

Sea-cage aquaculture impacts market and berried lobster (*Homarus americanus*) catches

I. Milewski^{1,*}, R. H. Loucks², B. Fisher³, R. E. Smith², J. S. P. McCain¹, H. K. Lotze¹

¹Department of Biology, Dalhousie University, Halifax, Nova Scotia B3H 4R2, Canada

²RH Loucks Oceanology Ltd., Halifax, Nova Scotia B3M 1L3, Canada

³Port Mouton, Nova Scotia B0T 1T0, Canada



Background

- Port Mouton Bay is an historically important habitat for lobsters, supporting generations of fishers
- Within 2-3 year from the start of fish farming operations in the Bay, fishers observed declines in catches
- Lobster fishers in New Brunswick have also reported declines but no data has been collected



Port Mouton Fish Farm

- first fish farm appeared in 1995
- 2007-2009 stocked with Atlantic Salmon
- fallowed 2009 -2012
- 2012-2014 stocked with rainbow trout
- 2015-2017 fallowed

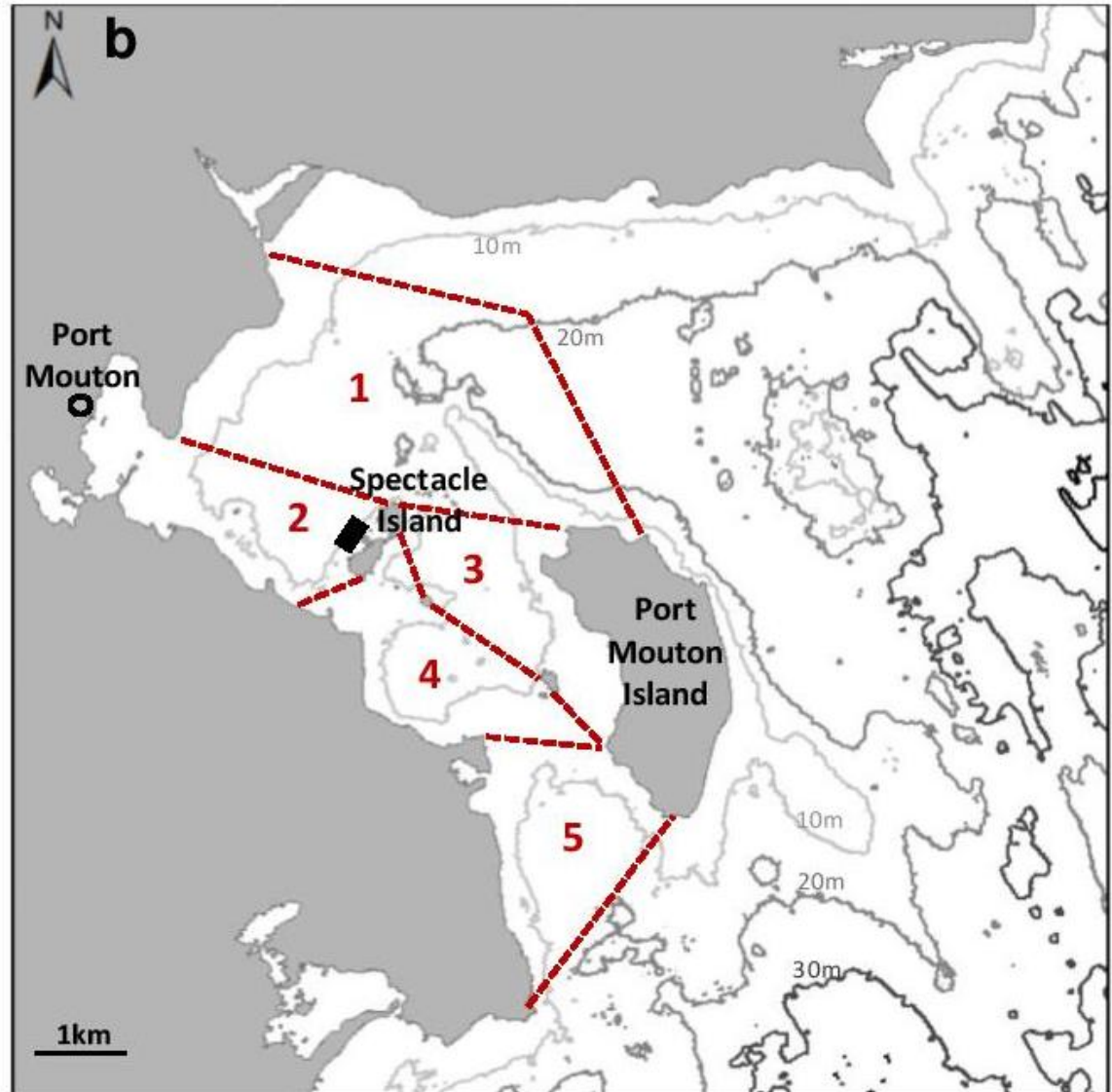


How did we do our study?

