

CFRF's Lobster and Jonah Crab Research Fleet: A Collaborative Fishing Vessel Approach to Addressing Data Needs for the American Lobster and Jonah Crab Fisheries

Final Report - July 2023

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Executive Summary

The American lobster, *Homarus americanus*, is an iconic New England fishery that was valued at nearly \$875 million in 2021. The Jonah crab, *Cancer borealis*, fishery is strongly tied to the lobster fishery and has grown tremendously since the early 2000s with an ex-vessel value of over \$11 million in 2021. Scientists, managers, and fishermen, however, agree that the data being used to assess these stocks lacks sufficient spatial and temporal coverage, particularly in offshore waters. In 2013, the Commercial Fisheries Research Foundation (CFRF) developed an industry-based data collection program to address these data gaps and improve trust in the assessment and management process for two of New England's most valuable fisheries. CFRF's "Lobster and Jonah Crab Research Fleet" sought to integrate biological and environmental data collection into standard fishing vessel operations, and develop working partnerships between scientists, managers and members of the lobster and Jonah crab fisheries. The ultimate goal of the Lobster and Jonah Crab Research Fleet was to ensure the ecological and economic sustainability of the lobster and Jonah crab populations and fisheries by supporting a collaborative approach to monitoring, assessing, and managing these living marine resources.

The Lobster and Jonah Crab Research Fleet has exemplified the value of integrating a collaborative approach to biological sampling from the outset. Members of the commercial fishing industry, scientists, and managers worked together to finalize data parameters of interest and sampling protocols, creating a sense of meaningful collaboration from all parties. As the project progressed, the CFRF staff worked closely with state, regional, and federal agencies to ensure the data collected by the Research Fleet could be integrated into formal assessment processes in a timely manner. Data management strategies also ensured that industry members felt confident in the ownership of their data and the fact that the data were utilized by management agencies. The ongoing communication that is maintained by CFRF has helped build trust, transparency and confidence that the data are credible and used by all parties involved. Also, the sampling methodology has evolved over the years to collect additional pertinent biological parameters to aid in the management of these valuable fisheries. This Research Fleet approach to collecting data has the potential to serve as a model for other fisheries and in other regions. In particular, this methodology can be applied in areas and during times of the year that are not that are not well-represented in existing federal and state surveys.

Lobster and Jonah crab data collection followed the same protocols that were established during the pilot project in the summer of 2013. Participating vessels were asked to sample 300 lobsters or 60 lobster traps and 150 crabs or 60 crab traps per month, and it was encouraged to split the sampling effort across three different fishing trips. During each sampling session, the date/time of sampling, location (latitude/longitude), depth, and soak time of sampled traps, and the number of traps sampled were recorded. For lobster, Research Fleet participants recorded the carapace length (mm), sex, egg-bearing and v-notch status, shell disease severity, shell hardness, and disposition (kept/discarded), notes/observations, and took photos as needed on the On Deck Data (ODD) data app. Jonah crab biological parameters were similar and included carapace width, sex, egg-bearing status, shell disease severity, shell hardness, disposition (kept/discarded), notes/observations, and took photos as needed using ODD. Upon returning to the dock, data was uploaded via WIFI to a MySQL database managed by the CFRF. Vessels deployed Vemco Minilog temperature sensors in a chosen trap to record bottom water temperature. These data were downloaded to a field reader supplied by the CFRF. The Ocean Temps app developed for the program was used to retrieve the temperature data from the field reader, view the data in graphical form, and send the data to the CFRF database via WIFI.

The data collected by the Lobster and Jonah crab Research Fleet provide a unique perspective into the characteristics of the lobster and Jonah crab fishery dynamics, catch, and linkages to bottom water temperature. The spatiotemporal coverage of the Research Fleet offers a better understanding of how these characteristics may change between different management areas and seasons. The Lobster and Jonah Crab Research Fleet has collected biological data from over 209,000 lobsters and 124,000 Jonah crabs as well as over 4.57 million bottom water temperature readings from the Gulf of Maine to the Mid-Atlantic since 2013. Specifically, during this project (April 1, 2021 to March 31, 2023), 27 fishing vessels sampled 39,326 lobsters from 15 NMFS statistical areas and 23,064 Jonah crabs from 14 NMFS statistical areas. All of the lobster and Jonah crab biosample data collected by the Research Fleet have been regularly incorporated into the Atlantic Coastal Cooperative Statistics Program database and sent directly to lobster and Jonah crab stock assessment scientists and managers. The CFRF has provided data for the 2015 and 2020 American Lobster Benchmark Stock Assessment as well as the 2015 Interstate Fishery Management Plan for Jonah crab and the 2023 Jonah crab Benchmark Stock Assessment.

In addition to continuing and expanding the Lobster and Jonah Crab Research Fleet, this project supported analysis of the data collected. A variety of relationships were detected between biological traits of lobsters and Jonah crab with respect to size, day-of-year, and temperature. The proportion of female lobsters increased with carapace length, whereas the proportion of female Jonah crab decreased with carapace width. The likelihood of female lobsters being ovigerous increased with size, as did the likelihood of ovigerous female lobsters having shell disease. In both species, all the traits analyzed varied with day-of-year. Temperature was significantly related with lobster carapace length, the proportion of female lobsters that were ovigerous, and the proportion of Jonah crab that were female. With lobsters, there was a weak association between warmer temperatures and smaller carapace lengths in commercially caught males and females, although the magnitude of the effect was small. During fall, the proportion of female lobsters that were ovigerous also increased with temperature in both the commercial and ventless trap surveys. With Jonah crab, there was a decrease in the proportion of females with increasing temperature during the first half of the year, but only in the ventless traps.

Overall, this project has been successful in: 1) Continuing and expanding the lobster and Jonah crab biological data time series (2013 – 2019); 2) Adding new fishing vessels to the Research Fleet to expand spatial coverage; 3) Informing the lobster stock assessment and management plan by providing data on the size, sex, and reproductive structure of the lobster stock, particularly from offshore areas; 4) Collecting and communicating spatially and temporally explicit biological data on Jonah crab to support the development of a benchmark stock assessment; 5) Assessing the spatial and temporal variability in Jonah crab and lobster catch characteristics (e.g., sex ratio, size distribution, egg bearing status, disease prevalence, shell hardness, and discard rate) and their linkages to bottom water temperature; 6) Continuing piloting Bluetooth technology to expedite data collection; and, 7) Demonstrating a model approach to data collection, management, analysis, and utilization that can be duplicated in a cost effective way in other fisheries.

This report covers the activities of the Commercial Fisheries Research Foundation's Lobster and Jonah Crab Research Fleet during this award period (April 1, 2021- March 31, 2023) and analysis of data collected since 2013. The goal of the Lobster and Jonah Crab Research Fleet is to ensure the ecological and economic sustainability of the lobster and Jonah crab populations and fisheries by supporting a collaborative approach to monitoring, assessing, and managing these living marine resources. The Lobster and Jonah Crab Research Fleet has exemplified the value of integrating a collaborative approach to biological sampling from the outset. Members of the commercial fishing industry, scientists, and managers worked together to finalize data parameters of interest and sampling protocols, creating a sense of meaningful collaboration from all parties. Specifically, this award, sought to sustain and expand the Lobster and Jonah Crab Research Fleet and analysis biological and environmental data collected by the initiative.

Fleet Maintenance and Management

Continuation and Expansion of Lobster and Jonah Crab Research Fleet

Research Fleet maintenance and support was an ongoing task throughout the duration of the project. CFRF staff continued to be in close communication with Research Fleet members to assist with any issues and to document sampling. Common questions by Research Fleet participants involved assistance with uploading data, invoicing, offloading temperature data, replacing broken or missing equipment, and reviewing sampling protocols. Technical assistance included dock visits to troubleshoot or replace sampling equipment, and communication with Research Fleet participants to help troubleshoot any issues that arose regarding data collection efforts. Staff conducted regular audits of the MySQL database, including lobster, Jonah crab, and bottom water temperature data. Proper NOAA Exempted Fishing Permits and Rhode Island Collector's permits were maintained throughout the project period and updated as new vessels joined the Research Fleet.

Lobster and Jonah crab Fleet expansion was an ongoing goal throughout the project to increase the spatial coverage of the Research Fleet and to expand sampling coverage in areas of concern flagged by the ASMFC (Atlantic States Marine Fisheries Commission). In the summer of 2021, the F/V Anna Mary based out of Montauk, NY was added to the Research Fleet. The F/V Anna Mary fishes offshore in NMFS statistical area 537, which is an area that represents a large portion of the commercial landings for the Southern New England lobster stock, as well as important area for Jonah crab landings. The F/V Rachel Leah based out of Newington, NH was also added, and they fish in NMFS statistical area 562 which is a part of Georges Bank. In the spring of 2022, the F/V Adventure based out of Provincetown, MA was added to the Research Fleet. The F/V Adventure fishes offshore in NMFS statistical area 514, which is the area of Cape Cod Bay/Massachusetts Bay and was not covered by the Research Fleet at the time. The F/V Adventure retired from the Research Fleet in March 2023 due to feeling that they were too busy to be able to sample during their trips. Sampling fatigue, and changes in vessel ownership, captains, and crew are some of the reasons why vessels have retired from the Research Fleet. Also in the spring, the new captain of the F/V Timothy Michael, a previous Research Fleet participant, was trained to remain in the Research Fleet. The former captain of the F/V Timothy Michael was made the captain of the F/V McKinley based out of Manomet, MA and the vessel was added the Research Fleet. The F/V McKinley fishes NMFS statistical area 537 and would help provide additional coverage offshore where a large portion of Jonah crab landings reside. Early in 2023, two additional vessels were added to the Research Fleet. The F/V Menemsha Rose is based out of New Bedford, MA and fishes offshore in Lobster

Management Area (LMA) 3. The F/V Deborah H is based out of Block Island, RI and fishes in LMAs 2 and 3. The captain of the F/V Deborah H is a younger captain taking over his family's fishing vessel and expressed a strong interest in having an active role within collaborative fisheries research when he applied to join the fleet. By the end of the project period, there were a total of 23 participating vessels.

Extended Data Collection and Piloting of Bluetooth Calipers

The Lobster and Jonah crab Research Fleet continued record and log their biological data using the On Deck Data (ODD) application and their bottom water temperature data using the Ocean Temps application, which were developed during the Lobster and Jonah Crab Research Fleet Pilot Project (project funded by NOAA Award #NA09NMF4720414). CFRF staff were in communication with the app and database developers to ensure both apps continued to function smoothly for the Research Fleet participants. At the beginning of the project period, there were three vessels utilizing the Scielex Vernier Bluetooth adapters and Mitutoyo Digimatic IP-67 calipers for their Lobster and Jonah crab Fleet sampling which included the F/V Erica Knight, F/V Karen Ann and F/V Select. All three captains fish as single owner operators in Southern New England, and all three have reported few issues during this time period. By the end of the project period, the captain of the F/V Erica Knight has stopped using the Bluetooth calipers as he had grown more comfortable with sampling technique and rhythm. The Bluetooth calipers continue to be a viable sampling tool for those interested, and can be particularly helpful for vessels operating without deckhands or on smaller vessels.

Toward the end of the project period, the VEMCO Minilog temperature probes were nearing the end of their estimated battery life. In addition, this particular line of temperature loggers is no longer being manufactured, so CFRF staff explored options for new temperature probes. Further, they required removal from the trap and placement into a reader in order to offload the temperature data onto the Ocean Temps app. Over the years, participating vessel experienced connectivity issues between the VEMVO field reader and the provided Android tablets. CFRF staff have received feedback from several Research Fleet captains that they prefer different brands of temperature probes they have used in other collaborative research projects. Zebratech Moana temperature-depth sensors were purchased as a replacement and are the same sensors that the NOAA eMOLT program is using. These sensors should improve the user experience for collecting temperature data as they also provide temperature at depth information and the depth-activated sensors can trigger Bluetooth transmission of data during haulback without having to remove the sensors from the traps. These new sensors have the additional benefits of GPS functionality and depth information that will greatly improve the quality control processes for CFRF staff related to GPS locations and depth of sampling locations. The switch to the new temperature sensors will make the Ocean Temps app become obsolete as the last of the temperature data from the VEMCO loggers get offloaded and uploaded to the CFRF database.

