The effect of simulated warming ocean temperatures on the bacterial communities on the shells of healthy and epizootic shell-diseased American Lobster (*Homarus americanus*)

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American lobster (*Homarus americanus*)

Image: https://www.fisheries.noaa.gov/species/american-lobster

Maine pronunciation guide: “lob-stah”

Image: https://www.maine.gov/dmr/science-research/species/lobster/lobsterlicenseplate.html

Marine crustaceans

Ecological impact not well studied in all lobster species

- Mid-trophic level: push energy from primary producers up the food chain)
- Scavenge detritus / turnover decaying material

Molt their shells to grow

Up to 100 year lifespan

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Atlantic lobster industry

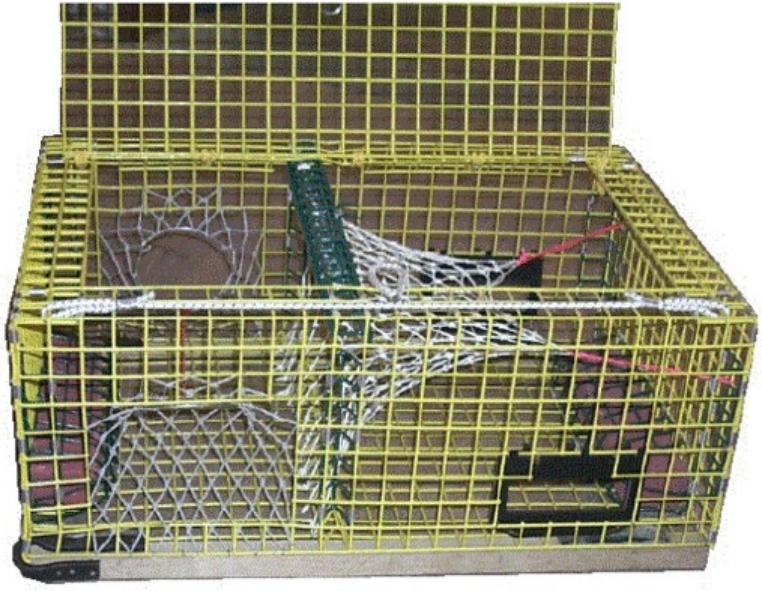

Image: https://www.fisheries.noaa.gov/species/american-lobster#commercial

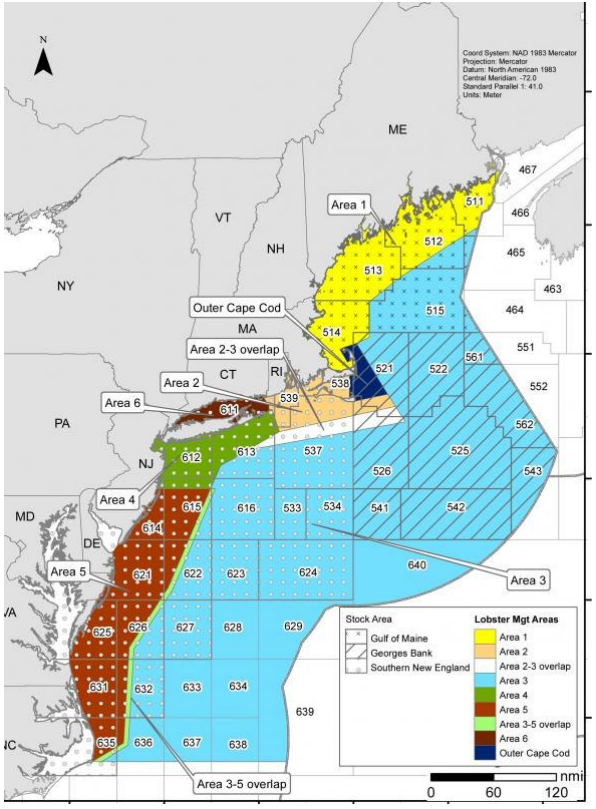

Image:penbaypilot.com/article/lobster-catch-maine-down-southern-new-england/57279