- recruited up to 15 boats and ~30 fishers
- fishers divided inner Port Mouton Bay into five traditional fishing regions
- catches of market lobsters and berried female counts reported for the last two weeks of May beginning in 2007 to 2017
- Fishermen and Scientists Research Society provided bottom temperature loggers; Society retrieves data and provides daily mean temperatures
- catches and counts were standardized by effort

Fishing Regions

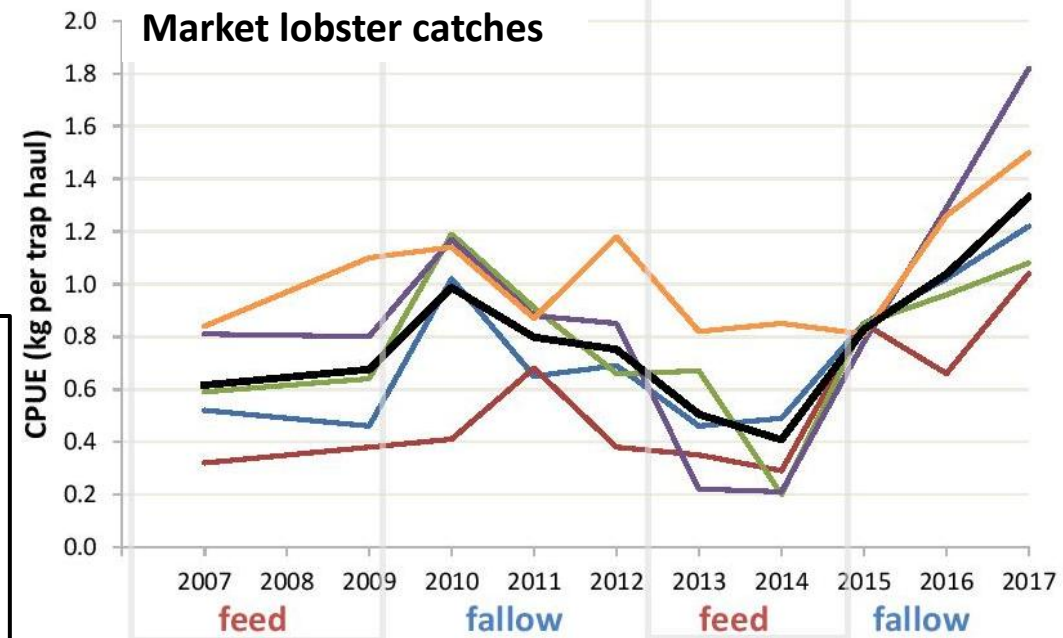
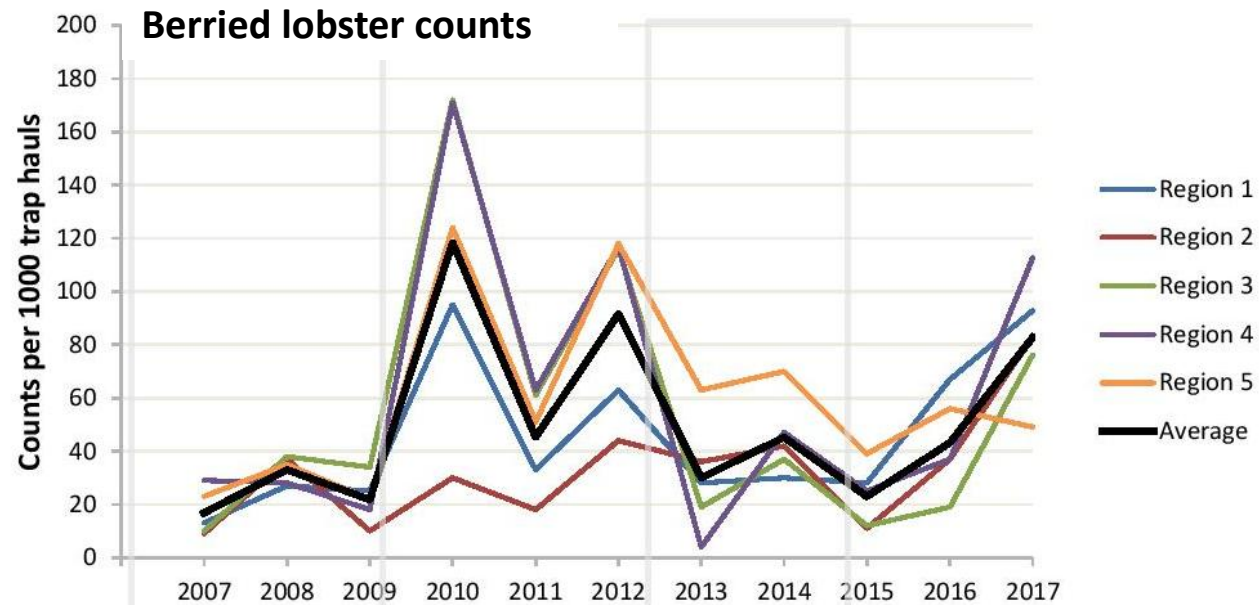
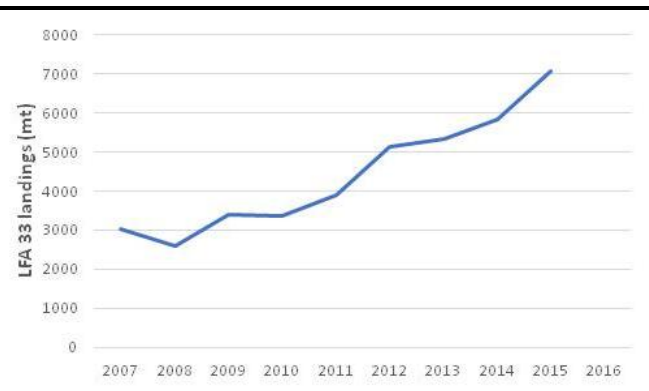
- cover an area of 26 km²
- fish farm located in fishing Region 2
- all fishing regions have same amount of suitable lobster habitat (gravel, mud, sand, rocky ledges)
- water depths range from 4-16 m in each fishing region