Compilation and communication of data

In order for the biological data collected by the Lobster and Jonah crab Research Fleet to be easily be utilized by state and federal fisheries managers the data were regularly queried, edited, and shared with the Atlantic Coastal Cooperative Statistics Program (ACCSP). The data were shared in six-month increments, and the data from January 1, 2021 through December 31, 2022 have been incorporated into the ACCSP Data Warehouse. In preparation for the 2023 Jonah crab Benchmark Stock Assessment, the AMSFC were provided with Jonah crab ventless trap biological data so staff could explore the data for potential use as an index of abundance. The New Hampshire Fish and Game were

provided biological data on ovigerous Jonah crabs to explore the distribution of eggers and to explore any evidence of Jonah crab egger aggregations. CFRF Staff also made themselves available to ASMFC staff during the course of the Jonah Crab Benchmark Stock Assessment Workshop Scheduled in April 2023.

To provide regular feedback to Research Fleet participants, the CFRF staff compiled and distributed data summary reports for the participating vessels every three months. It is important to the Foundation that the fishermen participating always had access and ownership of the data they collected to help build respect, transparency and trust. In addition to the summary statistics, the Research Fleet participants were provided copies of the photos that they uploaded to the CFRF database as well as digital versions of their raw data in the form of a Microsoft Excel file. Printed versions of raw data records and compilations of bottom water temperature time series were provided upon request. Summaries of the bottom water temperature data were also made available upon request. Vessel-specific quarterly reports included the following summaries:

Lobster Sampling Statistics:

- Number of commercial lobster sampling sessions conducted
- Number of ventless lobster sampling sessions conducted
- Number of lobsters sampled
- Percent of lobsters that were Male/Female
- Male: Female ratio
- Percent of lobsters with shell disease
- Minimum/Maximum/Average carapace length
- Percent of females that were egg-bearing
- Percent of females that were v-notched
- Percent of lobsters with soft shell
- Percent of lobster catch retained for sale

Jonah Crab Sampling Statistics:

- Number of commercial Jonah crab sampling sessions conducted
- Number of ventless Jonah crab sampling sessions conducted
- Number of Jonah crabs sampled
- Percent of Jonah crabs that were Male/Female
- Male: Female Ratio
- Minimum/Maximum/Average carapace width
- Percent of Jonah crabs with soft shell
- Percent of females that were egg-bearing
- Percent of Jonah crab catch retained for sale

Outreach and Education

Throughout the Award Period, the CFRF staff maintain the Lobster-Jonah crab Fleet project website (<http://www.cfrfoundation.org/jonah-crab-lobster-research-fleet/>), which is used to convey background information on the project, current pictures and data summaries. Website features include: real-time counts of the number of lobsters and Jonah crab sampled weekly, a list of participating fishing vessels, lobster, Jonah crab, and bottom water temperature protocols, and a photo reel of images

collected by the Research Fleet participants. The project website is visited regularly, with peaks in activity following press articles, conference presentations, and newsletter releases. Articles and announcements of the project's progress were featured in the CFRF July 2021 and March 2022 newsletters (Appendix 1). The project title and a link to the project website were included in all CFRF newsletters during the project period. CFRF's newsletter reaches over 1,500 individuals involved in the fisheries/seafood system. Four Facebook and two Instagram posts about the project were also made by CFRF. Combined these posts had close to 2,500 views. Two Lobster and Jonah crab Research Fleet Meetings were held during the project period—one in December 2021 and one in January 2023 (Appendix 1). At these meetings, summaries of the Research Fleet data were presented, any updates to the sampling methodologies, applications, or equipment were explained, updates on any extension research projects were shared, and questions from the Research Fleet Participants were answered.

CFRF staff also participated in several professional and industry events to communicate the work of the Research Fleet. In September 2022, CFRF's Executive Director participated in the NOAA NMFS Cooperative Research Program Annual Meeting during one of the Stakeholder Engagement days hosted at Superior Trawl in Narragansett, RI (Appendix 1). This meeting focused on collaborative research here in New England, and the presentation on our Lobster and Jonah Crab Research Fleet included all the extension projects that have come from the Fleet, and the importance of this work. At the end of the reporting period, CFRF staff participated in a Fisheries Learning Exchange with a delegation of fisheries professionals from the UK. This exchange was facilitated by the Fishmongers Company's Fisheries Charitable Trust and included representatives from governmental and non-governmental organizations from Northern Ireland, Scotland and England. We were able to share the work we do at the CFRF as well as its impact on stock assessments and management plans. In February 2023, Noelle Olsen presented a poster on the Lobster-Jonah crab Research Fleet program and research extension projects at the New England Cooperative Research Summit held in Providence, RI (Appendix 1). In March 2023, the CFRF Executive Director participated in a panel discussion at the Maine Fishermen's Forum in Rockport, ME. This panel focused on industry-based environmental monitoring programs, and the CFRF Executive Director presented an overview of the Lobster-Jonah crab Research Fleet. Additionally, CFRF had an outreach booth at the Maine Fishermen's Forum supplied with a tablet loaded with the On Deck Data application so Forum participants could practice using the tablet used by the Fleet Participants. At the end of March, CFRF had an outreach booth at the Massachusetts Lobstermen's Association Annual Weekend in Hyannis, MA. The tablet was used as an outreach tool at this event, and CFRF staff in attendance were approached by several potential Lobster-Jonah crab Fleet applicants.

Data Exploration

Assessment of Spatiotemporal Catch Characteristics

American lobster

Exploring the size structure of sampled lobster by season there are several trends that are apparent. Consistent with historic sampling and the scientific literature, female lobsters are more abundant and larger across all seasons. Additionally, there appears to be no difference in length structure between seasons for both female and male lobster (Fig. 1).

Lobster Length Frequency

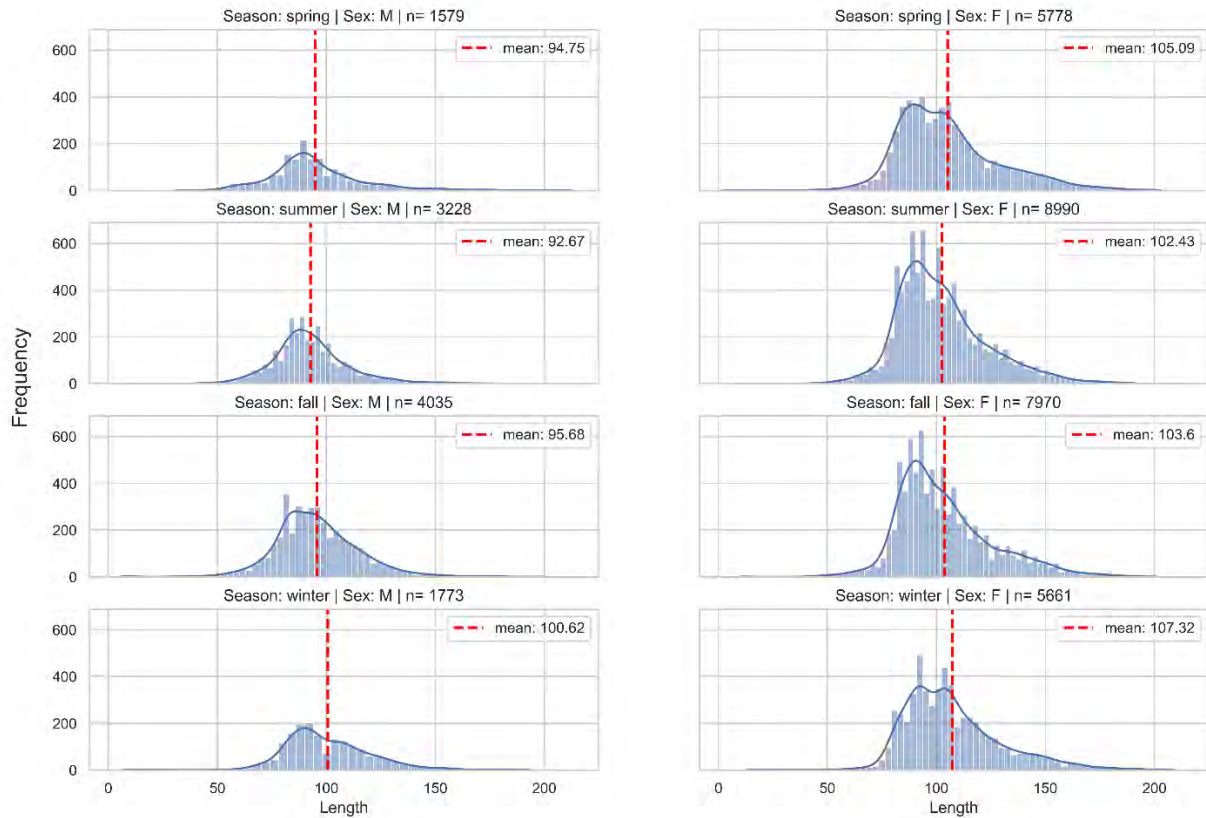


Figure 1: Length frequency for lobster by sex and season. The red dashed line represents the mean carapace length.

Exploring the differences in size structure between inshore and offshore lobsters it appears that offshore lobsters are, on average, larger. Furthermore, the dichotomy in size distribution for male and female lobster is less pronounced inshore. The smaller lobster size overall would suggest that younger lobsters are more likely to be found inshore and, as they grow and mature, they move offshore. There could be other factors contributing to this relationship such as sample size. There are nearly three times as many lobsters sampled offshore ($n=28635$) compared to inshore ($n=10405$). The addition of more samples collected inshore could resolve some of the observed phenomena (Fig. 2).

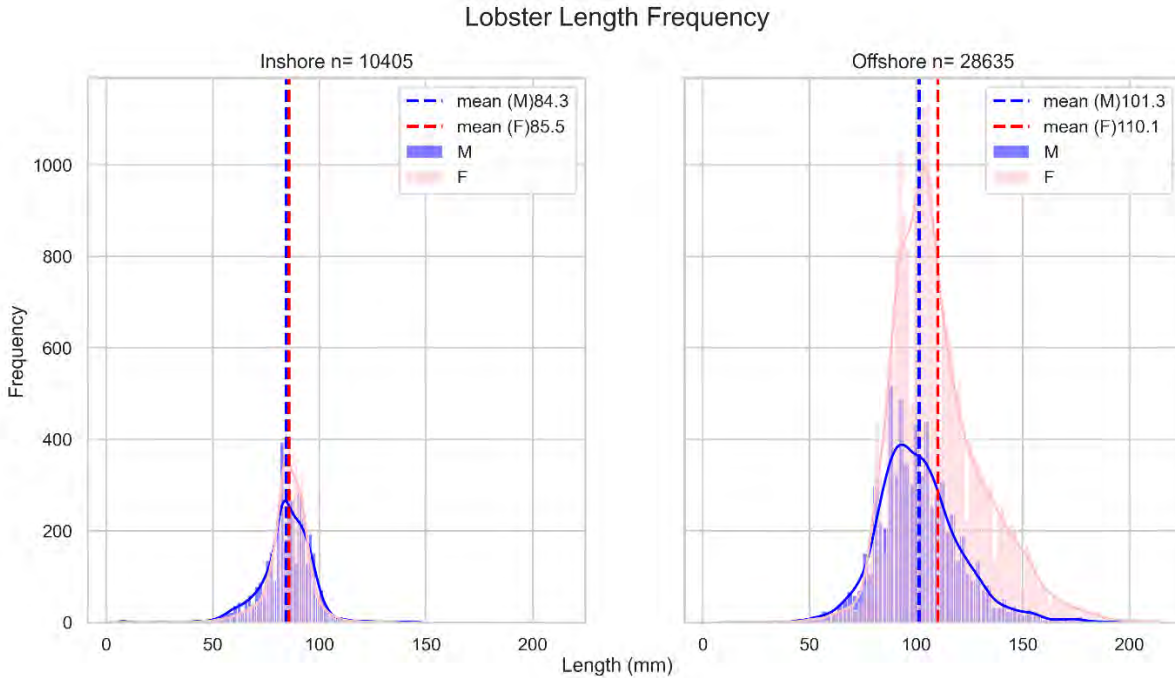


Figure 2: Inshore (LMA 2) and offshore (LMA's 1,3,4,5) length frequency for male and female lobsters. The blue (male) and red (female) dashed lines represent the mean carapace length for each sex.

