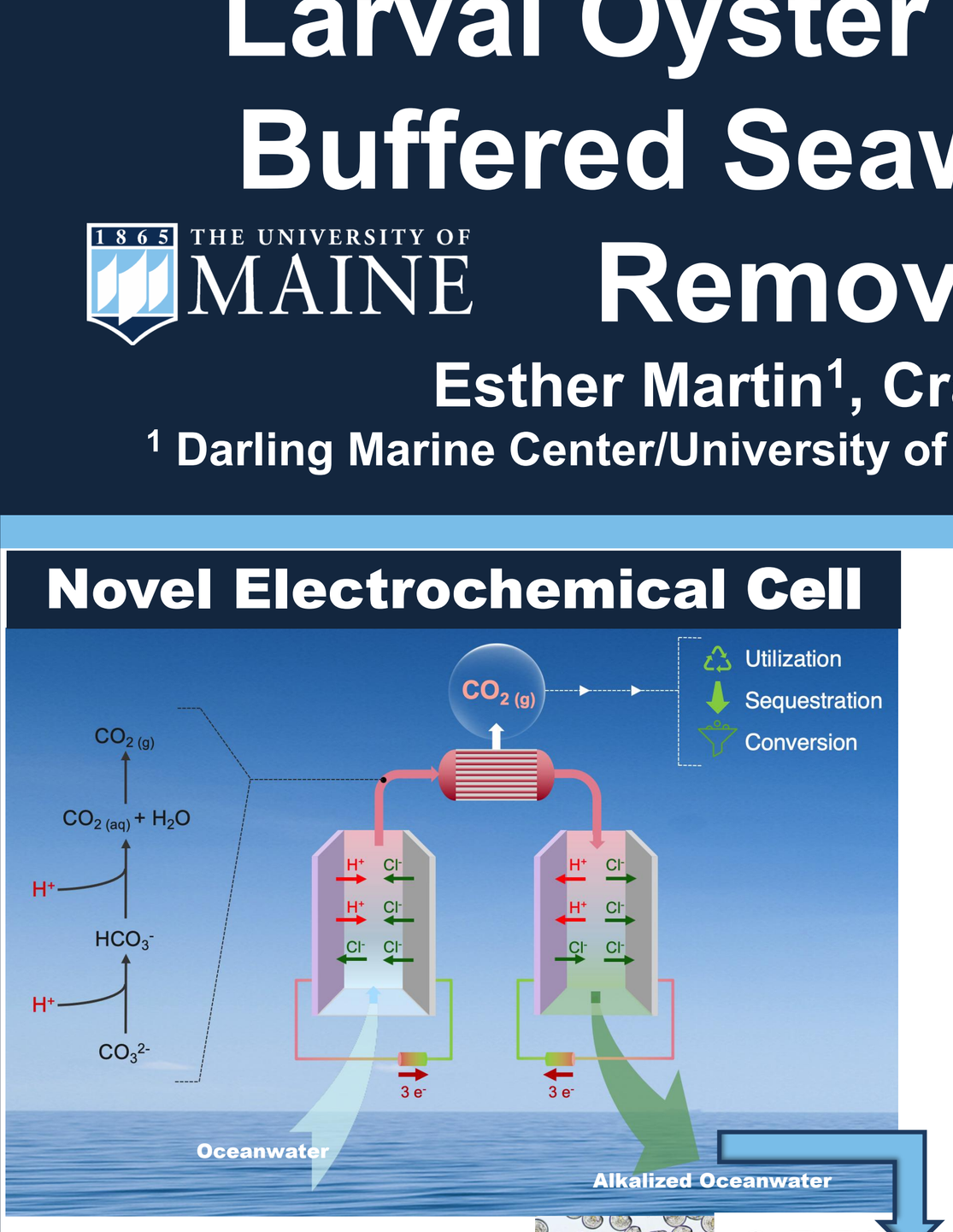
Larval Oyster Biocompatibility with Buffered Seawater from Novel CO_2 Removal Technology