Results

- market lobster catches and berried counts fluctuated in Port Mouton Bay between 2007-2017

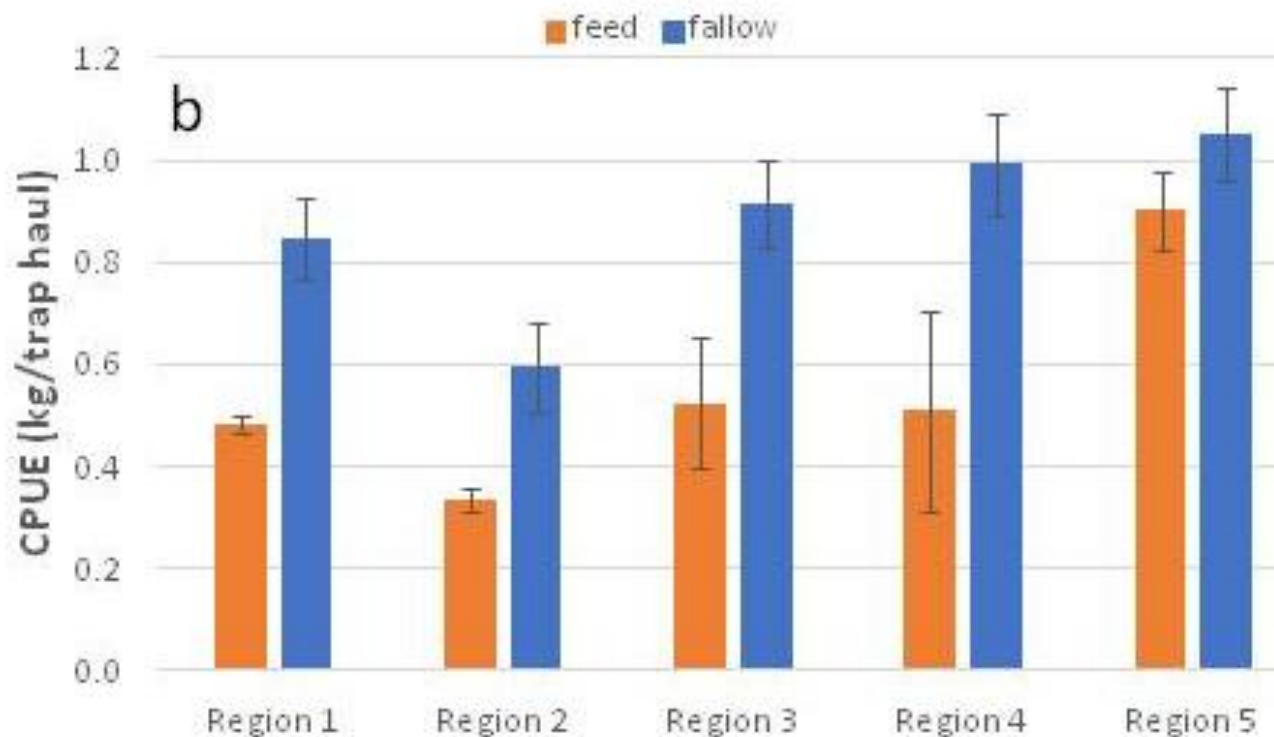
- market lobster catches in LFA 33 increased between 2007-2017