Given the wide spatial and temporal coverage of the Research Fleet and the diversity of gear being deployed, the data collected by the Research Fleet provides a unique opportunity to explore the distribution of small juvenile lobsters across the continental shelf. Traditionally, scientists have believed that small juvenile lobsters are constrained to inshore waters and absent from offshore waters and canyons deeper than 100 meters. During the project period, 103 small-sized lobsters were sampled by the Research Fleet (Fig. 3). These data challenge the traditional assumption surrounding the inshore distribution of small, juvenile lobsters and suggest that the conditions in offshore canyons and shelf habitats are suitable for juvenile and adult lobsters alike.

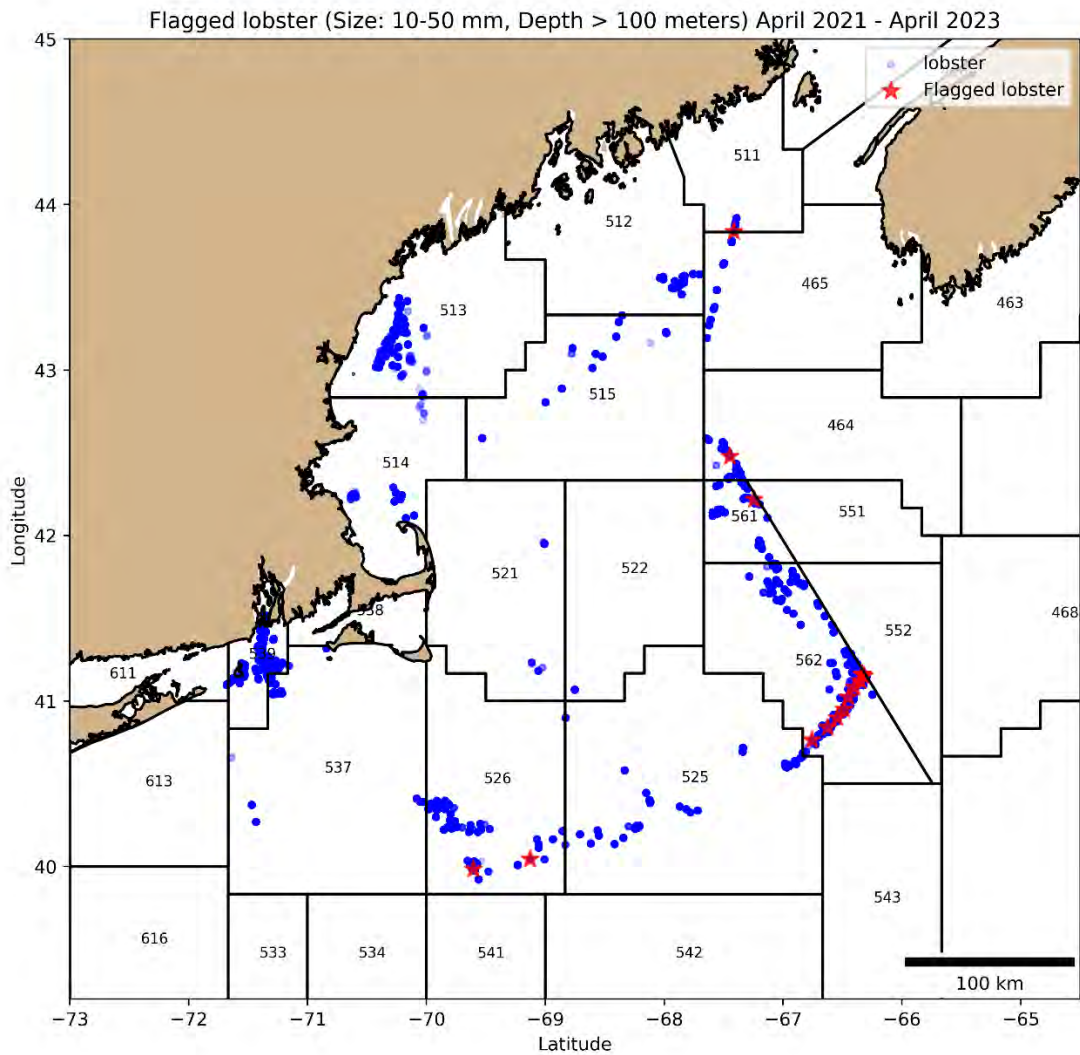


Figure 3: Map of lobsters sampled with a carapace length between 10 – 50mm. The red stars represent locations of lobsters that were fished at a depth greater than 100m.

The locations of ovigerous lobsters appear to overlap with the locations of non-eggbearing female lobsters both inshore and offshore (Fig. 4). About 20% of the inshore (LMA 2) female lobsters and 17% of the offshore (LMA's 1,3,4,5) female lobsters sampled were ovigerous throughout the project period. The percent of female lobsters sampled that were ovigerous varied slightly by season. About 6% of the sampled female lobsters were ovigerous in the spring and summer, about 9% sampled in the fall, and only around 4% sampled in the winter.

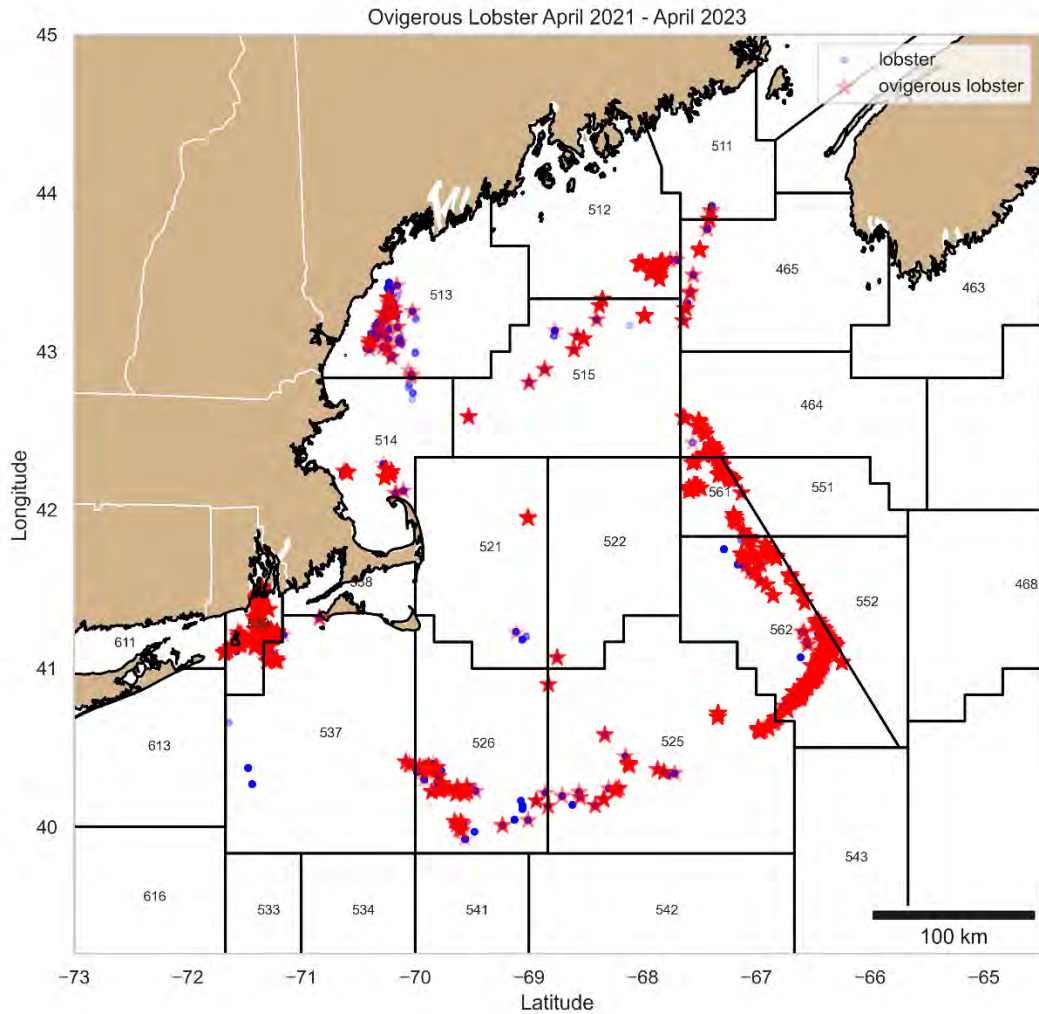


Figure 4: Map of female (blue circle) and ovigerous (red star) female lobsters sampled.

Epizootic shell disease (ESD) in lobsters increasingly has become a concern to the commercial lobster industry, particularly in conjunction with the rapidly increasing ocean temperatures in the Northwest Atlantic Ocean. There appears to be fewer incidences of ESD at higher latitudes (Fig. 5). Overall, about 18% of the inshore (LMA 2) lobsters sampled exhibited signs of ESD, and only about 2% of the offshore (LMA's 1,3,4,5) lobsters had ESD. The percent of soft-shelled, or recently molted, lobsters varied very slightly between the seasons increasing from nearly 0% in the spring to just over 1% in the summer. The highest percent was found during the fall (3%) and dropping slightly to 2% in the winter months.

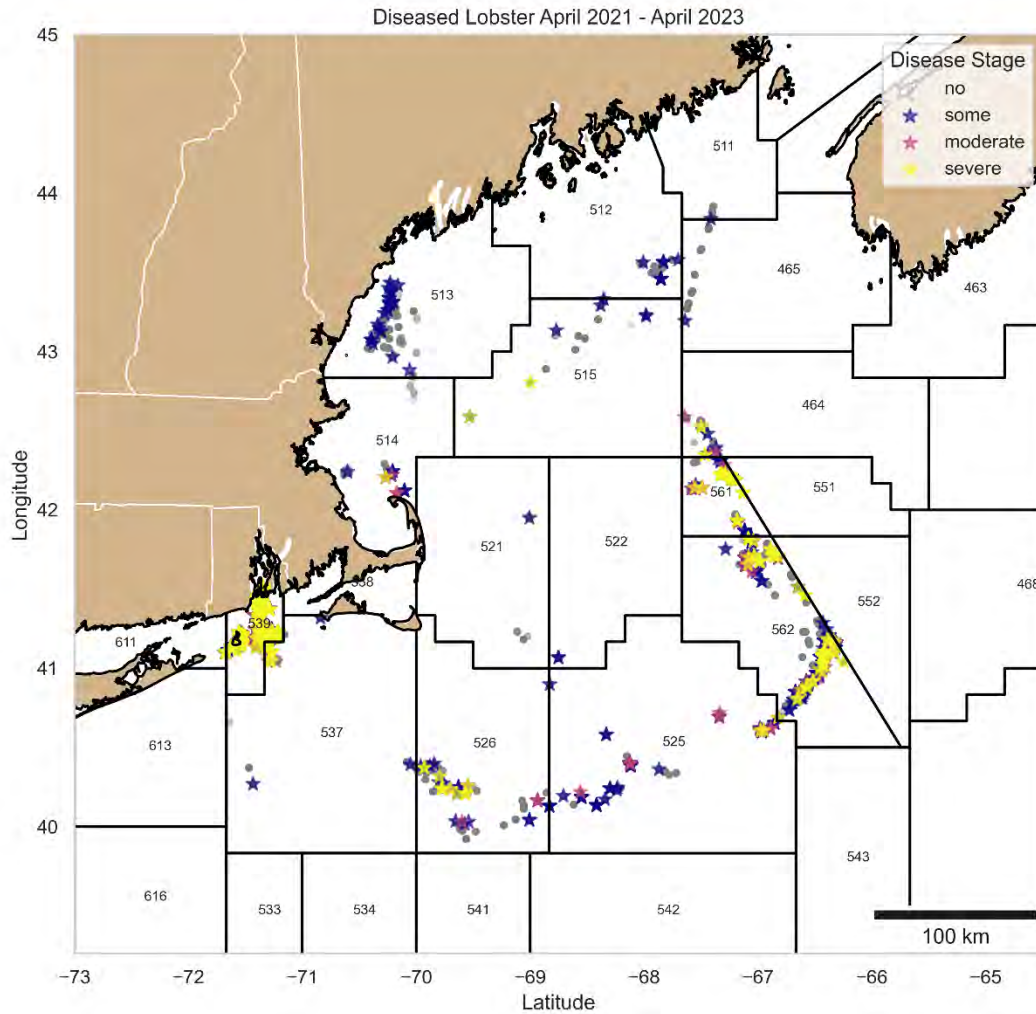


Figure 5: Map of shell disease conditions of both male and female lobsters sampled.