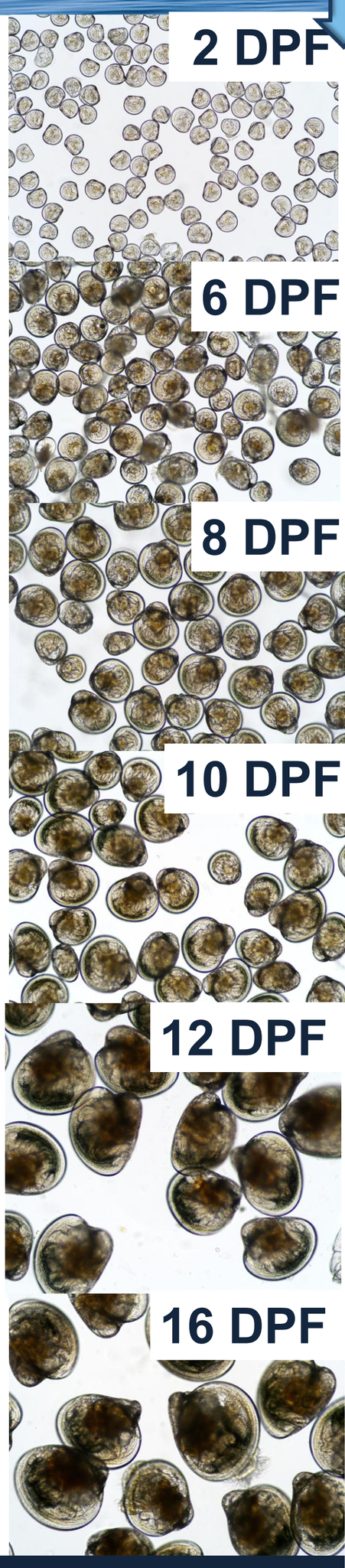
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Novel Electrochemical Cell



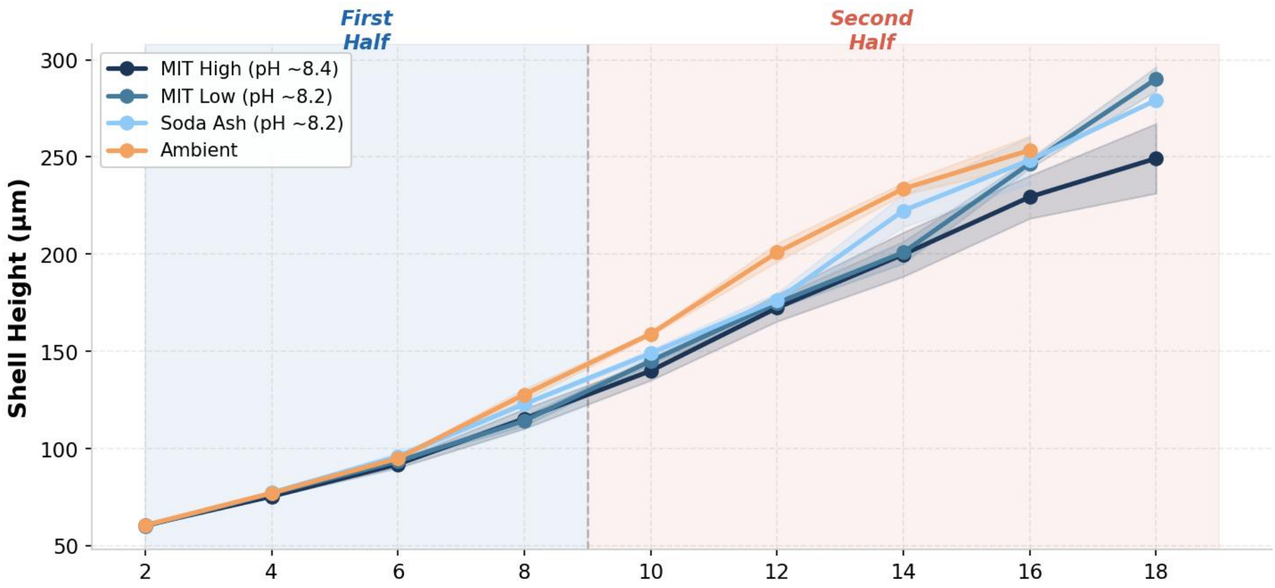
- Ocean acidification threatens larval shellfish by reducing aragonite availability for shell formation
- Hatcheries utilize buffers to mitigate risks of shell dissolution and to increase aragonite availability for larval oysters which can reduce energetic costs of early shell development
- This MIT–UMaine collaboration tests a novel electrochemical carbon removal cell that buffers seawater for potential hatchery use while sequestering CO_2
- The cell uses bismuth electrodes to create a chloride-mediated pH swing without chemicals or membranes required
- Seawater is acidified to release CO_2 in the first cell, then re-alkalized in the second cell enabling continuous, low-energy carbon capture