Results:

Market Lobster

- CPUE significantly ($p < .01$) higher during fallow (0.96 ± 0.09 SE) vs feed (0.55 ± 0.06 SE) period
- 42% average drop in catch between fallow vs feed periods
- Catches in Region 2 remained low during fallow periods vs other Regions
- Catches in Region 5, furthest from the fish farm decline during feed periods but were higher than other Regions



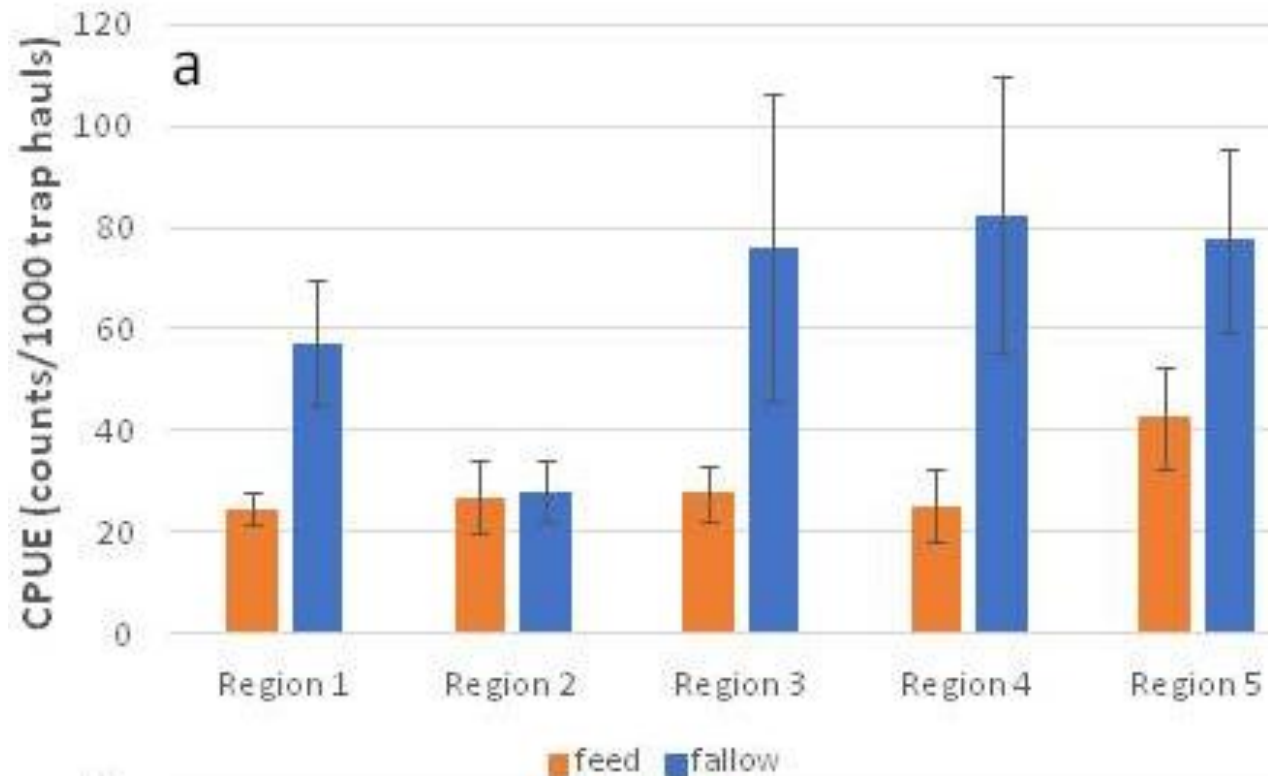
Results:

Berried Lobster

- Counts significantly ($p < 0.001$) higher during fallow (64.3 ± 14.7) vs feed (29.4 ± 4.9) periods

- 56 % average drop in counts between fallow and feed periods

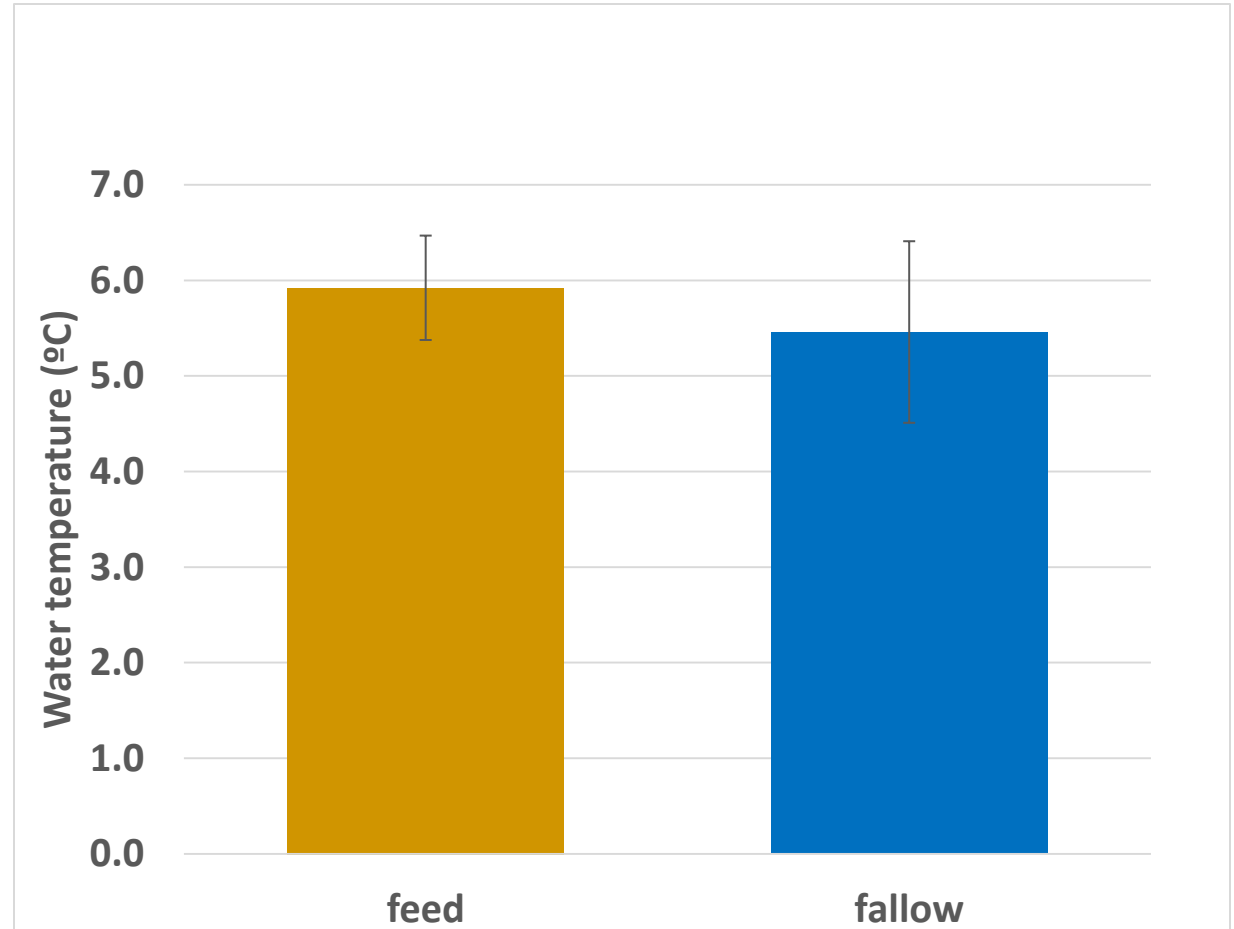
- Counts in Region 2 remained low during fallow periods compared to other Regions



Results:

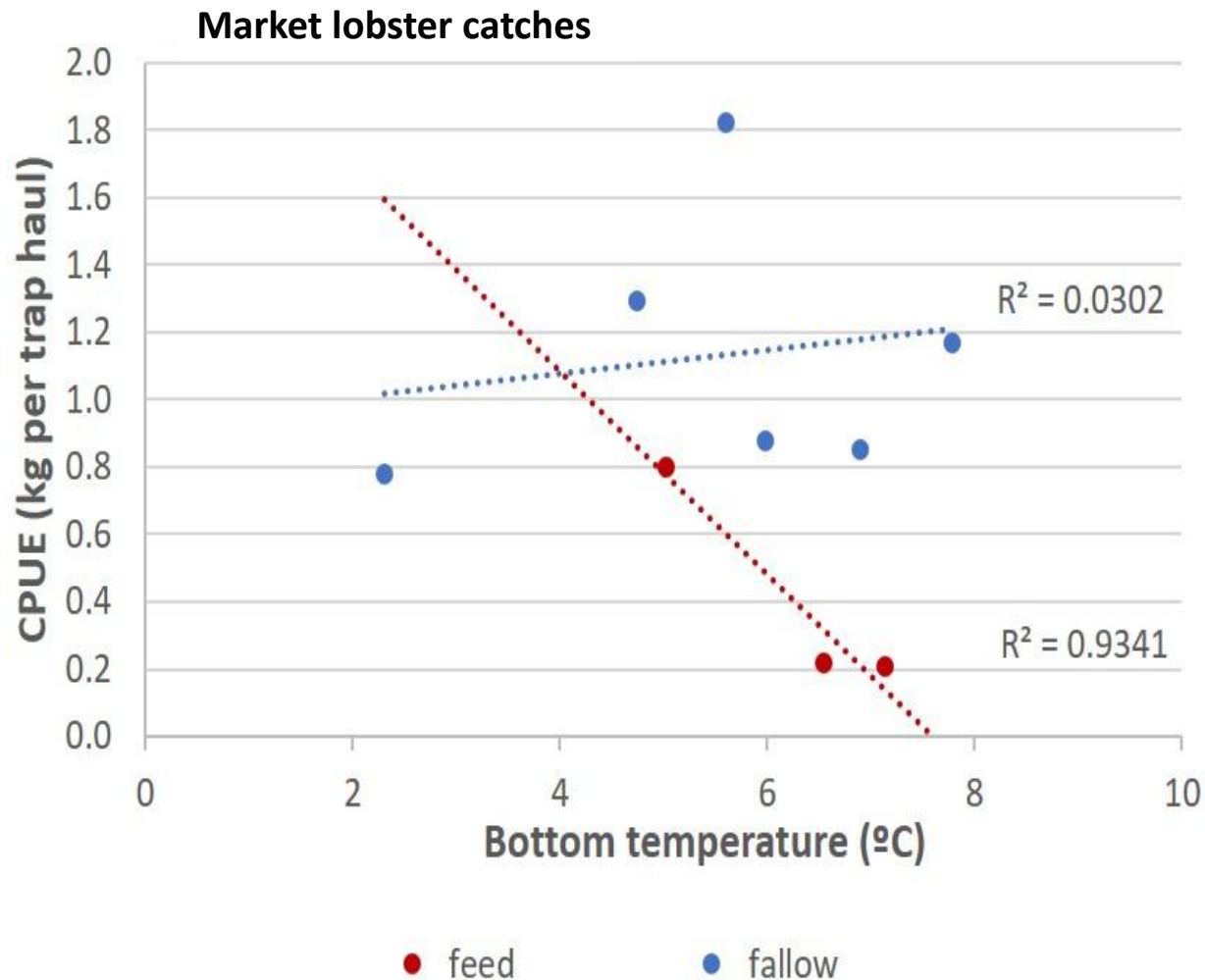
Bottom Temperature

- Bottom water temperatures during the study period (2007-2017, last two weeks of May) were not significantly different during feed and fallow periods