Jonah crab

Male Jonah crabs were larger than females across all seasons. Additionally, they appear to be in much higher abundance compared to females. Neither male or female Jonah crab appear to experience seasonality with respect to width frequency or abundance (Fig. 6).

Jonah Crab Width Frequency

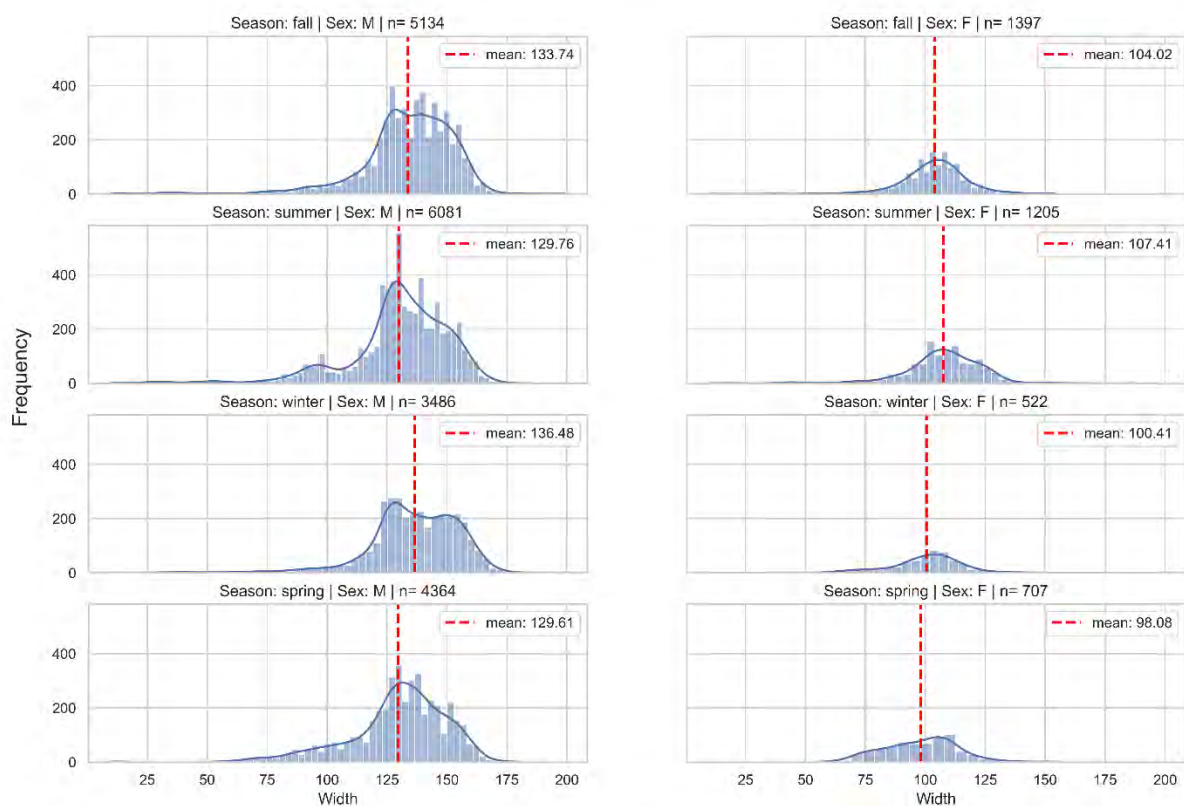


Figure 6: Width frequency distribution for Jonah crab by sex and season. The red dashed line represents the mean carapace width.

Emerging patterns in Jonah crab width frequency for inshore and offshore distribution follow a similar pattern to lobster. Inshore populations tend to be smaller than those found offshore. Like lobster, these observed trends could be an artifact of sampling bias; there were less Jonah crabs sampled inshore (n=9229) compared to offshore (n=13684). Unlike lobster, male Jonah crabs observed were larger than females across all spatial domains (Fig. 7).

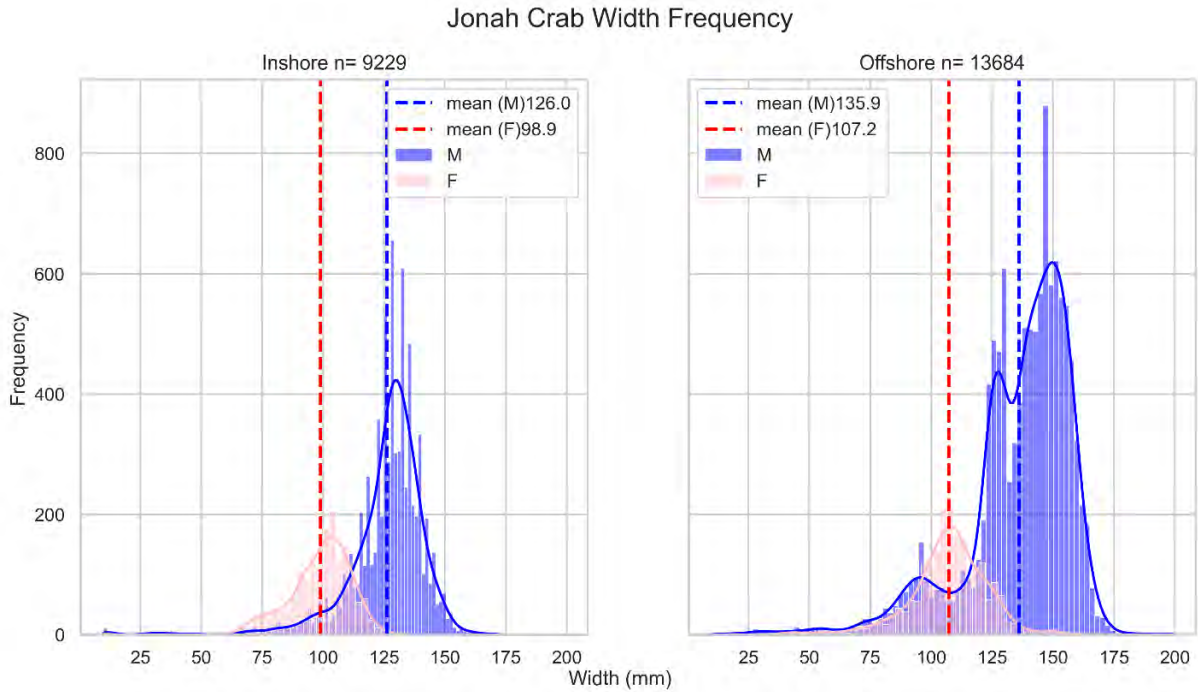


Figure 7: Inshore (LMA 2) and offshore (LMA’s 1,3,4,5) width frequency for male and female Jonah crabs. The blue (male) and red (female) dashed lines represent the mean carapace length for each sex.

Habitat use at life stage and migration patterns of Jonah crabs are poorly understood. In addition, juvenile Jonah crabs can be difficult to sample as their small size makes it easier for them to fall unnoticed onto the deck and slip between cracks during sorting. The use of both commercial and ventless traps helps aid in the process of capturing some insight into the locations of juvenile Jonah crabs. A total of 159 small-sized Jonah crabs were sampled both inshore and offshore as well as at depths greater than 100m offshore during the project period (Fig. 8).

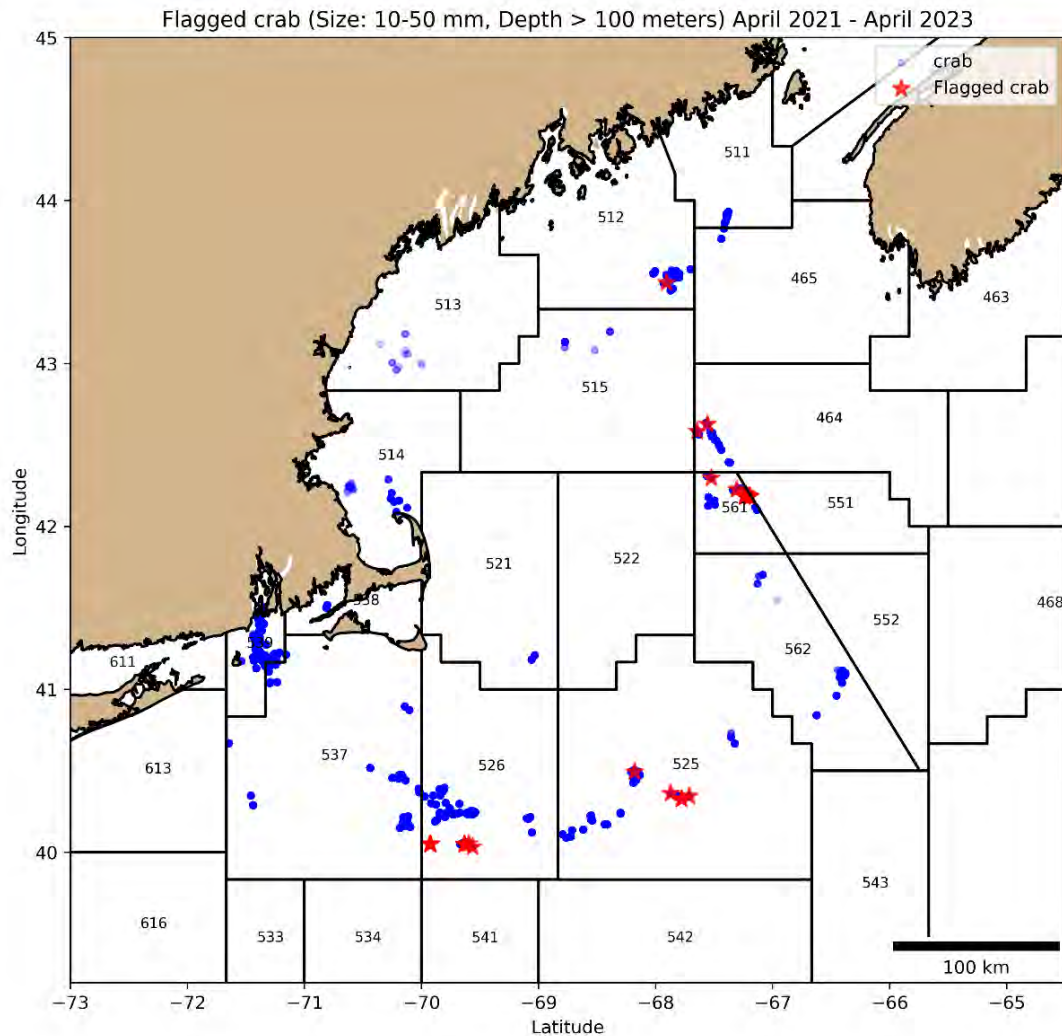


Figure 8: Map of Jonah crabs sampled with a carapace width between 10 – 50mm. The red stars represent locations of are Jonah crabs that were fished at a depth greater than 100m.

