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Negative Effect of Jellyfish on the American Lobster in the Gulf of Maine

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It is important to quantify how larger jellyfish blooms may affect other species, and how jellyfish can be used as an indicator species. This project investigates a potential relationship between larvae lobsters and jellyfish in the Gulf of Maine. It is plausible that the larvae would be competing with smaller jellyfish for the same zooplankton as a food source. Furthermore, larval lobsters may also be prey for some jellyfish, as larger medusae have more diverse feeding habits. I used three data sources; the first being a citizen science data base of jellyfish through GMRI, the Bigelow Lab for Ocean Sciences, and the Island Institute, larval tow data, and American Lobster Settlement Index (ALSI) data, focussing only on the lobsters under 13 millimeters. The first souces were used to determine immediate effects, and the ALSI data to determine sustained effects. Nearly all years of jellyfish data (excluding 2019) show considerable increases around the 180th day of the year. This could be due to geographical patterns, as the larval tow data shows similar patterns. Comparing the jellyfish data to ALSI data annually shows a pattern of lobster abundance decreasing as jellyfish increase. In 2016, jellyfish abundance was 116% of the previous year's, and was the largest abundance of the data set. The opposite occurred in the ALSI data, where 2016 was the most dramatic negative shift. Using 2015's average of .298 as a baseline, 2016 was 78% of 2015. Other years saw positive shifts of 120% (2017) and 125% (2019. This has pointed to a correlation between the two species, although it is less significant than other indicator relationships for lobster larvae. Although this does not function to clearly quantify the impact of jellyfish on lobsters, it does encourage further evidence into the relationship.

Introduction

Recently, jellyfish abundance has been increasing across the world, with prominent examples in the Bering sea or the Black Sea. Whether this is due to long-standing, periodic patterns in growth (Condon 2012), or changing oceans and eutrophication, it is important to quantify how these larger blooms will affect other species, and how jellyfish can be used as an indicator species. I was specifically interested in a potential relationship between larvae lobsters and jellyfish in the Gulf of Maine. In the weeks while lobsters are still in the water column (stages 1-4), it is plausible that the larvae would be competing with smaller jellyfish for the same zooplankton, like copepods as a food source. By examining the gut contents of postlarval lobsters from Rhode Island, the most common prey group included copepods and decapod larvae, and 80% of lobsters with copepod remains had greater than two copepods (Juinio Cobb, 1992). Medusae smaller than 12 centimeters showed at most, three types of prey—mostly fish eggs and copepods (Graham Kroutil, 2001). This shows how both species rely on the same food source as large part of their regular diet. Furthermore, larval lobsters may also be prey for some jellyfish, as larger medusae have more diverse feeding habits (up to thirteen different prey groups), and have the ability to capture faster zooplankton (Graham Kroutil, 2001).

I aimed to determine if there was any correlation between the two species, and if it was substantial enough to be quantified in lobster population assessments. If there was a correlation, I expected it would be a small, but negative impact on larval lobster abundance with rising jellyfish populations. When I set out to research what information existed already on this question, I found that little research had been done on this in the past, and the predatory consequences of jellyfish on lobsters in the Gulf of Maine ware fairly unknown.

Methods

To accomplish this, I used three data sets; The Maine Jellyfish Tracking data base beginning in 2015, which reports jellyfish sightings as north as the Baie Verte peninsula, and south to New Jersey— although most sightings are around Nova Scotia and down the coast of Maine. The second source was larval tows from years 2018 and 2019, conducted July through September, and measured in larval densities per cubic meter squared of water, focusing primarily on stage one lobsters around the first meter of the water column. Finally, to get a greater look at lobster trends over time, I used the American Lobster Settlement Index (ALSI) (The Wahle Lab - University of Maine) data from 2015 forward, which is a count of all crabs and lobsters within a half meter squared quadrat. Because I was only focusing on stage four lobsters who had just settled, I filtered the data to only look at lobsters below thirteen millimeters in carapace length.

These three sources helped me determine first, if the jellyfish had an immediate effect on the lobster population by comparing jellyfish and larval tow data trends for specific years. Then, to determine if the effect continued later into the ALSI data in September and October when lobsters were settling.

To compare the jellyfish data, I organized all data first by year (2015-2019), then aggregated them into two-week sets, based off of a regular calender. For all years, the first set began on July first, and depending on the year, went as late as September 17th. I also excluded any counts of zero, over 3,000, or counts of NA to exclude outliers or non-numerical data. For both jellyfish and ALSI, the data is averaged—the citizen science by jellyfish per trip for every two weeks, and AlSI by larval density per ½ meter squared quadrat. The AlSI (2015-2019) data only included American Lobsters with carapace length less than 13 millimeters. The larval tow data was translated for 2018 and 2019 from a graph of abundance of stage one lobsters per day of the year.