Results: Temperature effects on market lobster

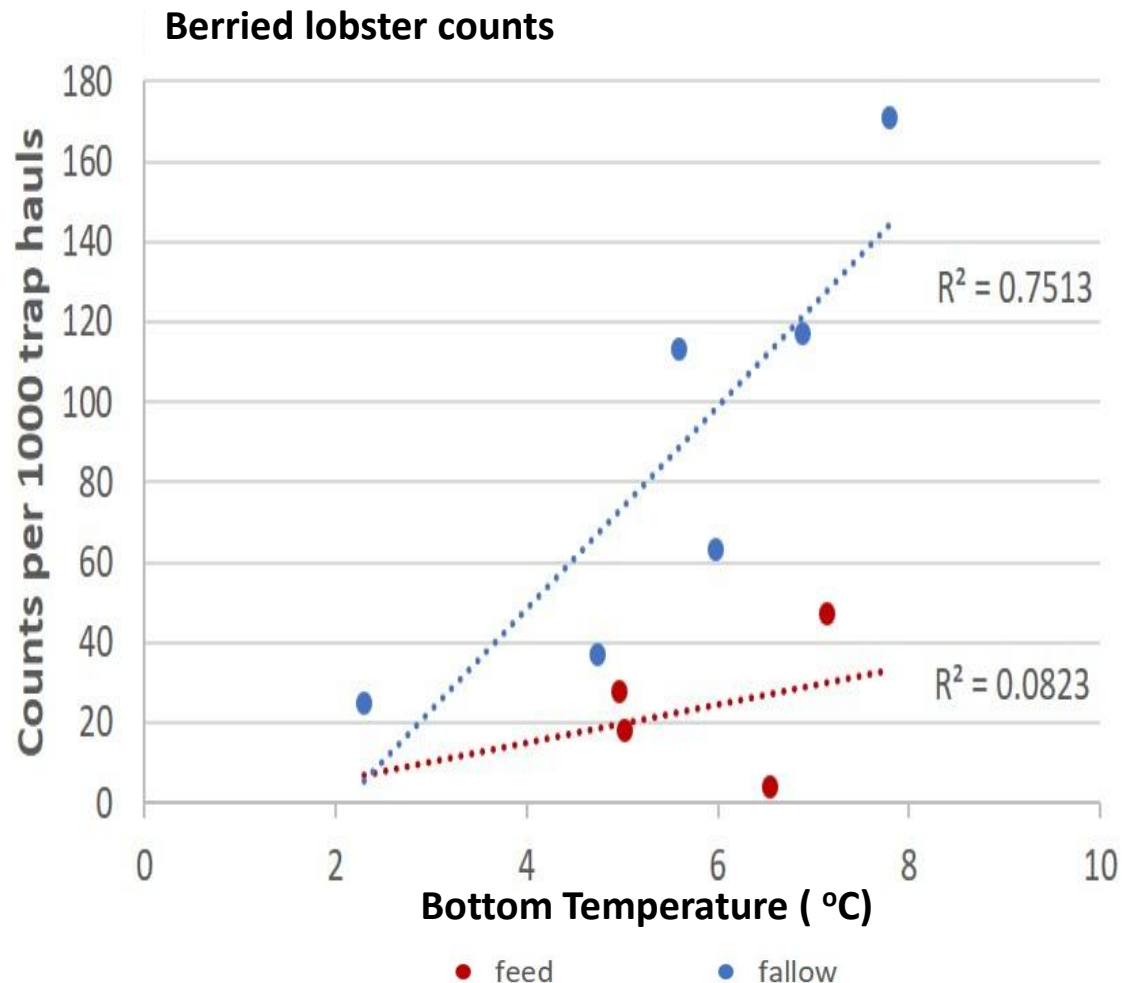
- Catch rates unaffected by increases in temperature during fallow periods
- Catch rates decline as temperature increase during fish farm feed periods
- Data suggests the negative effects of aquaculture override the temperature effects



Results:

Temperature effects on berried lobster

- Counts increased as temperature increases during fallow periods
- Counts only slightly increased when temperature increase during feed periods
- Data suggests the negative effects of aquaculture override the temperature effects