The locations of ovigerous Jonah crabs exhibit a different pattern than seen in female lobsters (Figure 4), and there is not as much overlap between ovigerous and non-ovigerous crabs (Fig. 9). About 0.3% of the inshore (LMA 2) female Jonah crabs and 0.6% of the offshore (LMA's 1,3,4,5) female Jonah crabs sampled were ovigerous throughout the project period. The percent of female lobsters sampled that were ovigerous varied slightly by season. About 2% of the sampled female lobsters were ovigerous in the spring, and less than 1% of the sampled female Jonah crabs were ovigerous in the summer, fall, and winter months. Some fishers have suggested that egg-bearing Jonah crabs may burrow in the sediment, making it harder for these crabs to be caught in traps.

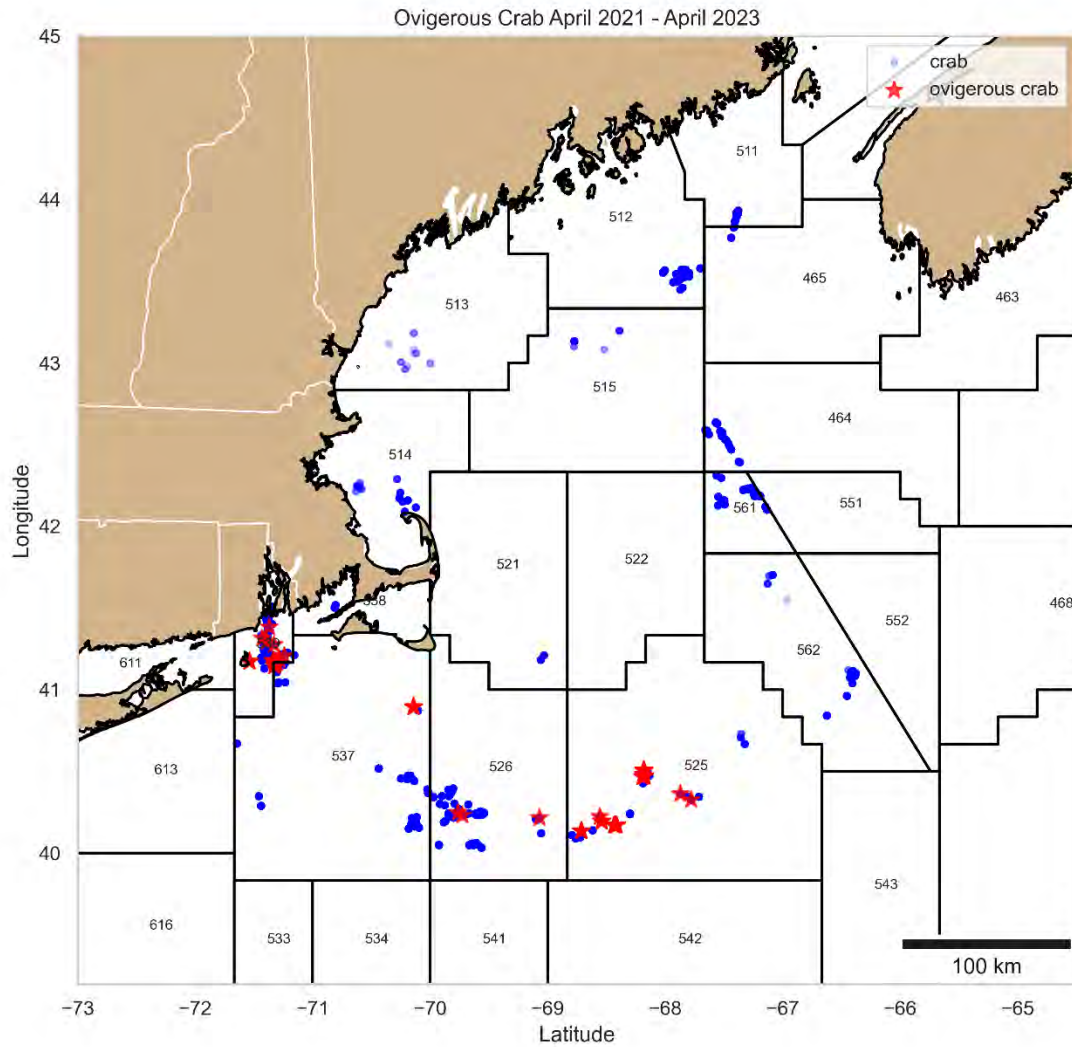


Figure 9: Map of female (blue circle) and ovigerous (red star) female Jonah crabs sampled.

Shell condition or shell disease scoring for Jonah crabs were not a feature in ODD until January 2022. Although the map in Figure 10 shows the entire dataset for Jonah crab, these data collected by the Lobster and Jonah crab Fleet offer a snapshot into some of the dynamics of the Jonah crab life cycle. The shell condition of a Jonah crab represents a relative time since molting, as in, the shell will become darker with more marks overtime and will only become mark-free after a molt. Smaller or younger Jonah crabs will molt more frequently until maturity is reached. Overall, the percent of soft-shelled Jonah crabs did not vary much by season, ranging from <1% in the fall and winter and only increase to slightly above 1% of crabs in the spring and summer.

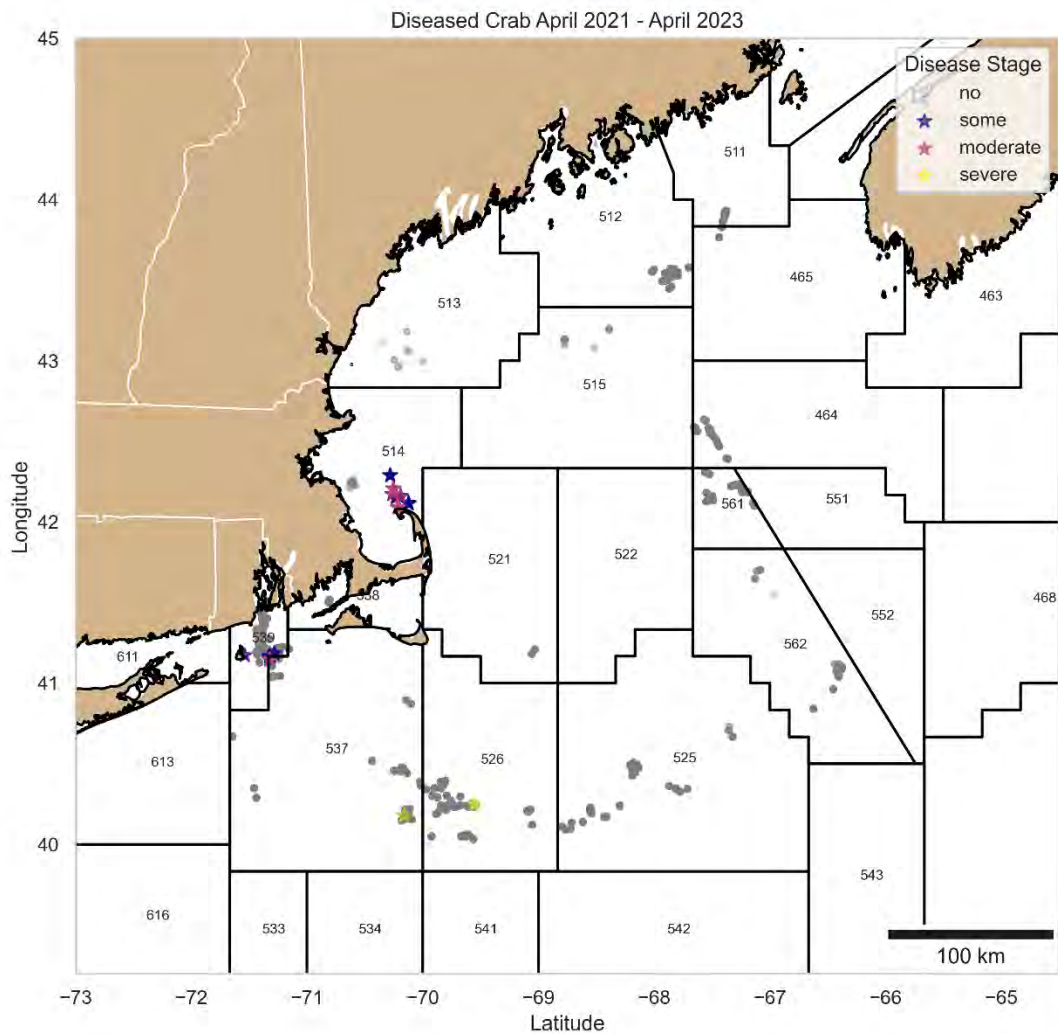


Figure 10: Map of shell disease conditions of both male and female Jonah crabs sampled. These data represent the entire project period of April 1, 2021 to March 31, 2023; however, Jonah crab shell condition scoring did not begin until January 2022.

Characterization of Lobster and Jonah Crab Fishery Activities

American Lobster

Lobster sampling occurred in 16 statistical areas with 37% of lobsters sampled between the grant period coming from statistical area 539. Most lobsters were sampled in the spring and summer with effort moving offshore during the fall and winter (Fig. 11). The seasons are defined as the following: Spring, March through May; Summer, June through August; Fall, September through November; and, Winter, December through February.