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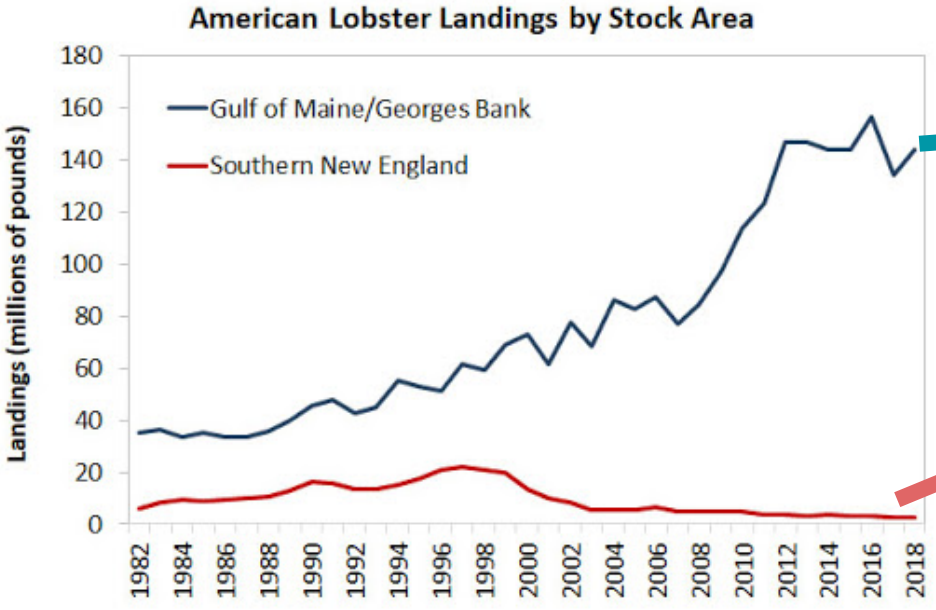
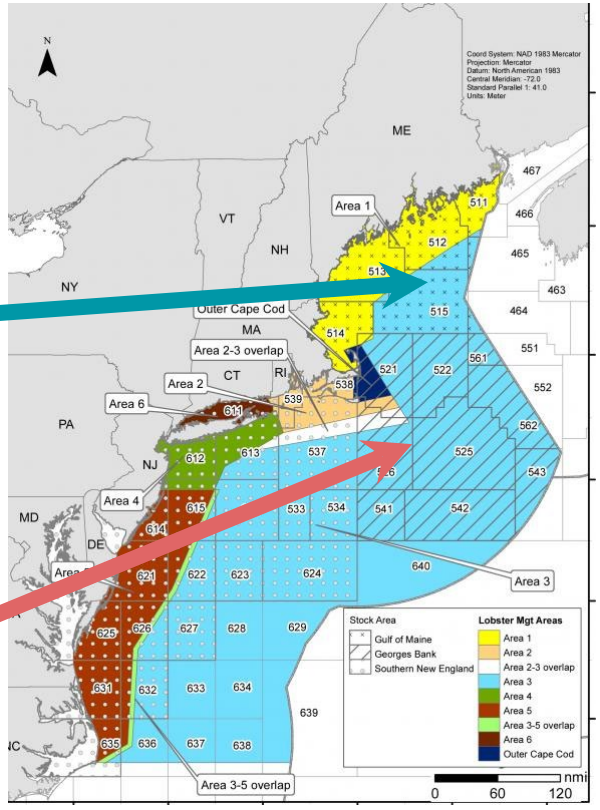
North Atlantic lobster industry



Source: Atlantic States Marine Fisheries Commission



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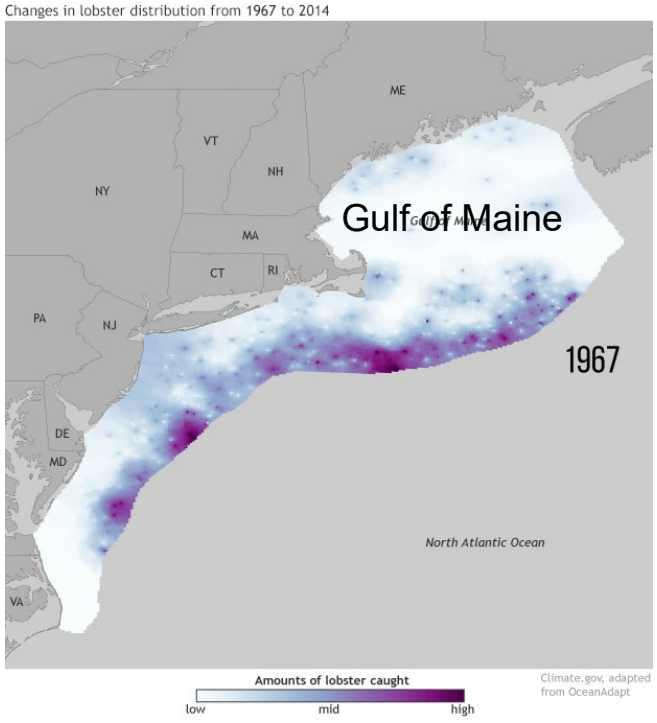
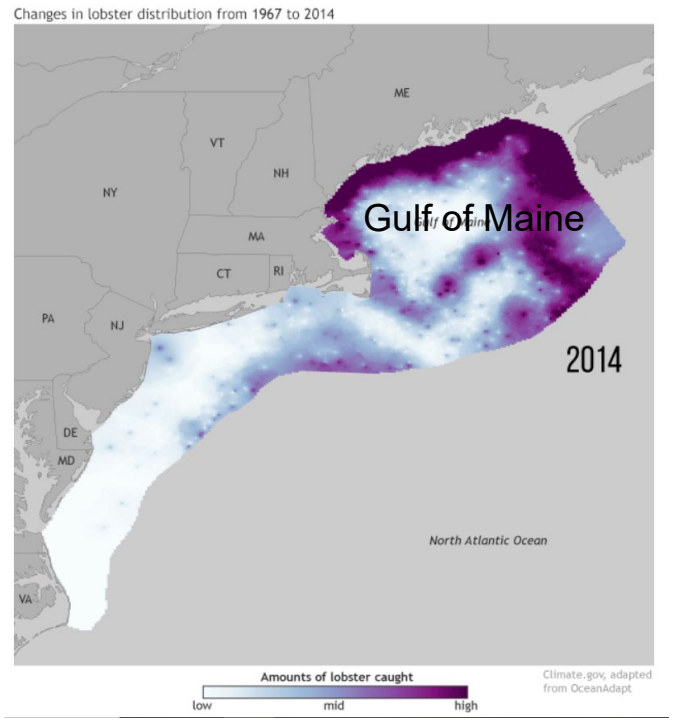
Warming coastal waters pushing lobsters north





Source: https://www.climate.gov/news-features/climate-and/climate-lobsters

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Epizootic shell disease (ESD)

Causative agent(s) unknown

Causes pitting or softening of the shell

- Is not known to kill a lobster directly
- Increases susceptibility to infection, predation, physical damage

Advancing rapidly in wild populations

- Connection to ocean warming?

