change conditions?

- Will hatch success decline?
- Will larval condition (length and weight) decline?
- Will larval deformities increase?



Divers collected eggs

	Temperature (C)	pH	Dissolved Oxygen (mg/l)
2020	13.0 ± 0.3	7.89 ± 0.04	9.2 ± 0.5
2050	14.6 ± 0.2	7.70 ± 0.02	7.4 ± 0.5
2100	15.7 ± 0.4	7.52 ± 0.07	6.0 ± 0.5

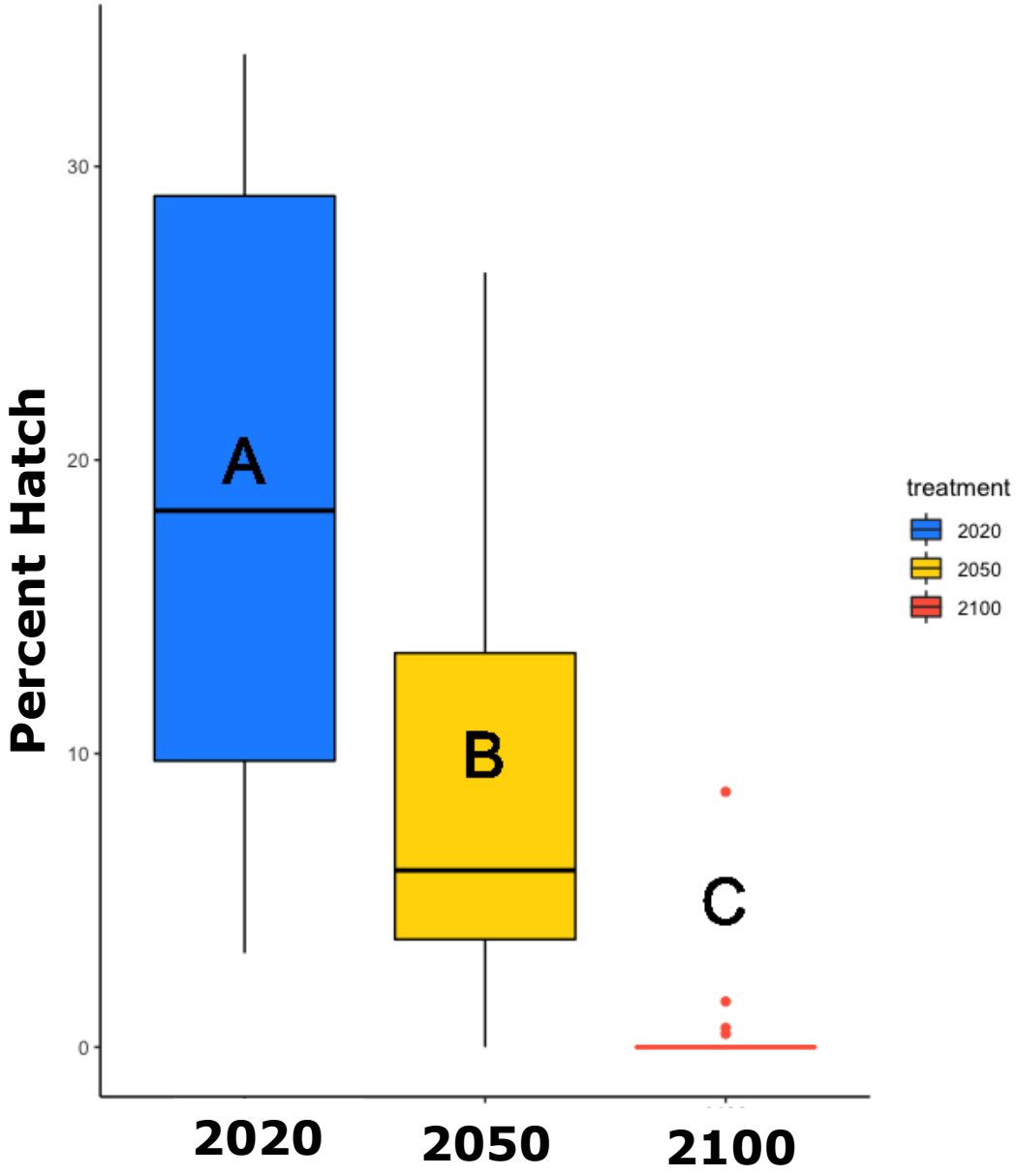


Fertilization and development checked

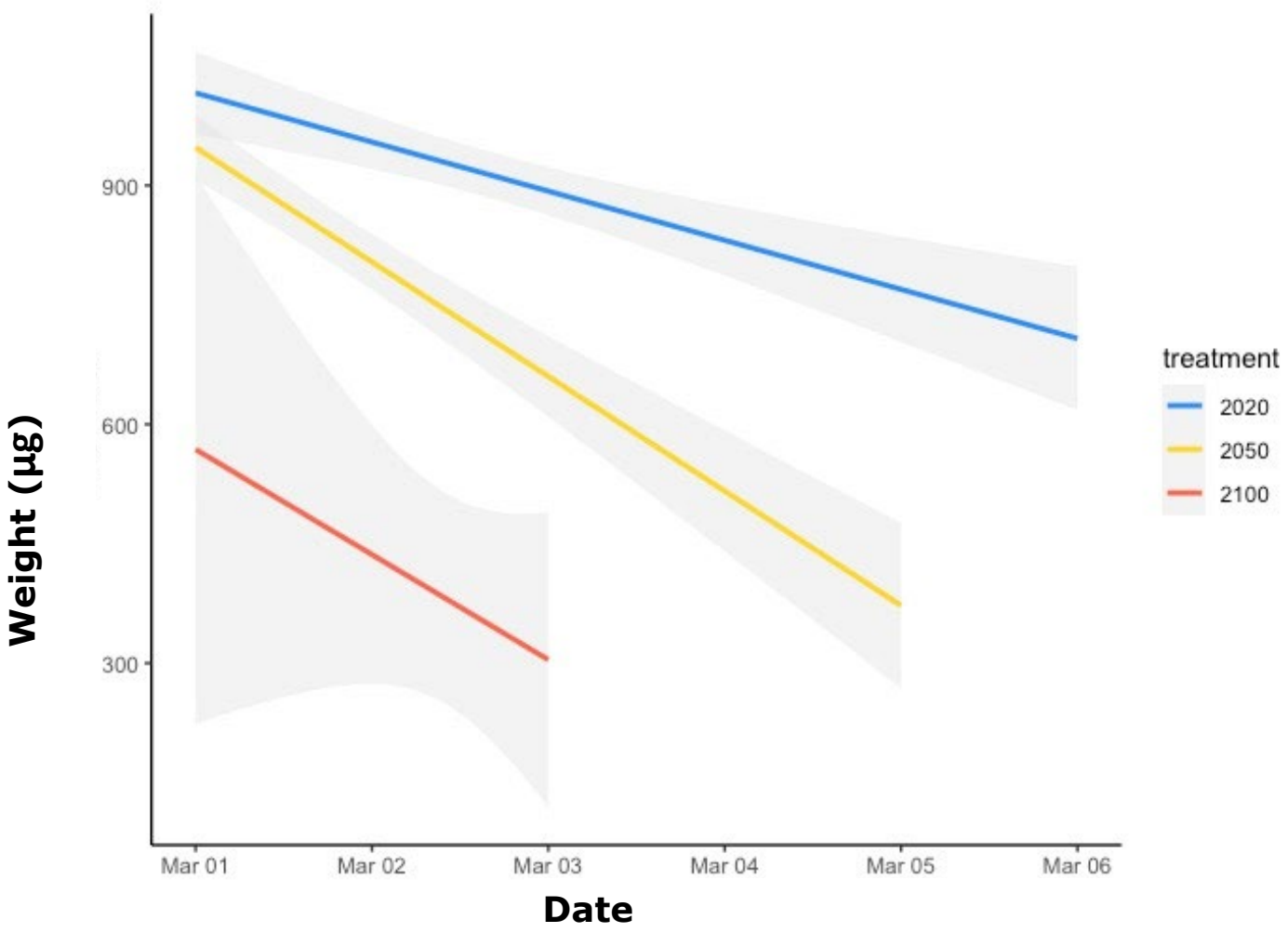
Egg masses placed in treatment conditions