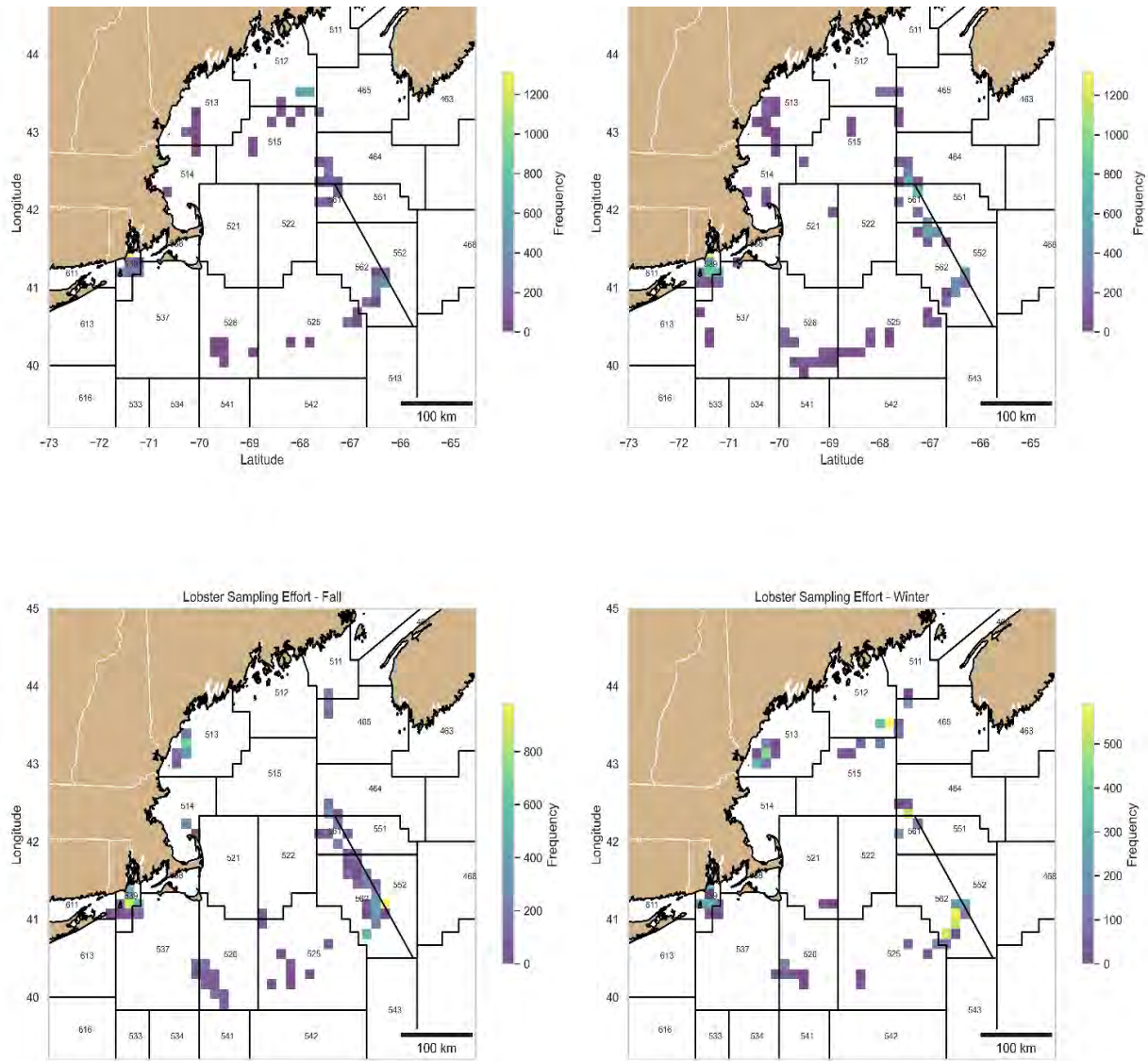


Figure 11: Lobsters sampled by CFRF fleet participants by season, April 1, 2021 - March 31, 2023.

The information on the characteristics of discarded and retained lobsters is another unique aspect of the Lobster and Jonah crab Research Fleet dataset, as discard information for commercial catch is typically only available through state and federal fishery observer programs. On average, offshore vessels are retaining both male and female lobsters that are larger than those being retained in inshore areas (Table 1). The higher numbers of discarded female lobsters seen in both offshore and inshore areas are likely influenced by the presence of either eggs or a v-notch.

Table 1: Lobster fishing area, disposition, sex, mean carapace length (mm), number of lobsters caught, and the sex composition (%) of discarded and retained lobsters caught between April 1, 2021 - March 31, 2023.

Area	Disposition	Sex	Mean length	n	% Catch
Inshore	Discarded	F	82.4	4442	70.1
		M	76.2	1895	29.9
	Retained	F	91.7	2279	56
		M	93	1786	43.9
Offshore	Discarded	F	107.2	10292	85.5
		M	82.6	1744	14.5
	Retained	F	112.7	11386	68.7
		M	107.6	5190	31.3

Jonah crab

Jonah crab sampling occurred in 16 statistical areas with 29% of Jonah crab sampled between the grant period coming from statistical area 562. Most Jonah crabs were sampled in the spring and summer however there does not appear to be any seasonality to spatial distribution of Jonah crab effort (Fig. 12). The seasons are defined as the following: Spring, March through May; Summer, June through August; Fall, September through November; and, Winter, December through February.

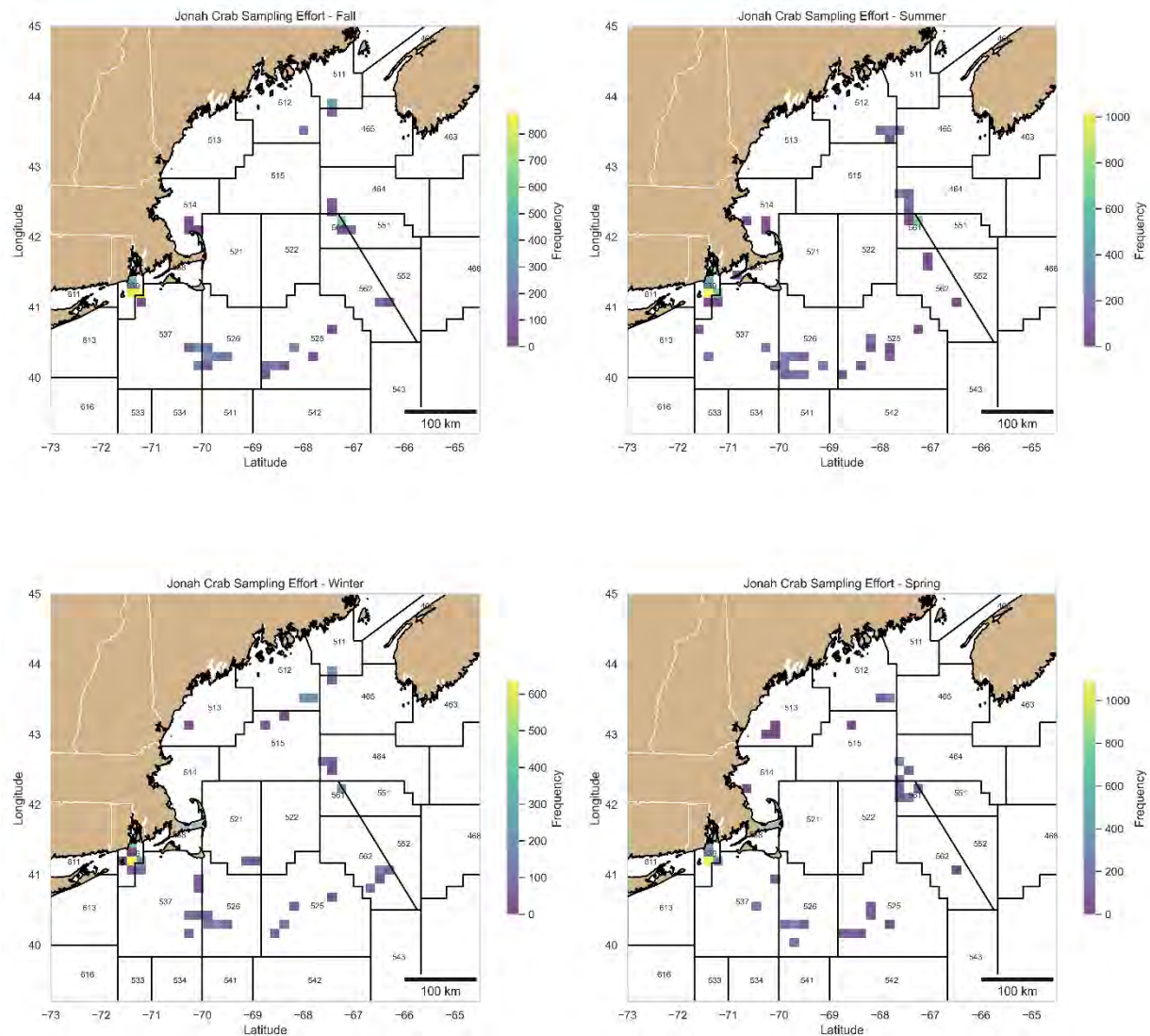


Figure 12: Jonah crab sampled by CFRF fleet participants by season, April 1, 2021 - March 31, 2023.

Data collected on the characteristics of discarded and retained Jonah crabs offers a unique glimpse into some of the behaviors of vessels who commercially fish for these crabs. These data help support the idea that the Jonah crab fishery is nearly a male-only fishery in both inshore and offshore areas, as very few female Jonah crabs were retained (Table 2). Also, it appears that, on average, offshore vessels are retaining larger Jonah crabs than inshore vessels. The mean carapace width of offshore Jonah crabs is nearly 20mm larger than the legal minimum size. There have been discussions with some Research Fleet participants who believe Jonah crab consumers prefer Jonah crab that are larger than the legal minimum size.

Table 2: Jonah crab fishing area, disposition, sex, mean carapace width (mm), number of crabs caught, and the sex composition (%) of discarded and retained crabs caught between April 1, 2021 - March 31, 2023.

Area	Disposition	Sex	Mean width	Count	% Catch
Inshore	Discarded	F	98.7	1694	39.5
		M	112.4	2593	60.5
	Retained	F	124.4	15	0.3
		M	133.2	4927	99.7
Offshore	Discarded	F	106.1	2025	28.5
		M	128.8	5086	71.5
	Retained	F	129.9	97	1.5
		M	141.5	6459	98.5

Bottom Water Temperature Data

Over the course of this project, 160 time series of bottom water temperature were collected in 12 statistical areas with 11 different vessels. In this case a time series was defined by a single data file offloaded by one tidbit data logger. Data were processed with a 7-oversvation moving median filter to remove erroneous data introduced by instrument error or observations made out of the water. Additionally, values have been removed from the record which were outside of the bounds for reasonable New England ocean conditions; values below 2.2 °C and above 24.4 °C. Fig. 13 is a plot of temperature data for visualization only, data incorporated into the linked biological-temperature analysis were processed with more scrutiny in the following section.

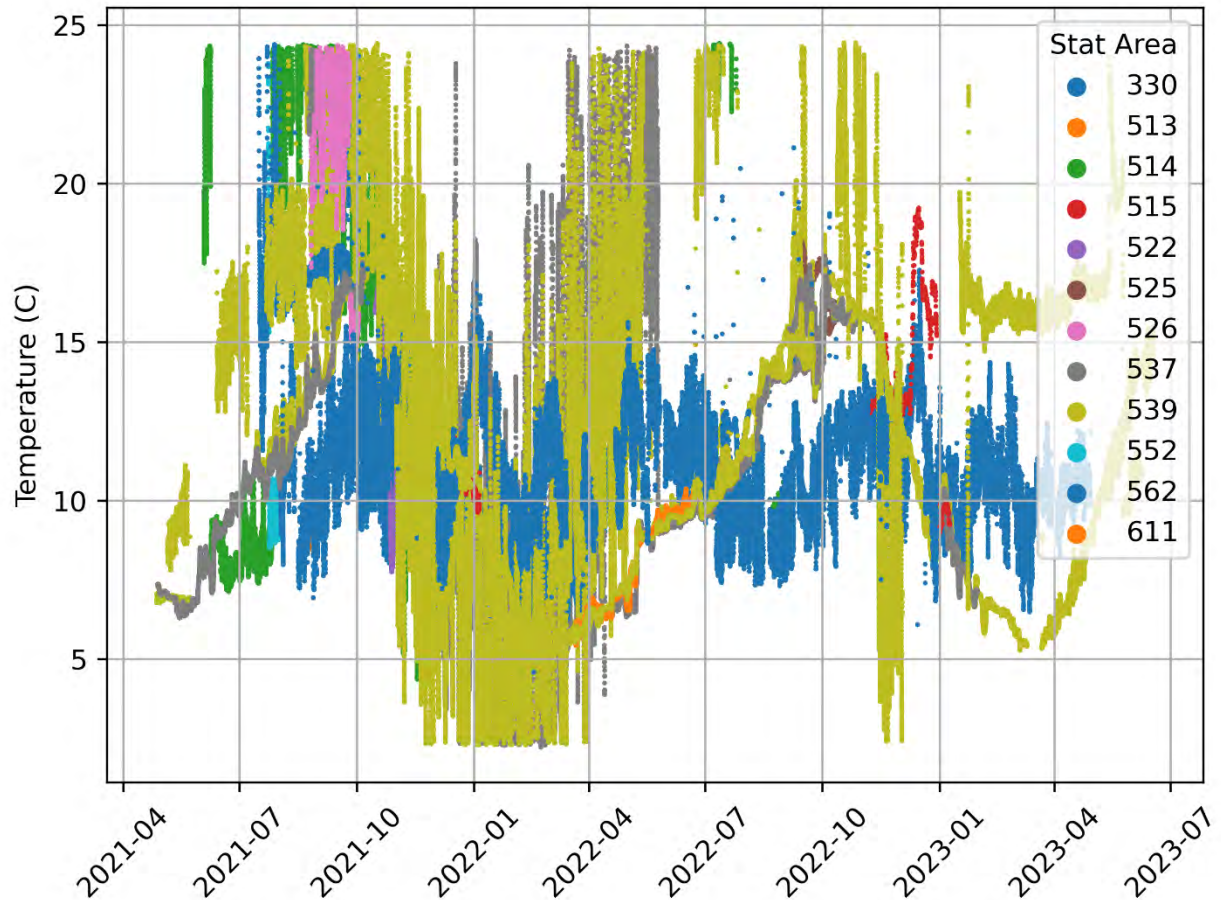


Figure 13: Bottom water temperature data (°C) collected from April 1, 2023 through June 30, 2023.