Image: https://www.vims.edu/research/departments/eaah/programs/crustacean/research/lobster_shell_disease/

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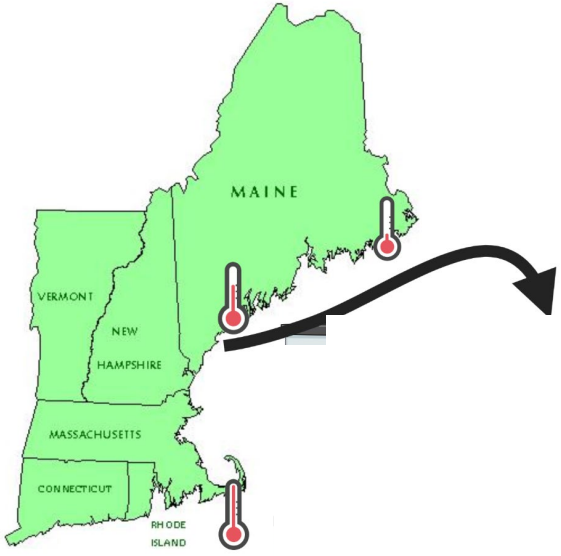
Experimental design

57 female lobsters collected from southern Maine coastal waters

Management zones F, G



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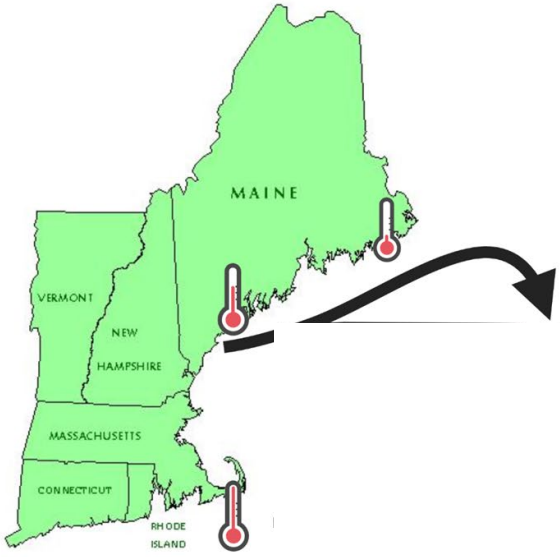
Experimental design

Lobsters were assessed for visible shell disease and scored by percent of shell covered (Smolowitz et al., 2005)

- 0, no observable signs
- 1, on 1 - 10% of shell
- 2, on 11 - 50% of shell
- 3, on >50% of shell



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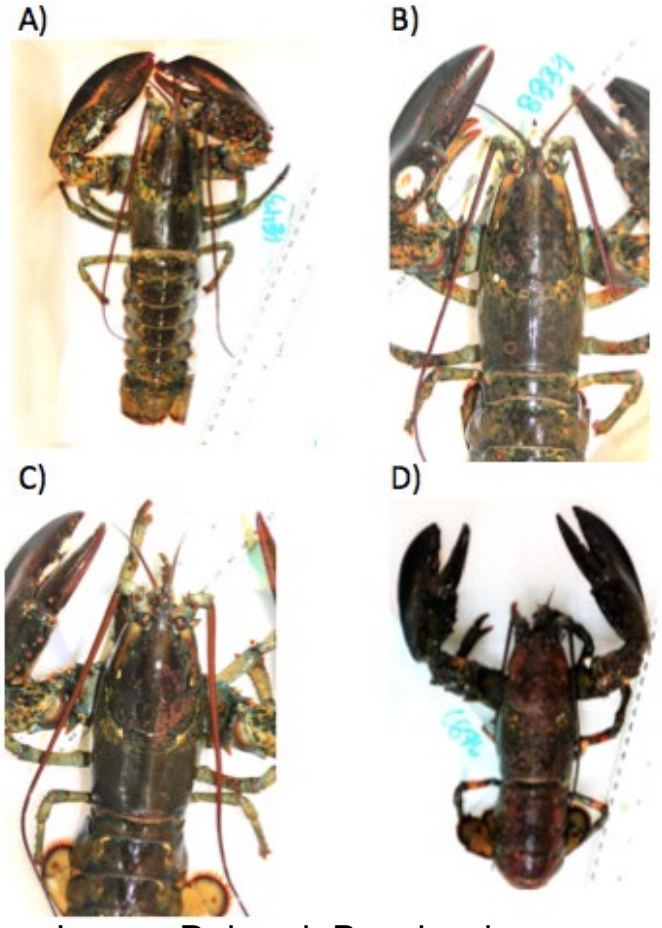

Image: Deborah Bouchard

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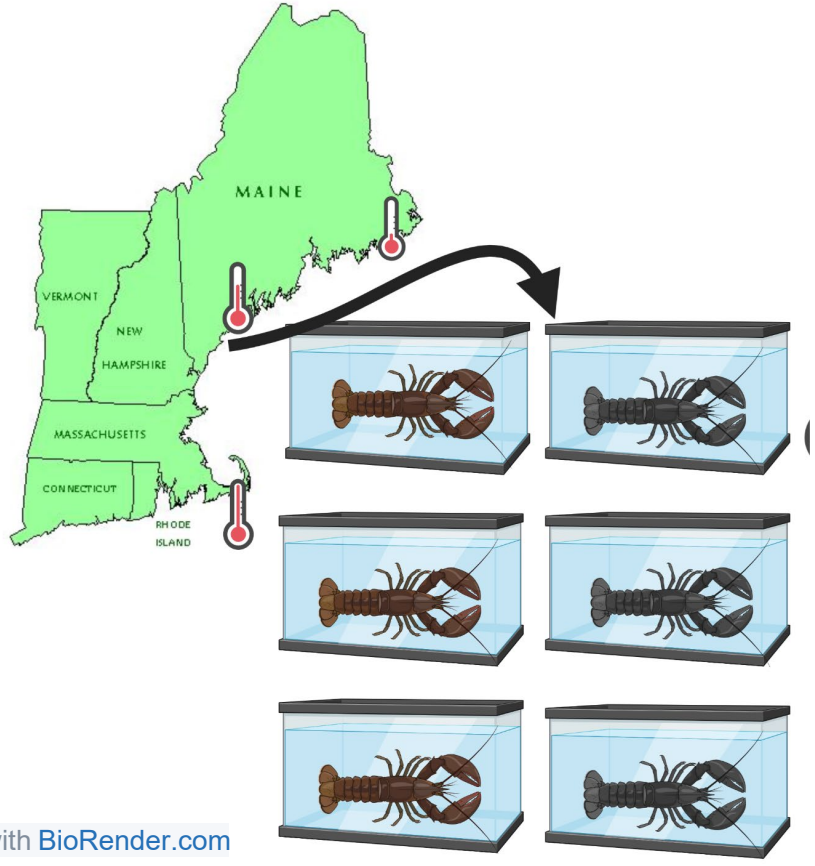
Experimental design