Other factors affecting lobster catches

- Moulting
- Wind
- Fishing effort
- Odour plumes and turbidity

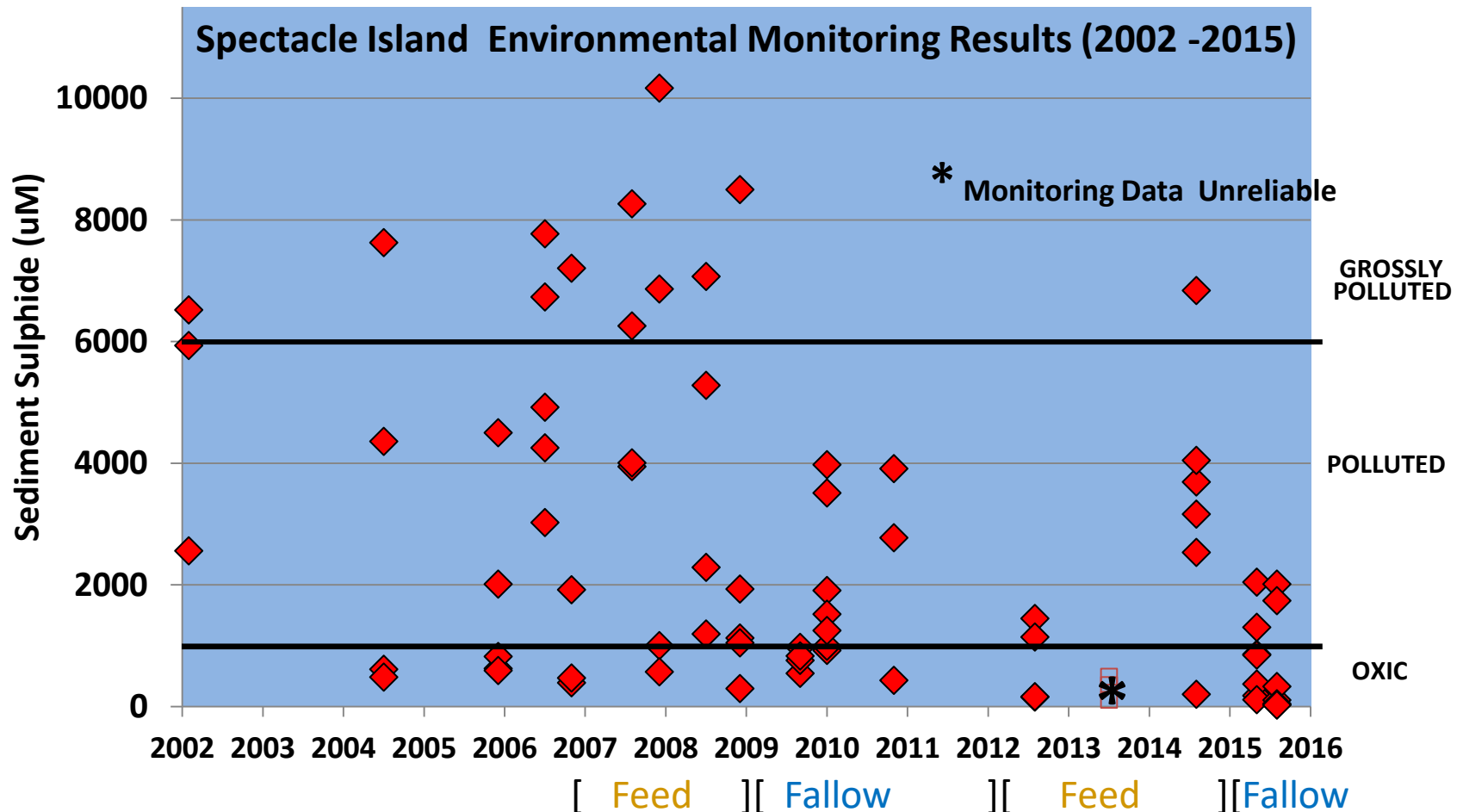


Lobster and Habitat Quality

- Lobster “sniff” the odour seascape with their antennules and chemoreceptors found on their legs
- Odours are used to locate food, find mates, detect predators and avoid environmental stresses
- Sulphides and ammonium have toxic and behavioural effects on adults and other lobster life stages
 - In laboratory studies, 50% of lobsters die within 3.3 days in low oxygen, low sulphides (5.5 μM) and ammonium (17 μM) conditions (Draxler et al. 2005)
- Berried lobster are very sensitive to odours and temperature
 - Berried lobster show retreat behaviour at 50 μM sulphide (Butterworth et al. 2004); at 500 μM and regular oxygen conditions, 50% of lobster died in 22.5 hr

Fish Farm Waste : Feces and Feed

- ~400,000 rainbow trout = ~ 760 mt /yr
- Fecal and feed waste production = ~ 130 mt/yr



Fish Farm Waste : Nitrogen Pollution

- Farm dissolved nitrogen (N) waste ~ 30 mt/yr
- Farm represents an ~ 14% increase in total dissolved N to Port Mouton Bay
- dispersion potential of N by currents is ~10-11 km



Effects of N Pollution

- Decrease in water quality
- Increase in epiphyte growth on eelgrass
- Increase in benthic algae
- Increase in nuisance or “slime” algae



Conclusions

- Lobster catches and counts significantly declined during feed compared to fallow periods
- Differences in catch and counts during feed and fallow periods are not driven by temperature
- Berried lobsters appear more sensitive to aquaculture and temperature effects than market lobsters
- Odours and water quality changes are likely reasons for changes in catch rates
- Protection and conservation of key lobster/shellfish habitat critical in the face of multiple environmental stressors

Thank You

- Lobster fishers of Port Mouton Bay
- Friends of Port Mouton Bay
- Fishermen and Scientist Research Society
- Canada Ocean Partnership