Linkages to Bottom Water Temperature

Temperature and biological data were paired for a subset of fleet participants. Due to the biological and oceanographic data streams being separate and distinct from each other there is no key directly relating the two. Therefore, inferred relationships between time and location of collected data were utilized. GPS positions were not always reliable for a myriad of technical reasons, additionally human error introduced by fishermen offloading data on their transit back to port obscured where the oceanographic data were collected. Outside of GPS challenges, cleaning the data to remove out of water values required extensive processing. Future efforts to implement a more robust method for merging the biological and oceanographic data streams is underway at CFRF.

Overview of the temperature data

A total of 959 biological sampling sessions (gear hauls) were recorded with matching temperature data. The sampling sessions occurred on 326 separate dates from 7/8/2014 through 10/25/2022, and between latitudes 39.5° N – 43.5° N and longitudes 66.2° W – 73.0° W (Fig. 14). Depths ranged from 14 m – 357 m (Fig. 15A), with inshore locations varying between 12 and 101 m (mean = 43, n = 747), and offshore locations varying between 79 and 357 m (mean = 227, n = 53). The temperature records were coupled with a total of 623 American lobster sampling sessions (374 commercial, 249 ventless trap) and 336 Jonah crab sampling sessions (195 commercial, 141 ventless trap). For each

biological sampling session, mean temperature was calculated from linked temperature data recorded over a six-day period prior to gear being hauled and sampled, or for the entire gear soak time if it was less than six days (Fig. 16). Six-day mean temperatures associated with biological sampling sessions ranged between 2.4 °C and 19.2 °C (Fig. 15B).

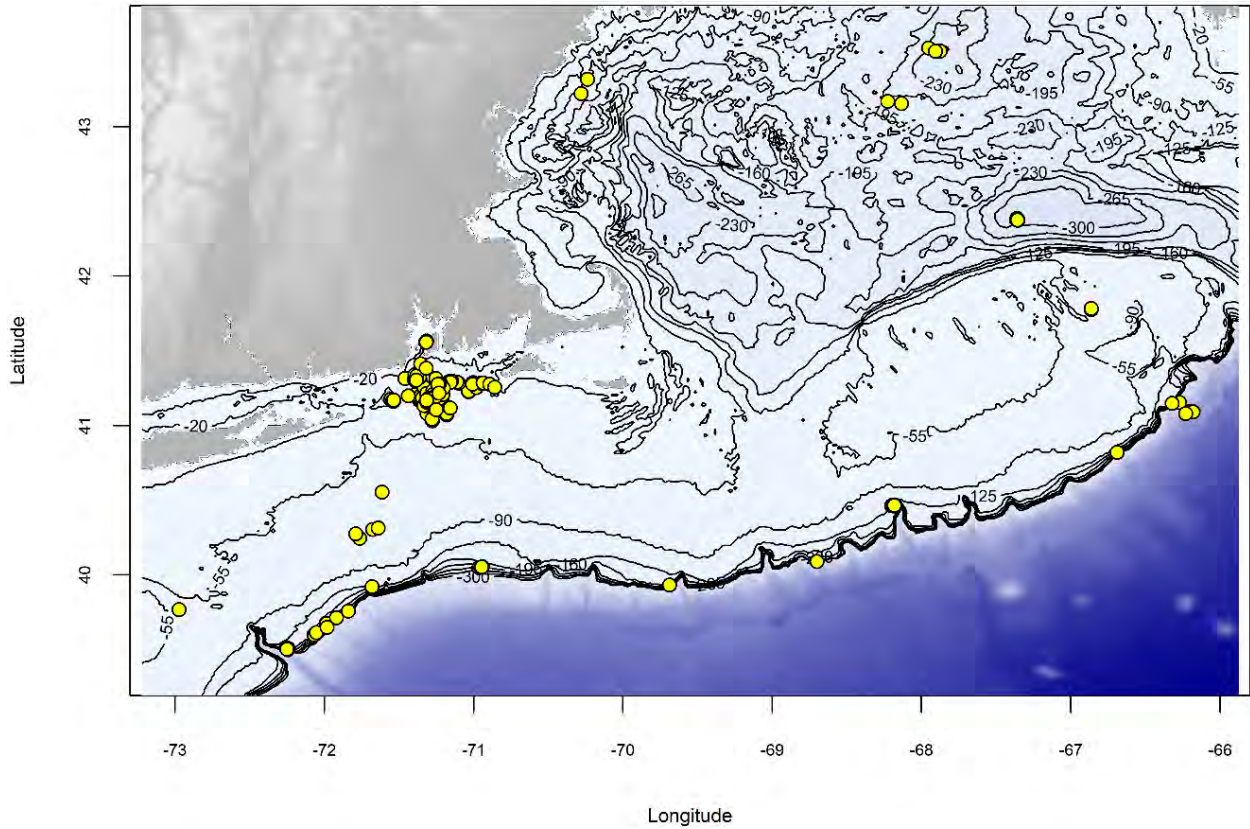


Figure 14: Map of locations where temperature data were matched with biological samples (n = 959 biological sampling sessions recorded by 19 vessels on 326 dates between 07/08/2014 – 10/25/2022).

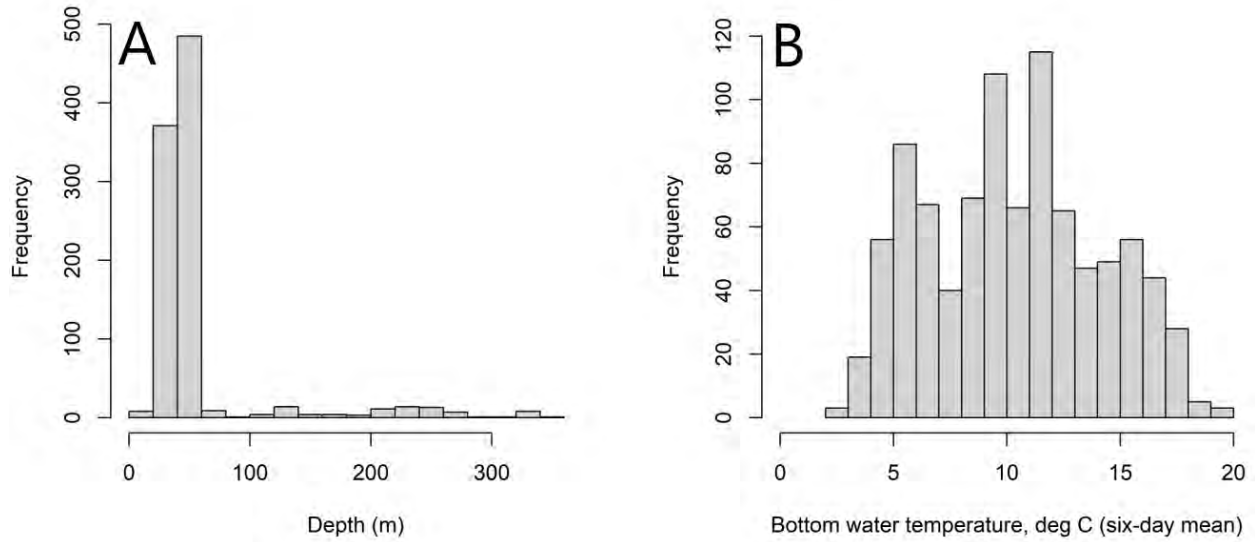


Figure 15: Distribution of (A) sampling depths, and (B) and temperatures (six-day mean prior to gear being hauled and sampled).

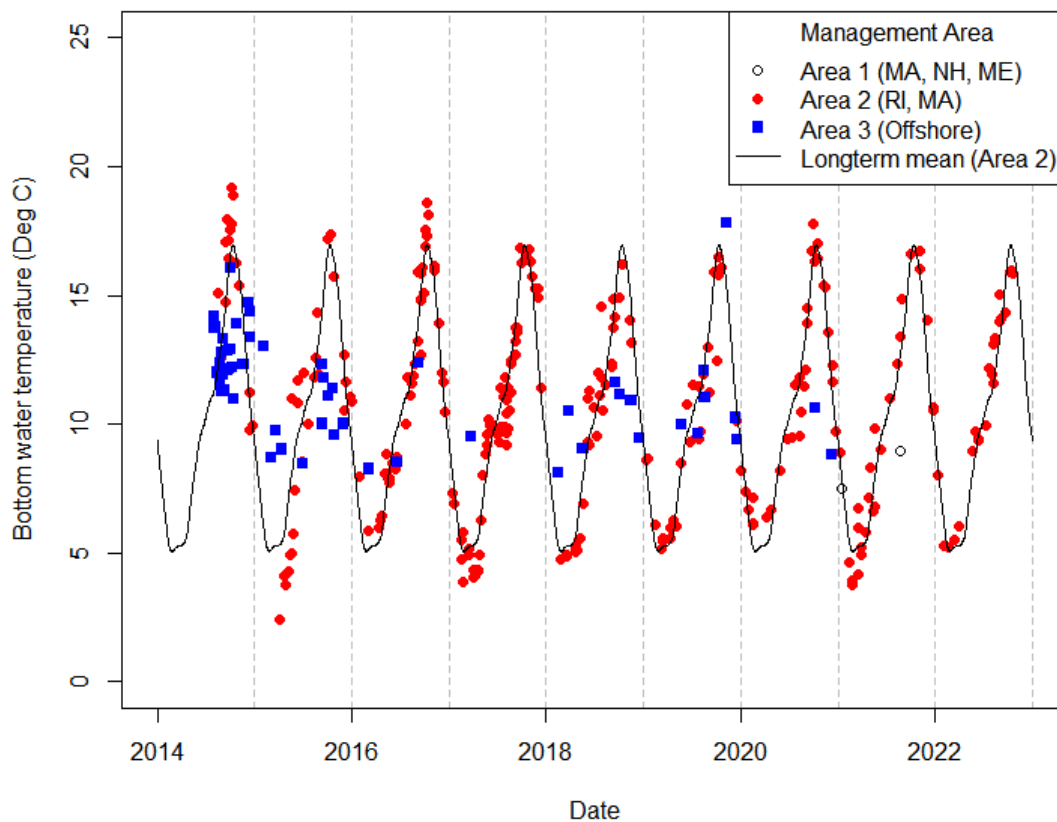


Figure 16: Time series of temperature data that were matched with biological samples. Each data point represents the mean temperature over a six-day period before traps were hauled (959 biological sampling sessions taken on separate 326 dates). The smoothed line represents the long-term day-of-the-year mean bottom water temperature in Area 2 (LOESS fit to all CFRF temperature data from area 2).

Relationships between temperature and size composition

Lobster carapace length

Mean carapace lengths of male and female lobsters (Table 3) caught by commercial gear in inshore and offshore waters were compared using a mixed ANOVA model (fixed factors: sex and shore type; random factors: vessel, sampling session, year, and month). Inshore lobsters were significantly smaller than offshore lobsters ($P < 0.01$), and there was a significant interaction between shore type and sex ($P < 0.0001$), which was caused by females being significantly larger than males in inshore waters, but not in offshore waters. A separate analysis of the ventless trap lobster data also showed that offshore lobsters were larger than inshore lobsters ($P < 0.01$), but there was no interaction between shore type and sex ($P = 0.1$). Instead, females were larger than males in both inshore and offshore waters ($P < 0.001$).