Lobsters were placed into separate tank systems based on

A) Apparently healthy
B) Shell Disease Index 1 - 3

Lobsters housed in individual tanks



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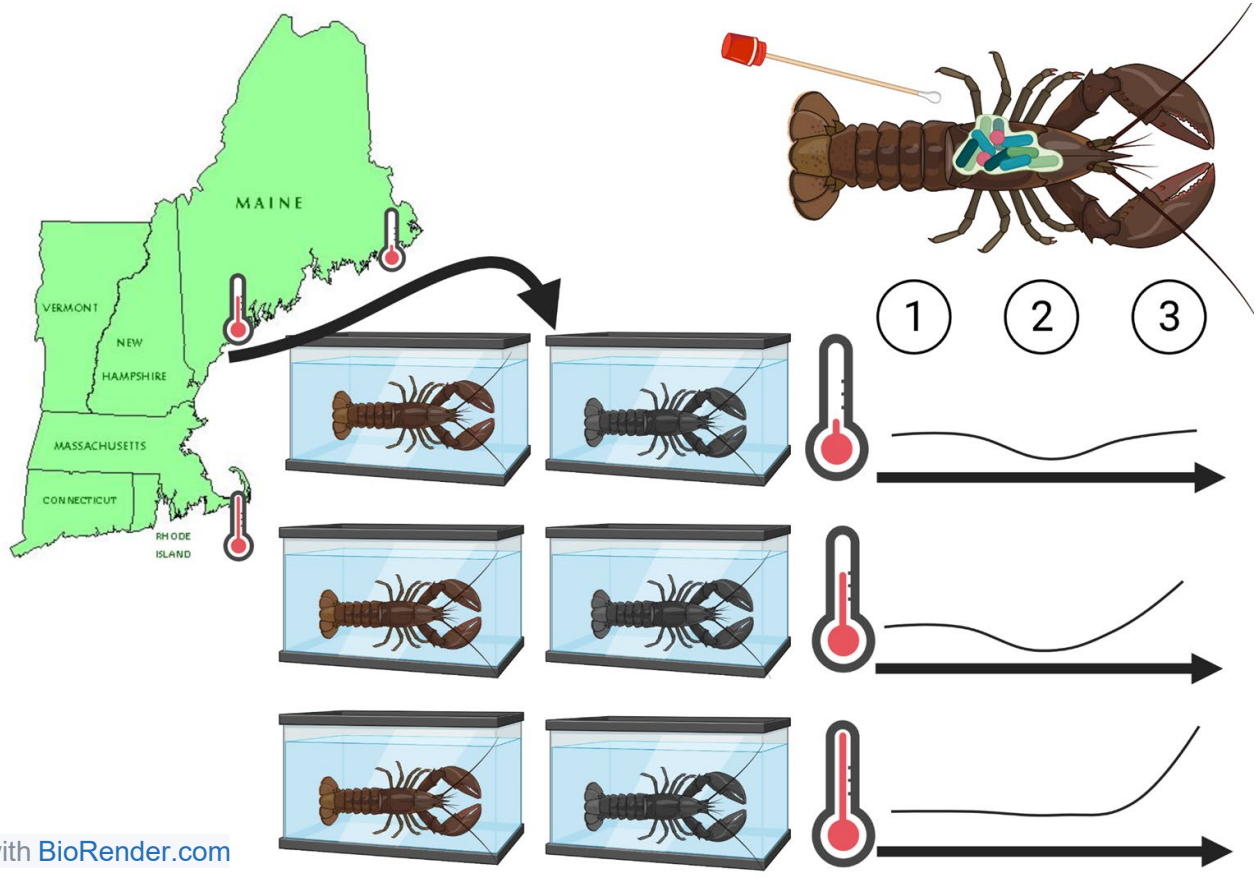
Experimental design