In one of my graphs, I wanted to examine in detail the trends of both jellyfish and lobster, and if there was a potential effect, so I focused solely on 2018's data. This compared the larval tows and the jellyfish on a graph with a secondary axis. This also showed me if both species had been affected by outside variables (i.e. geographical, or wind patterns), and if they showed similar reactions.

the jellyfish citizen science is a relatively small data source, with some two week sets only containing a couple—or in one case, only one—point. This does have the potential to skew a few of my data points, and it lead to a large range of 154.75. However, I believe finding the averages for each set of two weeks helped to alleviate most potential bias or outliers.

Results

Figure one shows years 2015-2019 overlaid on a graph of jellyfish per trip, for per numerical day of the year. 2016 is a particularly interesting year, as it shows a dramatic increase compared to other years. This is also echoed when finding the average jellyfish per trip, per year. Using the average for 2015 of 34.672 as a base line for all other years, 2016 is 116% of the previous year, this is a huge spike, compared to other fluxes in abundance like 52% (2017), or 44% (2018). It is also interesting that nearly all years (excluding 2019) show a considerable increases around the 180th day of the year. This could be due to geographical patterns, as the larval tow data shows similar patterns.

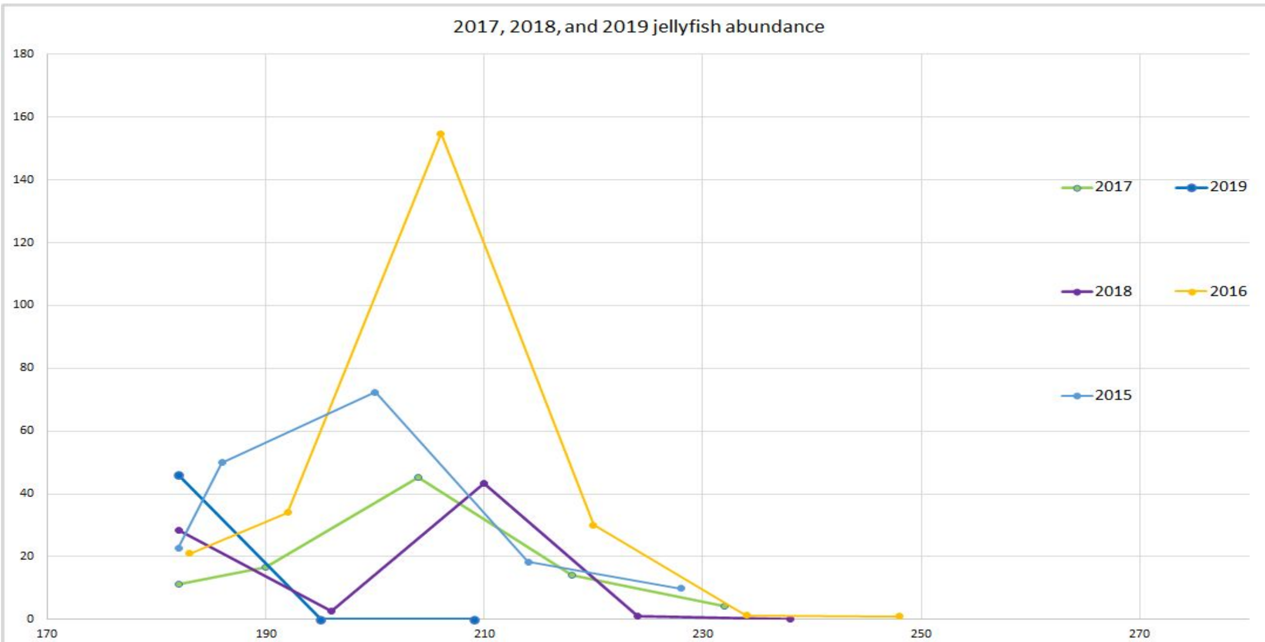

fig. 1

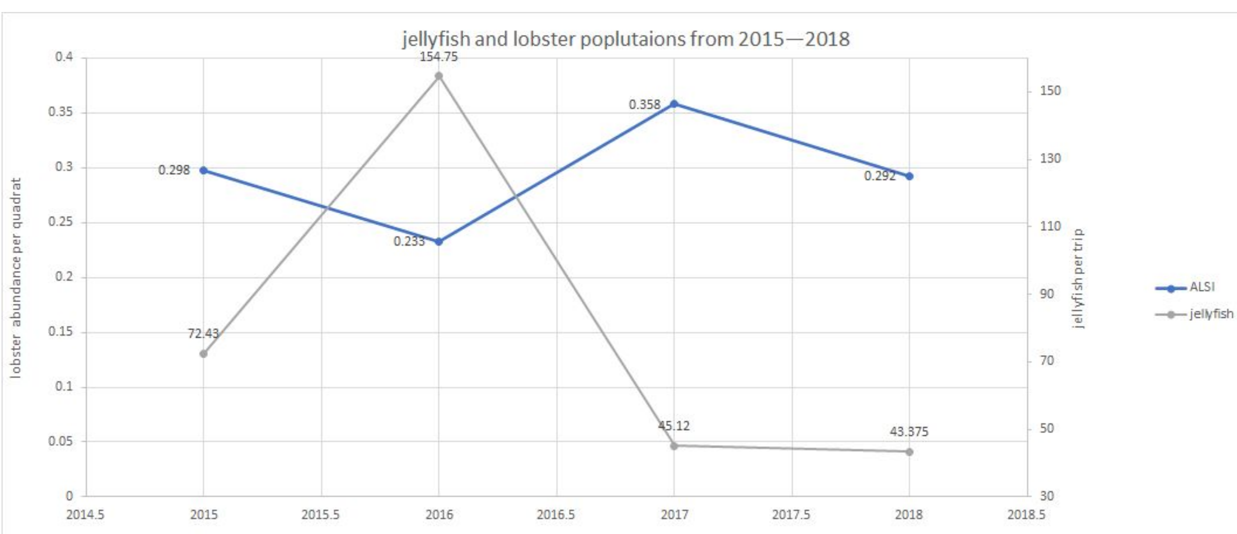