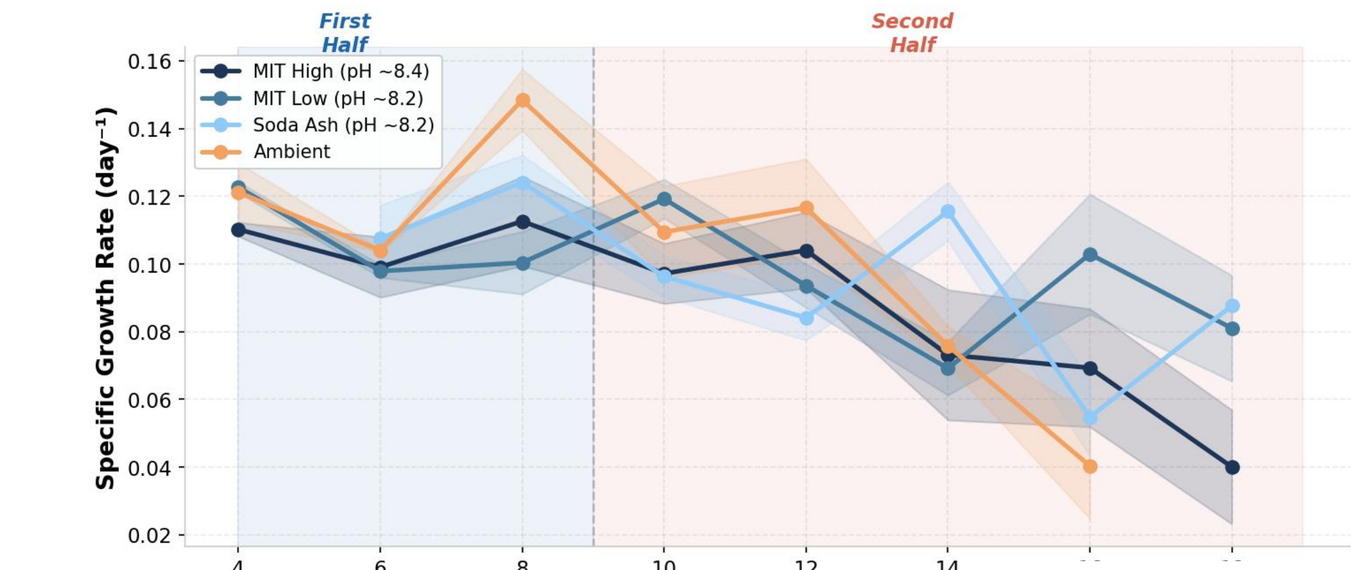


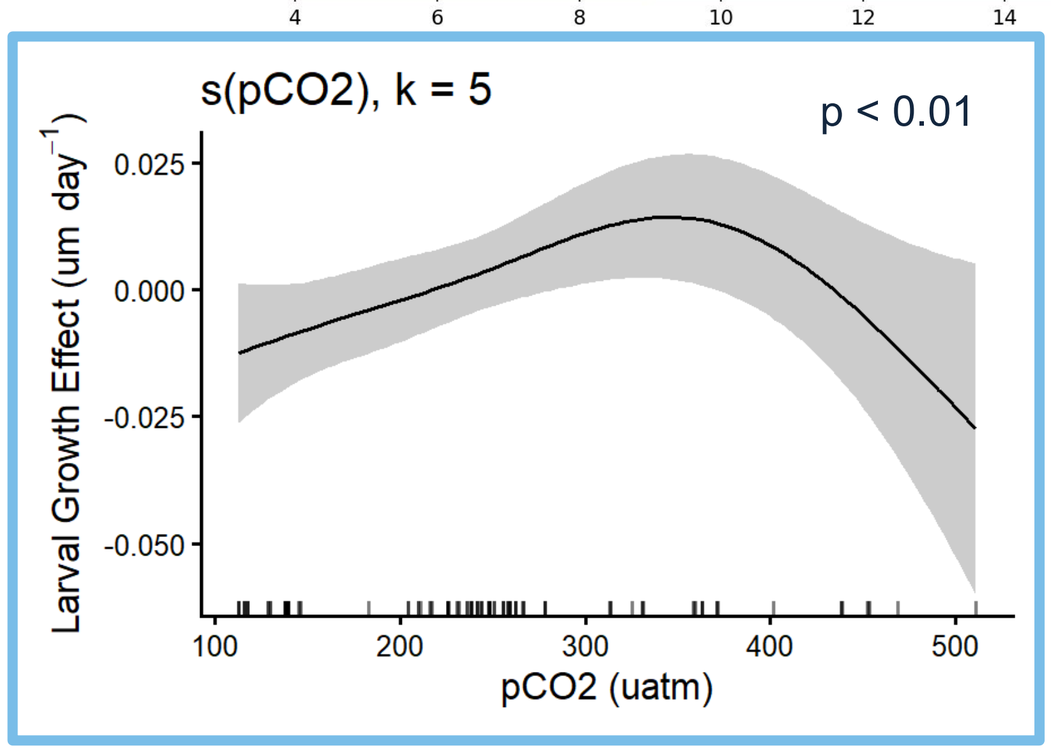
Animal Husbandry

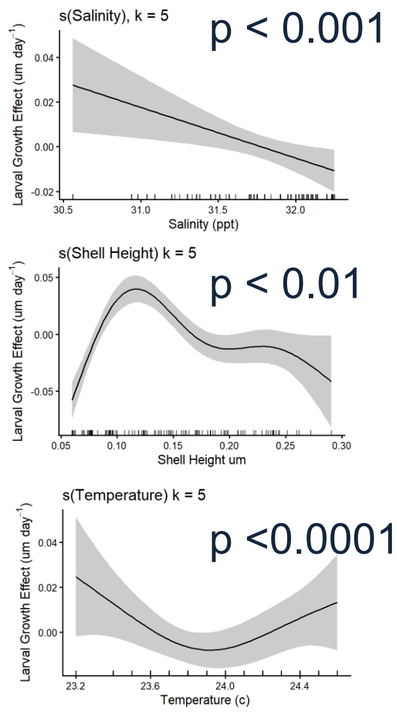
- Eastern Oysters (*Crassostrea virginica)*
- 4 treatments across 4 independent spawning events (February, March, April, May in 2026) (Only February data presented here)
- MIT High (pH ≈ 8.4) • MIT Low (pH ≈ 8.2) • Soda Ash (pH ≈ 8.2) • Ambient (pH ≈ 8.0)
- 3 replicate tanks per treatment; n = 50 larvae measured per tank every 2 days
- Full carbonate chemistry analysis includes TA, pH, salinity, temperature, DIC; ΩAr and pCO_2 calculated via CO2SYS







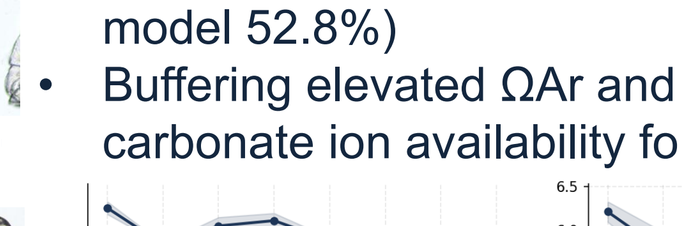




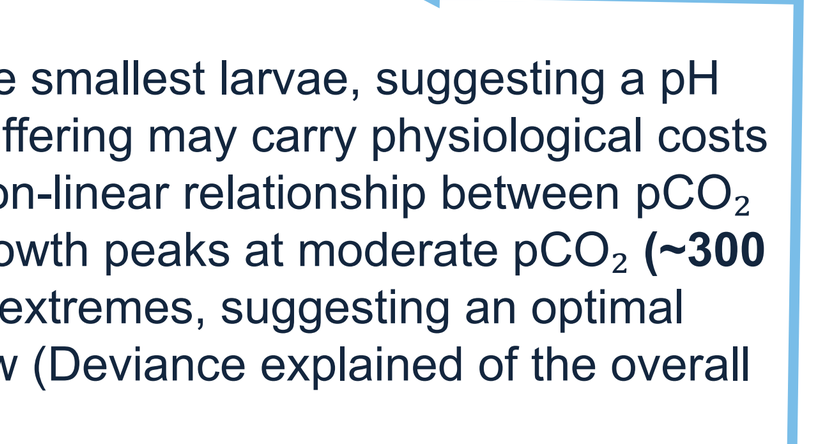
Growth Findings

- **MIT High (pH ≈ 8.4)** had the smallest larvae, suggesting a pH optimum exists and over-buffering may carry physiological costs
- GAM analysis confirms a non-linear relationship between pCO_2 and specific growth rate: growth peaks at moderate pCO_2 **(~300 µatm**) and declines at both extremes, suggesting an optimal carbonate chemistry window (Deviance explained of the overall model 52.8%)
- Buffering elevated ΩAr and pH, reducing pCO_2 and increasing carbonate ion availability for shell biogenesis

MIT buffer smooths variation in aragonite saturation. It is a liquid buffer that mixes quickly making it user friendly compared to a solid buffer.



Supported by ARPA-E. We thank the MIT team for their ongoing collaboration, Craig Condon for his commercial aquaculture expertise, and Damian Brady for his mentorship.



TA:DIC ratios confirm the MIT buffer raises alkalinity disproportionately relative to dissolved inorganic carbon, a distinct chemical signature from soda ash at equivalent pH

Sources: 1) Alan Hatton et al., (2022) "Electrochemical removal of carbon dioxide and related methods". WO 2022/1781192) S. Kim, M. Nitzsche, S.B. Rufer, J.R. Lake, K.K. Varanasi and T.A. Hatton, Energy Environ. Sci., 2023, DOI: 10.1039/D2EE03804H.!.
2) Ekstrom et al. "Vulnerability and adaptability of US shellfisheries to ocean acidification* Nature Climate Change 5, 207-214 (2015)
3) Salisbury et al. Coastal Acidification by Rivers: A Threat to Shellfish Eos Transactions American Geophysical Union 89(50) (20008)