2 weeks of adaptation

Baseline sampling (summer)
- Tank water a 11℃

4 months later (winter)
- Tank water respective to regional simulation

10 months later (summer)
- Tank water respective to regional simulation



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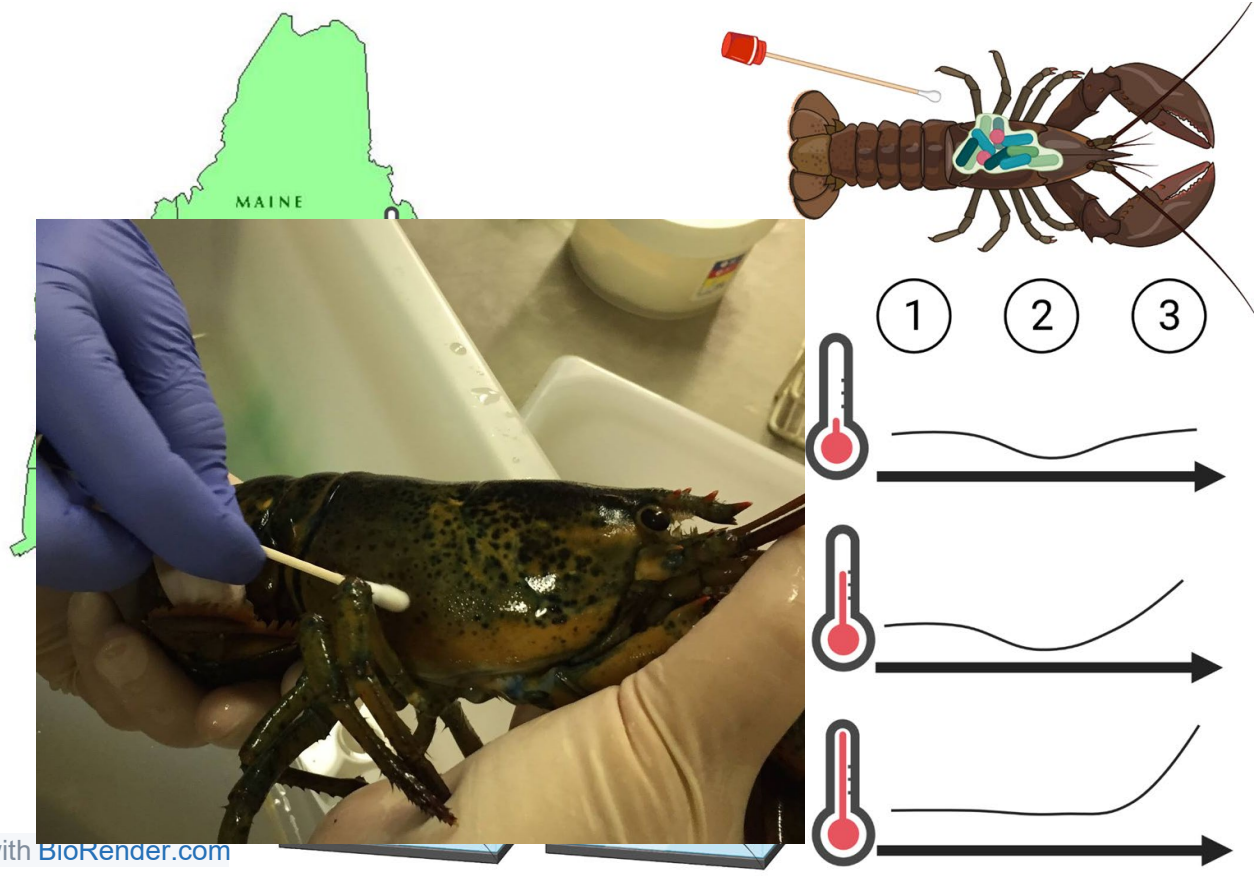
Experimental design

Samples collected at 3 timepoints

- Shell bacterial community, lobster weight, lobster length, Shell Disease Index

A designated portion of the shell was swabbed to sample shell-associated microbial community



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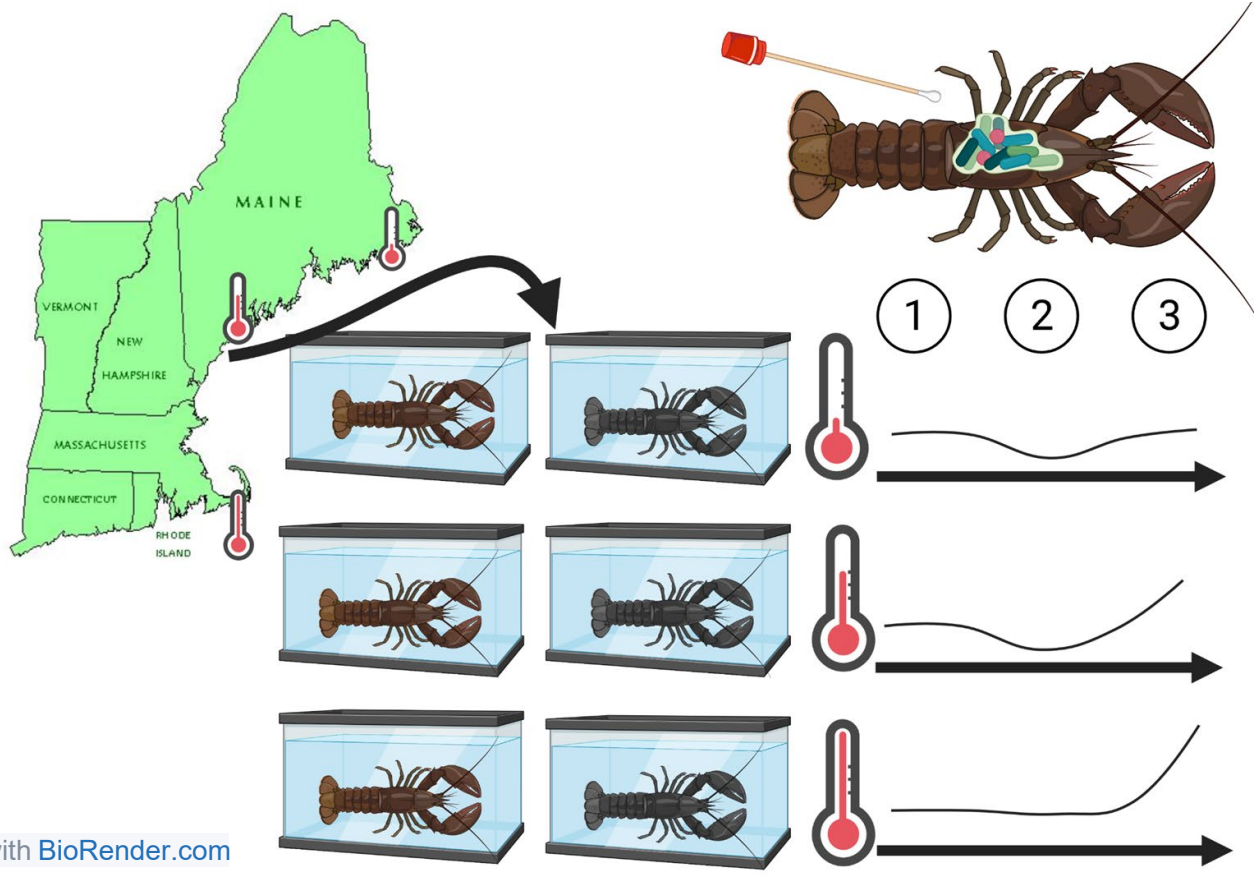
Experimental design