Fig. 2: Jellyfish show a negative correlation coefficient of negative .84 with lobster populations.

When comparing the jellyfish data to ALSI data annually (figure two), there appears to be a pattern of lobster abundance decreasing as jellyfish increase. This is shown most effectively in 2016, where I above mentioned jellyfish abundance was 116% of the previous year's. Similarly, in the ALSI data, the only two years that show negative trends are 2016, and 2018. Once again using 2015's average of .298 as a baseline, 2016 was 78%, and 2018 was 97% of 2015. Other years saw positive shifts of 120% (2017) and 125% (2019) of 2015. 2016 was a more dramatic negative shift, which was also the most dramatic increase for jellyfish. Furthermore, following 2016, 2017 instantly rose to a high abundance at 120% of 2015, which was the highest point in all four years. This also echoes the low jellyfish populations in 2017, which were down 52% from 2015. This was also reflected in the correlation of -.84, which shows that the majority of the points for these four years followed a very similar negative linear progression.

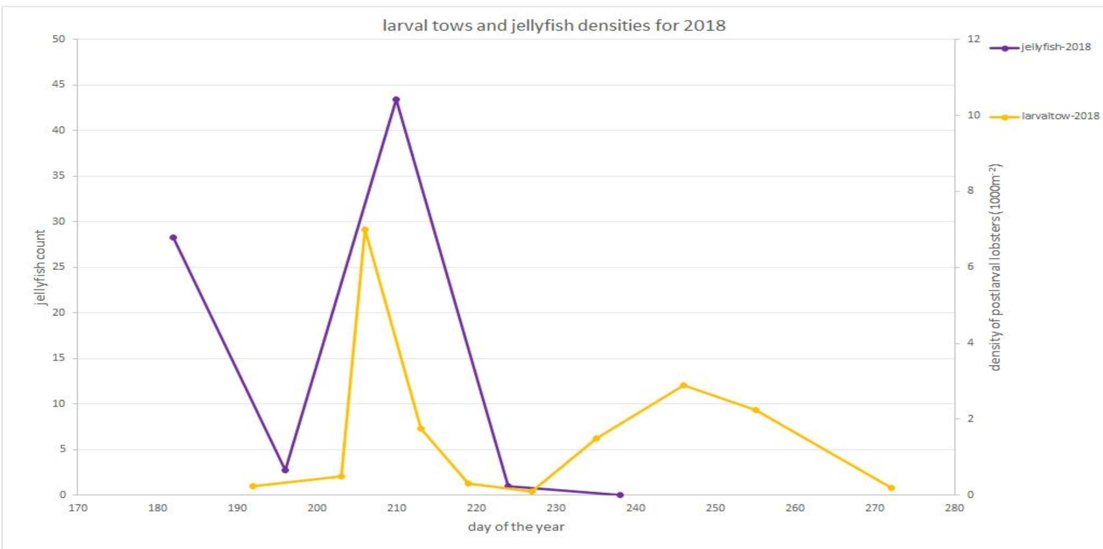

Fig. 3

Finally, figure three compares larval tows and jellyfish densities—focussing solely on 2018. In this graph, both species peaked around day 208 (August 27th), with jellyfish reaching 43.38 jellyfish per trip, and lobsters at seven larval lobsters per quadrat. The larval tows also saw another peak around day 245, although this was not as dramatic as the first one. Jellyfish decreased to zero, although this could be due to lack of data more than specific trends in population.