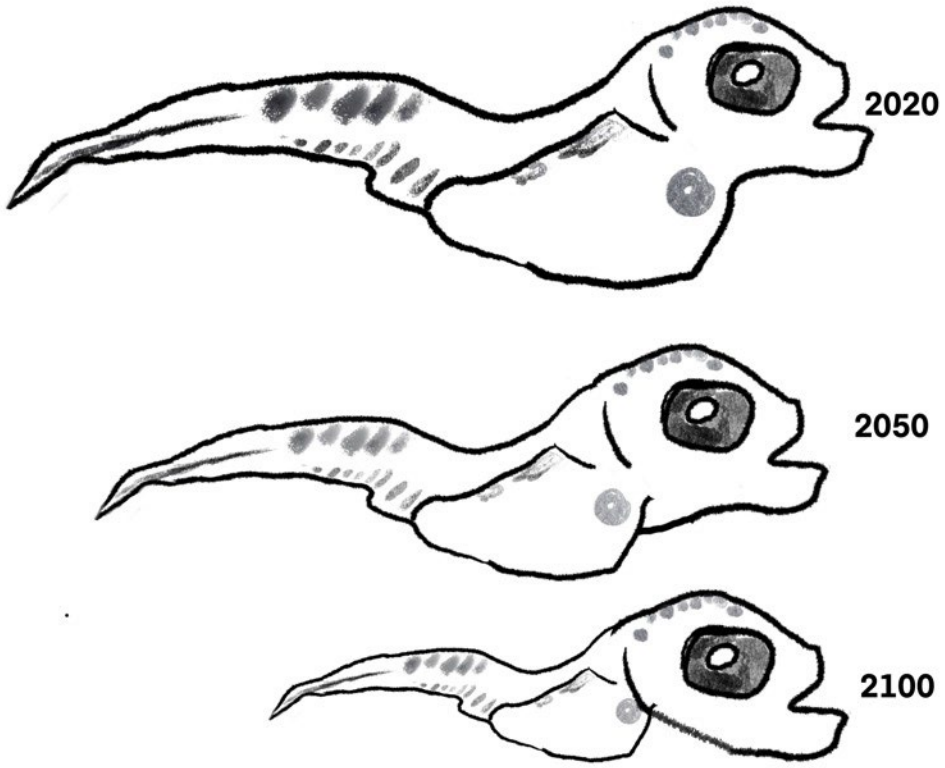
Larvae collected every 12 hours

Survival declines in global change conditions

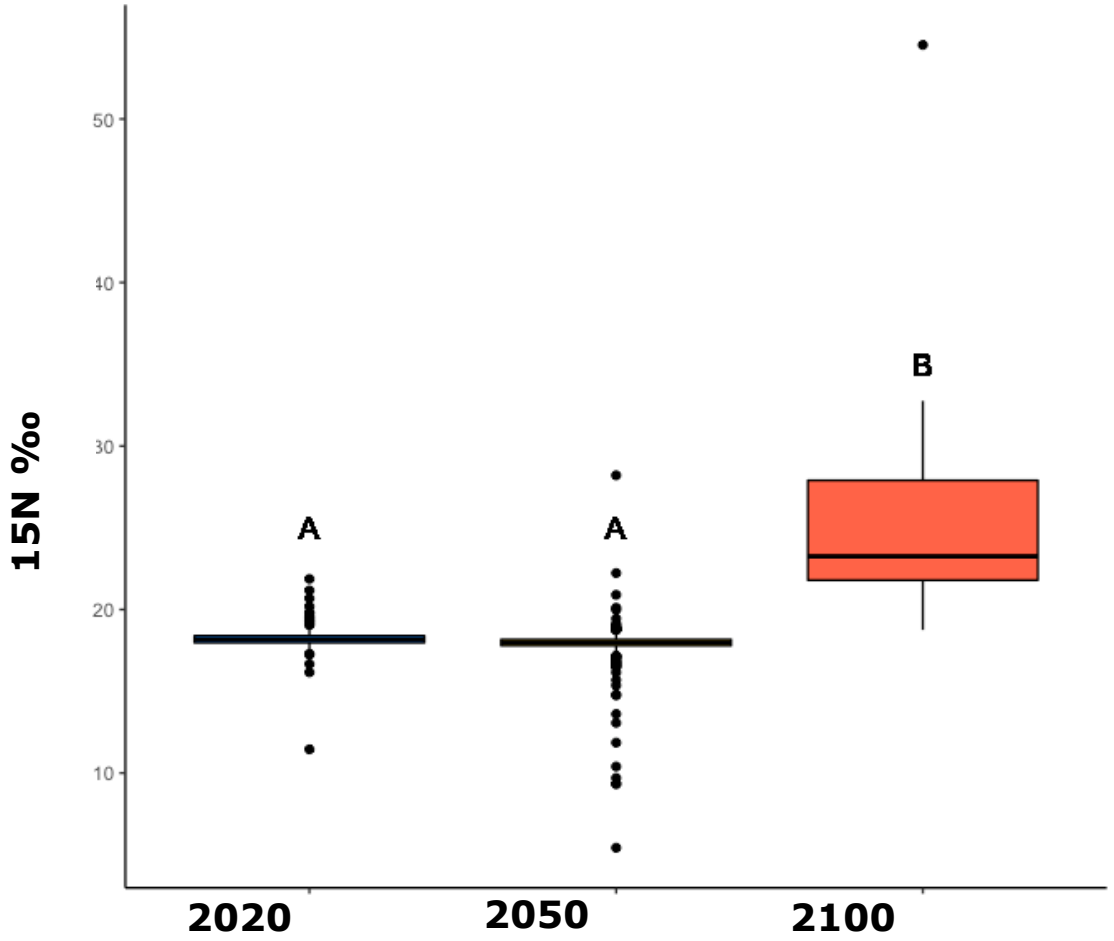


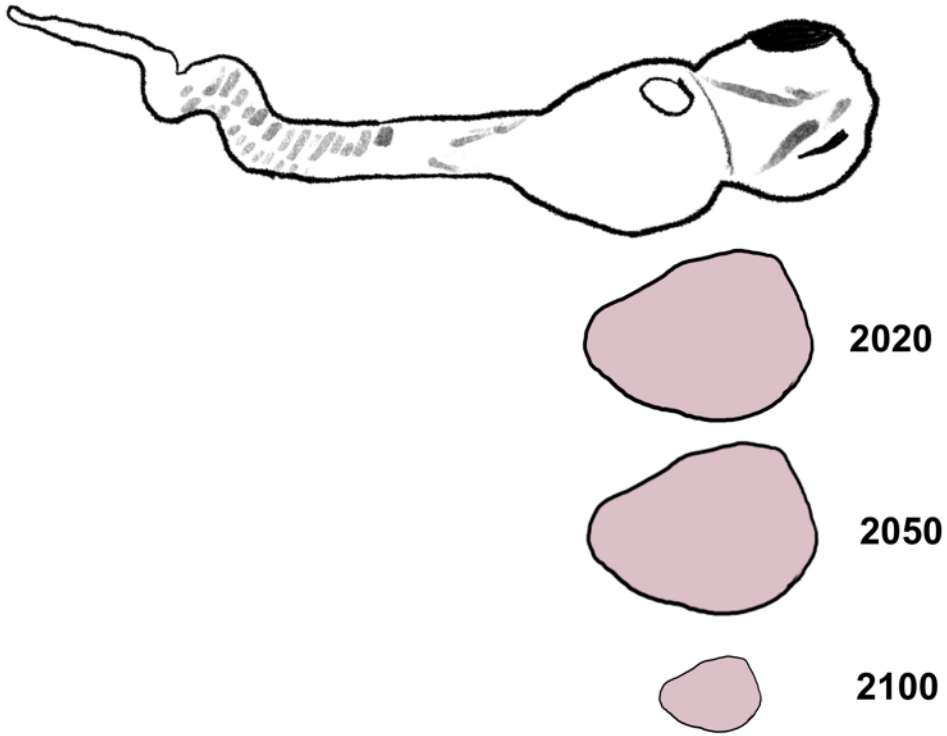
Larval size declines in global change conditions





Protein reserves are minimal in year 2100 conditions





Larval deformities increase in global change conditions

Normal Larva

Deformed Larvae

Conclusions

- Lingcod recruitment will likely decrease with global change
- The ability to swim, consume prey, and escape predators will likely decrease with global change

Lingcod is highly vulnerable to global change unless there is acclimation and adaptation to future conditions

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Multistressor global change drivers reduce hatch and viability of Lingcod embryos, a benthic egg layer in the California Current System

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Early life history stages of marine fishes are often more susceptible to environmental stressors than adult stages. This vulnerability is likely exacerbated for species that lay benthic egg masses bound to substrate because the embryos cannot evade locally unfavorable environmental conditions. Lingcod (*Ophiodon elongatus*), a benthic egg layer, is an ecologically and economically significant predator in the highly-productive California Current System (CCS). We ran a flow-through mesocosm experiment that exposed Lingcod eggs collected from Monterey Bay, CA to conditions we expect to see in the central CCS by the year 2050 and 2100. Exposure to temperature, pH, and dissolved oxygen concentrations projected by the year 2050 halved the successful hatch of Lingcod embryos and significantly reduced the size of day-1 larvae. In the year 2100 treatment, viable hatch plummeted (3% of normal), larvae were undersized (83% of normal), yolk reserves were exhausted (38% of normal), and deformities were widespread (94% of individuals). This experiment is the first to expose marine benthic eggs to future temperature, pH, and dissolved oxygen conditions in concert. Lingcod are a potential indicator species for other benthic egg layers for which global change conditions may significantly diminish recruitment rates.

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