131 experimental samples, plus 10 controls

- PCR amplification and purification,
- Illumina MiSeq ver. 4 sequencing,
- passed quality-control filtering.

Sequences were processed using the R software platform, using DADA2, phyloseq, vegan, and assorted other packages.



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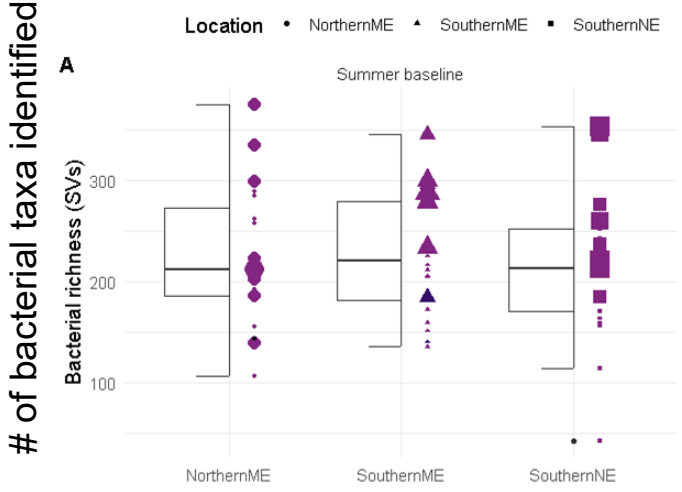
Bacterial richness on shells was same at baseline (as expected)



All lobsters collected from same location

Baseline is 2 weeks after collection, all at 11℃

Point shape = location the tank temperature will mimic

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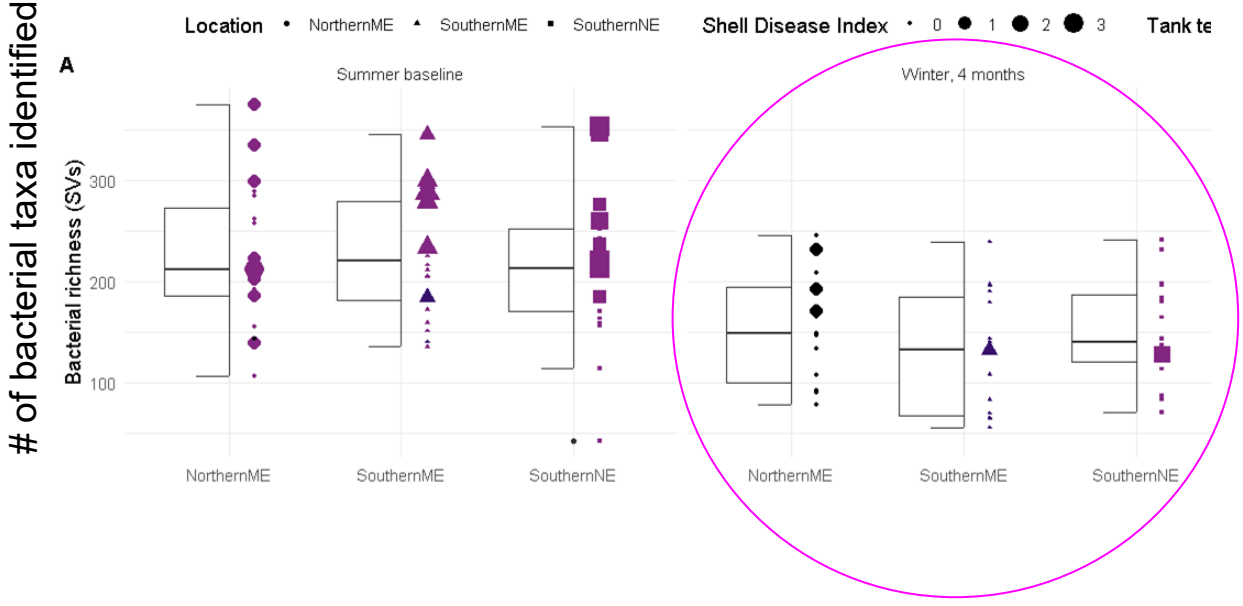
Bacterial richness on shells affected by tank temperature