Discussion & Conclusions

As figure three shows, both species are being effected by the same natural phenomena—like an oceanographic feature or a wind pattern—as they both show dramatic increases within a couple days of each other. This means that both species are in the same habitat, and therefore have the potential to be affected by a predator-prey relationship.

After determining that both species have the potential to effect each other, I then turn towards both species' trends in 2016. As I have shown above, this year represented the highest point in the entirety of my data set for jellyfish—at 116% of the previous year—and it also represented the lowest point in ALSI, with larval densities only 78% of 2015. It is also important to note that in 2017, the ALSI data fully recovered, even higher than the first year 2015, to 120%. Meanwhile, jellyfish plummeted to little more than half (52%) of 2015. I believe the reason why these dramatic changes correlate between species is due to two potential reasons. The first, being lobsters under stage 4 are small enough zooplankton to be included as one of the prey groups for larger jellyfish. The second reason is a slightly more complicated relationship, that the lobsters and jellyfish—including those of smaller size—would be competing for the same food source of small zooplankton, within the same top couple meters of water.

Although my data does not prove either of these potential causes, I belive both could explain how when jellyfish are extreme highs or lows, lobsters seem to react in the opposite manner, and I suggest that both relationships may have an effect on lobster abundance in early stages.

It is also important to note that in 2018, this pattern from 2015 to 2017 is not continued. Both species decreased in abundance, although by less substantial losses than before. It is understandable that this pattern would not show as clearly in the ALSI data, when the shifts in jellyfish were fairly steady, because this relationship may not be as important or as stong an effect compared to other variables for lobster populations. The ALSI data, and even the larval tows both reflect many relationships and environmental factors that effect lobsters—of which jellyfish may be one small aspect of. So when I'm looking at trends in ALSI data, I understand that there are many variables effecting these high and low years, and this is why ithe pattern may not continue into 2018 as clearly, and why I am still confident that there is an effect on lobsters from jellyfish abundance.

This is not substantial enough evidence to suggest including jellyfish in larval lobster assessments, because this data has not quantified the actual relationship in detail. But I do believe it is enough evidence to suggest further research into this topic. As jellyfish blooms grow larger and more frequent, I belive it is important to understand how this will effect the species crucial to Maine's economy. This data has shown that there is a correlation, if not a steady one, that along with other factors, has potential to harm larval lobster abundance, and, by looking at the correlation coefficient, has also shown that in past years, this relationship has been stronger that I originally thought.

The data I worked with were all relatively small sets, or samples of data sets, so there is a larger margin of error in averaging when the number of data per two weeks can vary so greatly. However, I was still able to see consistent, annual trends in jellyfish, which were echoed in the larval tows. Although this data cannot give any definite answers, I think it points to an clear relationship to be explored in the future. Examining the gut contents of larger jellyfish in the gulf of Maine, would provide interesting further results, and help give reasoning for this relationship, beyond a hypothesis.

Acknowledgments

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References

American Lobster Settlement Index (ALSI) - The Wahle Lab - University of Maine. (n.d.).

Retrieved from https://umaine.edu/wahlelab/american-lobster-settlement-index-alsi/

Barton, A. D., Pershing, A. J., Litchman, E., Record, N. R., Edwards, K. F., Finkel, Z. V., . . . Ward, B. A. (2013). The biogeography of marine plankton traits. *Ecology Letters, 16*(4), 522-534. doi:10.1111/ele.12063

Condon, R. H., Duarte, C. M., Pitt, K. A., Robinson, K. L., Lucas, C. H., Sutherland, K. R., . . . Graham, W. M. (2012). Recurrent jellyfish blooms are a consequence of global oscillations. *Proceedings of the National Academy of Sciences, 110*(3), 1000-1005. doi:10.1073/pnas.1210920110

Graham, W. M. (2001). Size-based Prey Selectivity and Dietary Shifts in the Jellyfish, Aurelia aurita. *Journal of Plankton Research, 23*(1), 67-74. doi:10.1093/plankt/23.1.67

Juinio, M., & Cobb, J. (1992). Natural diet and feeding habits of the postlarval lobster Homarus americanus. *Marine Ecology Progress Series, 85*, 83-91. doi:10.3354/meps085083

Maine Jellyfish Tracking. (2016, January 20). Retrieved from https://www.gmri.org/our-work/research/projects/maine-jellyfish-tracking