After 4 months in tanks, all lobster shells hosted fewer bacterial taxa

Starting to see differences by simulated geographic ocean temp

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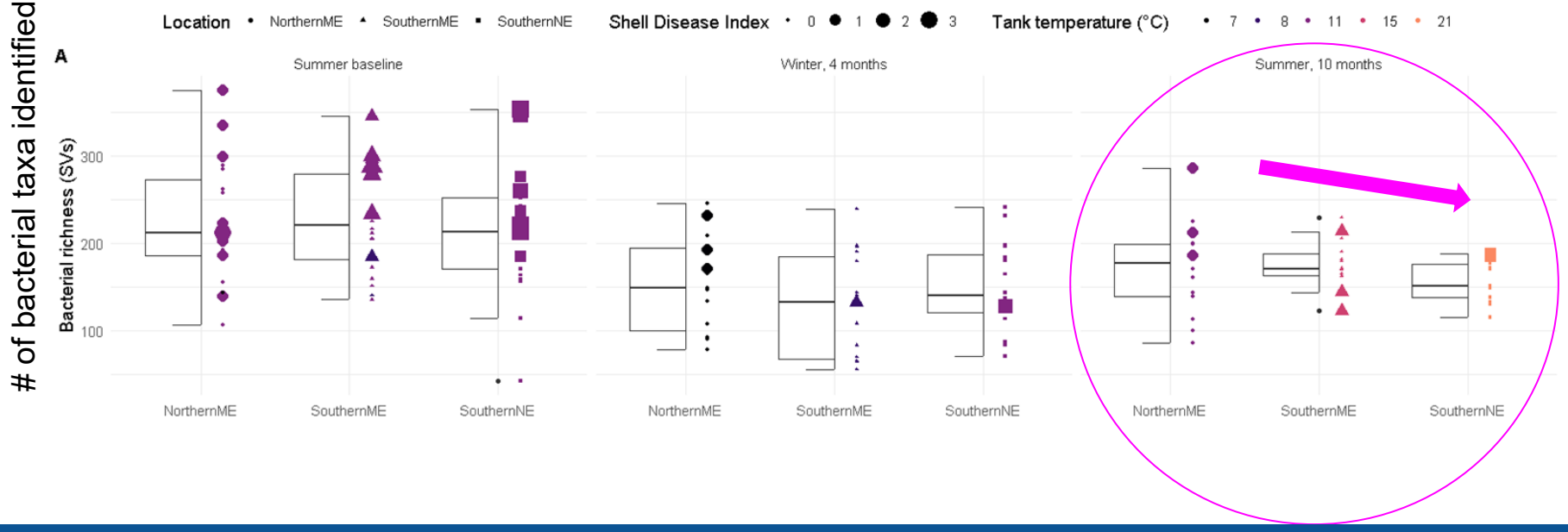
After 10 months, lobster shells in warmer water host fewer different bacterial taxa



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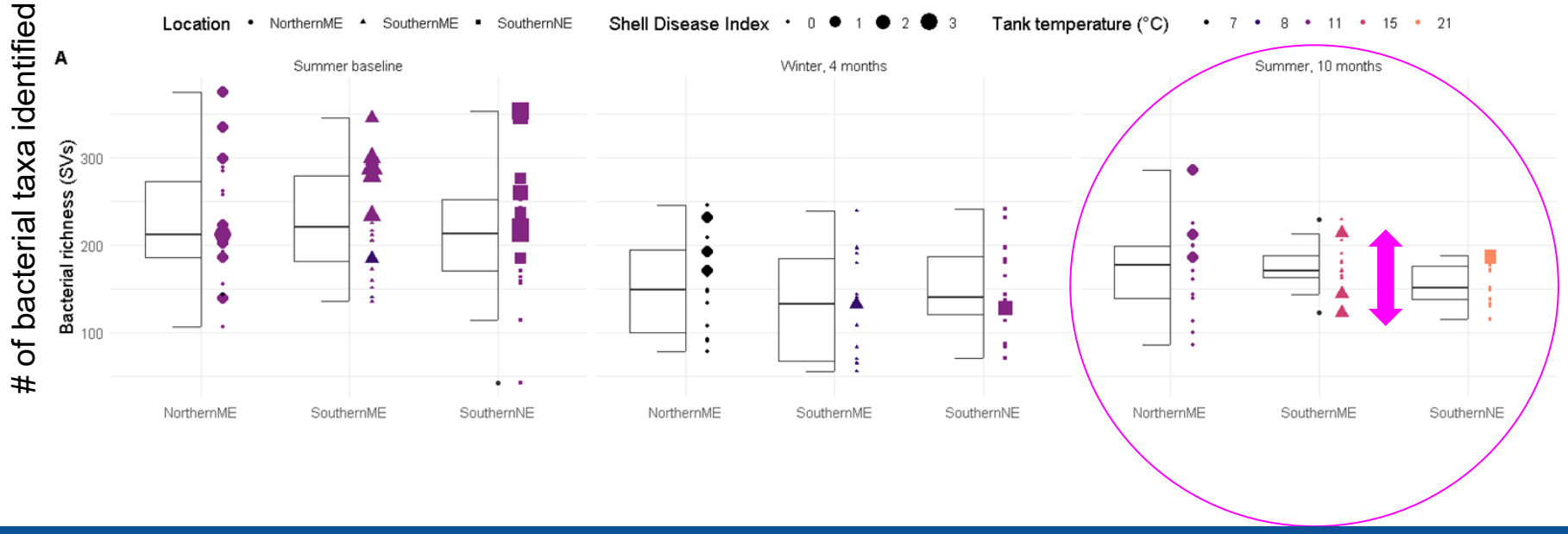
Lobster shell bacterial community richness in warmer water were less variable



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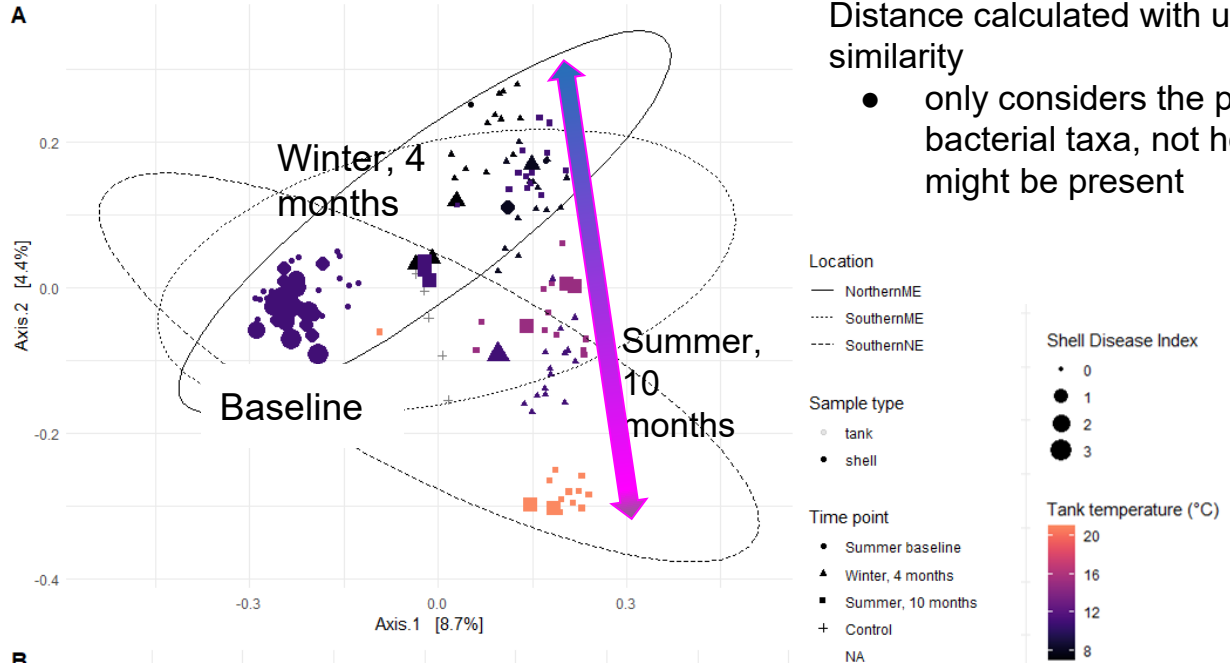
Tank temperature affects “who” is found on lobster shells



Distance calculated with unweighted Jaccard similarity

- only considers the presence or absence of a bacterial taxa, not how many of that taxa might be present

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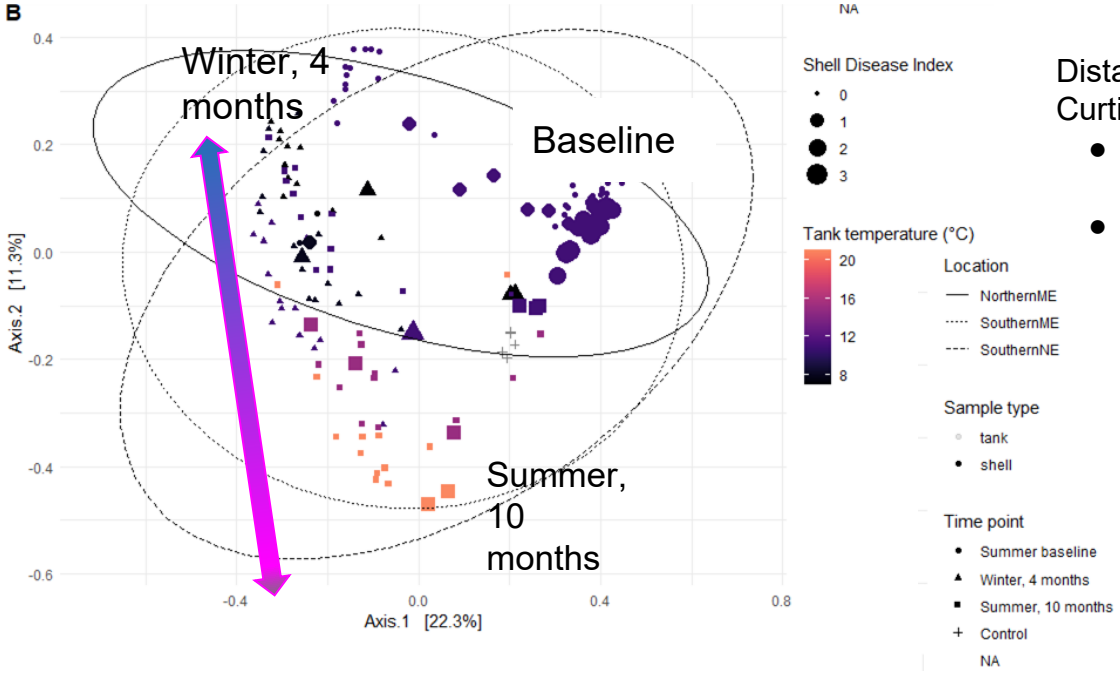
Tank temperature affects abundance of each bacterial taxa found on lobster shells



Distance calculated with weighted Bray-Curtis similarity

- considers the presence/absence of a bacterial taxa
- AND how many of that taxa might be present (abundance)

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Subtle changes to the bacterial community in healthy vs. epizootic shell diseased

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Broader impacts of this work

New England lobster industry survey:

- Been lobster fishing for decades
- Most have significant financial investments in their business (personal funds, loans)
- 9 - 36% have not finished high school
- In Maine especially, few local economic alternatives

Surveyed by Gulf of Maine Research Institute, 2008, http://www.lobstermen.com/wp-content/uploads/2009/10/RES_DH_reports_Lobster-Socioec-Survey.pdf

Image: https://pixabay.com/photos/boating-lobster-fisherman-fishing-1343347/

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