Table 3: Sizes of American lobster (carapace length, mm) and Jonah crab (carapace width, mm) specimens sampled by fishing sessions coupled with bottom water temperature data. n represents the specimens; sessions represent the number of gear hauls from which specimens were sampled.

Area	Gear type	Species	Sex	mean	min	max	sd	n	sessions
Inshore	Commercial	American lobster	F	89.0	49	142	7.0	4,182	314
	Commercial	American lobster	M	87.0	44	129	10.3	1,303	268
	Commercial	Jonah crab	F	100.0	52	157	12.9	711	126
	Commercial	Jonah crab	M	127.0	11	169	16.1	6,338	166
	Ventless	American lobster	F	79.9	46	106	7.8	748	145
	Ventless	American lobster	M	76.2	43	112	9.5	492	120
	Ventless	Jonah crab	F	105.0	57	143	9.9	476	80
	Ventless	Jonah crab	M	122.0	13	164	12.8	1,736	109
Inshore total								15,986	1,328
Offshore	Commercial	American lobster	F	97.4	69	156	12.8	590	16
	Commercial	American lobster	M	94.7	57	174	11.2	486	16
	Commercial	Jonah crab	F	113.0	106	119	5.2	6	2
	Commercial	Jonah crab	M	139.0	85	158	13.8	124	4
	Ventless	American lobster	F	86.6	61	120	11.1	87	24
	Ventless	American lobster	M	83.0	54	117	10.2	132	21
	Ventless	Jonah crab	F	113.0	91	128	8.4	57	4
	Ventless	Jonah crab	M	131.0	88	165	14.1	79	8
Offshore total								1,561	95
Grand total								17,547	1,423

An analysis of commercially caught inshore female lobsters showed that carapace length varied with month (mixed ANOVA with month as a fixed factor, and vessel, session, and year as random factors; $P < 0.001$), although the magnitude of monthly variation was quite small (Fig. 17A). A significant effect of month was also detected with commercially caught inshore male lobsters ($P < 0.01$) (Fig. 17B).

To test whether temperature was related to carapace length of commercially caught inshore lobsters, several generalized additive mixed models (GAMMs) were fit to the carapace length data. The GAMMs (here, and further below) were fit to 2015-2021 data. In each model, smooths were fit to the relationship between carapace length and day-of-year (to account for seasonal patterns in size variation), and to the relationship between carapace length and temperature anomaly. Vessel, sampling session, and year were included as random intercepts. The goal was to explore whether lobster sizes

varied with respect to temperature (warmer or cooler than average), given the day-of-year they were sampled (to account for seasonal variation). Male and female data were analyzed separately. For each sex, an initial model was fit to data collected from all months of the year (Jan-Dec) to test whether temperature had a general year-round effect on carapace length. Separate models were then fit to Jan-Mar (winter), Apr-Jun (spring), Jul-Sep (summer), and Oct-Dec (fall) data to test whether temperature affected carapace length on a seasonal basis. GAMMs fit to year-round commercial catch data showed significant variation in carapace length with day-of-year in both female (Fig. 17C) and male (Fig. 17D) lobsters ($P < 0.001$ and $P = 0.02$, respectively), but there was no year-round relationship with temperature anomaly (females, $P = 0.93$; males: $P = 0.53$).

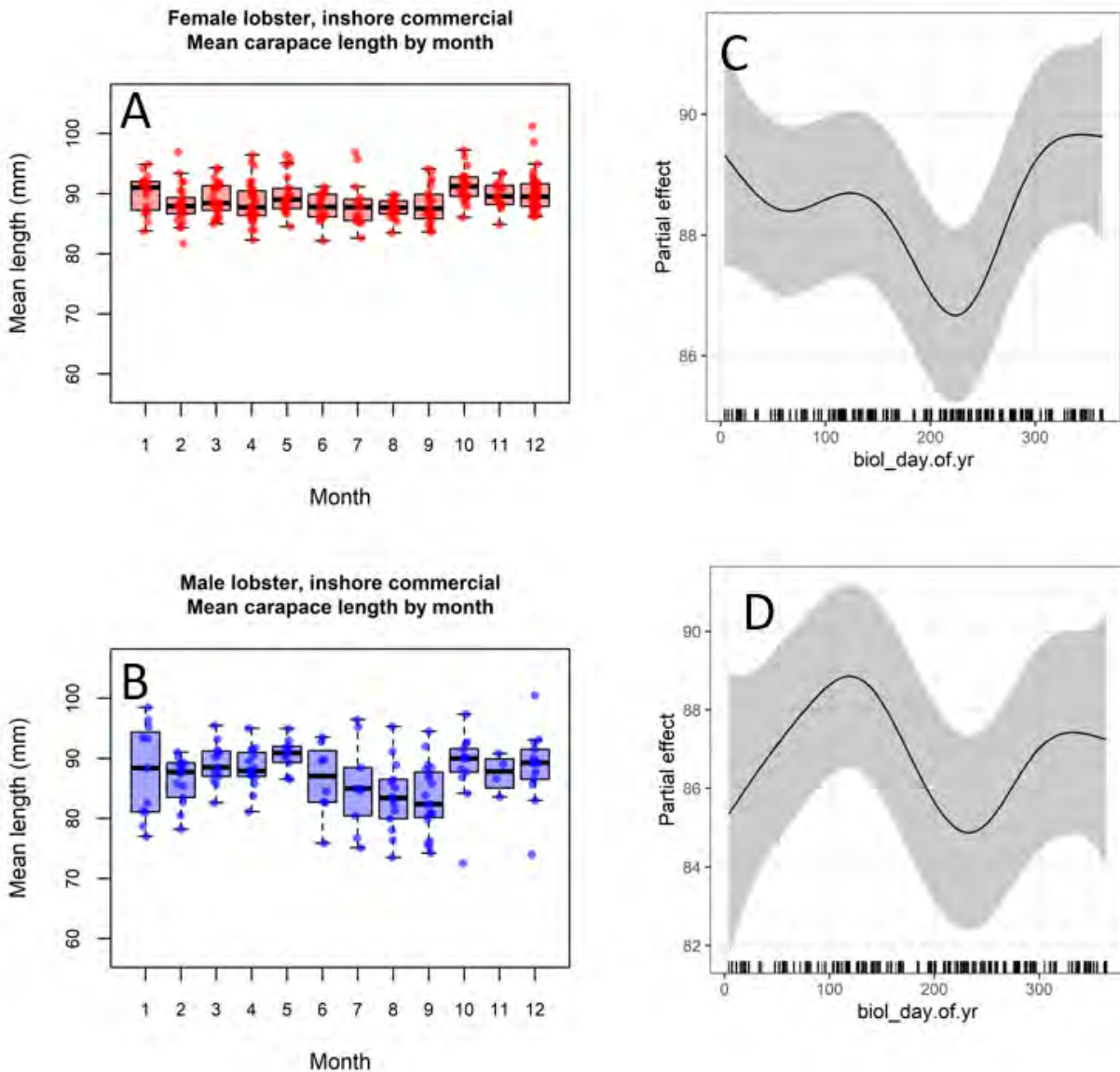


Figure 17: Variation in carapace length of commercially caught lobsters from inshore waters. (A) Females by month. (B) Males by month. (C) GAMM fit of female carapace length versus day-of-year. (D) GAMM fit of male carapace length versus day-of-year.

GAMMs fit to seasonal data did not detect relationships between carapace length and day-of-year (females, $P \geq 0.25$; males, $P \geq 0.38$). However, during winter, temperature anomalies were related to female carapace length ($P = 0.03$) and male carapace length ($P = 0.02$), with positive temperature anomalies (i.e., warmer than average conditions for the day-of-year) being associated with smaller carapace lengths in both sexes (Fig. 18). This temperature effect was not significant during other seasons (females, $P \geq 0.65$; males, $P \geq 0.20$).

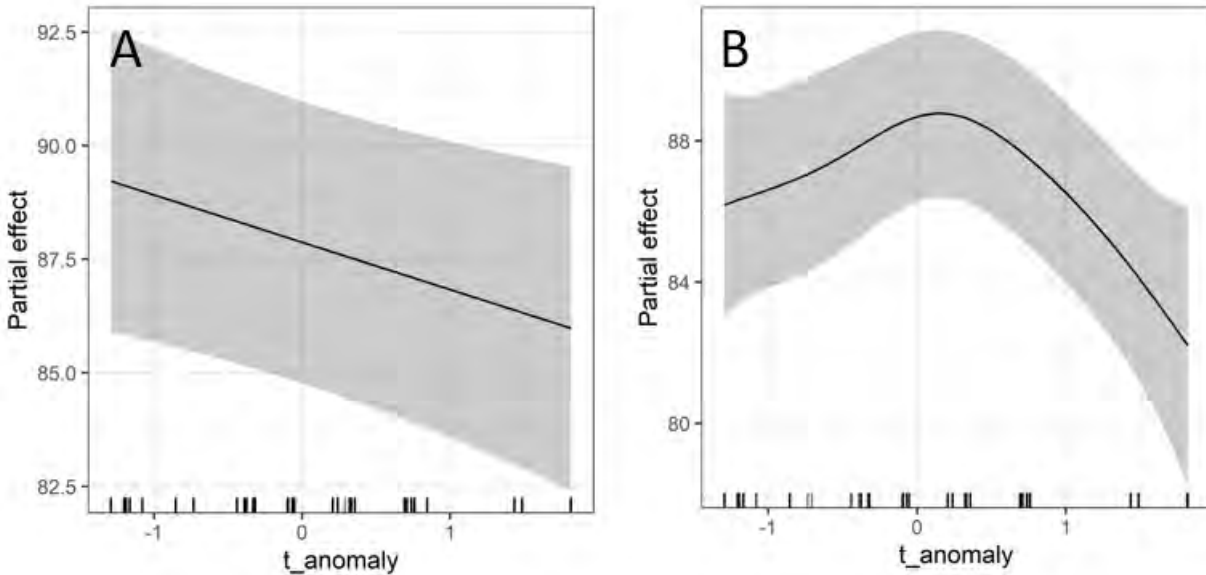


Figure 18: Smoothed GAMM fits showing relationships between carapace length and winter temperature anomalies in (A) commercially caught inshore female lobsters, and (B) commercially caught inshore male lobsters.

Jonah crab carapace width

Mean carapace widths of male and female Jonah crab in inshore and offshore waters (Table 3) were compared using a mixed ANOVA model (fixed factors: sex and shore type; random factors: vessel, sampling session, year, and month). Commercially caught inshore Jonah crab were significantly smaller than commercially caught offshore Jonah crab ($P = 0.04$), and males were significantly larger than females ($P < 0.0001$). A separate analysis of ventless trap Jonah crab found a similar effect of sex ($P < 0.0001$), but no difference between inshore and offshore crabs ($P = 0.11$). An analysis testing the effect of month on commercially caught inshore female Jonah crab showed that carapace width varied with month (mixed ANOVA with month as a fixed factor, and vessel, session, and year as random factors; $P < 0.001$) (Fig. 19A). Carapace width also varied by month in commercially caught inshore male crabs ($P < 0.0001$) (Fig. 19B). GAMMs fit to commercial data collected throughout the year showed significant variation in carapace length with day-of-year in both female (Fig. 19C) and male (Fig. 23D) lobsters ($P < 0.001$ and $P = 0.0001$, respectively), but there was no overall relationship with temperature anomaly ($P = 0.19$ and $P = 0.88$, respectively). None of the seasonal GAMMs fit to the commercial Jonah crab data detected a relationship between carapace width and temperature anomaly (for females, $P \geq 0.06$ in separate winter, spring, summer, and fall models; for males, $P \geq 0.07$).

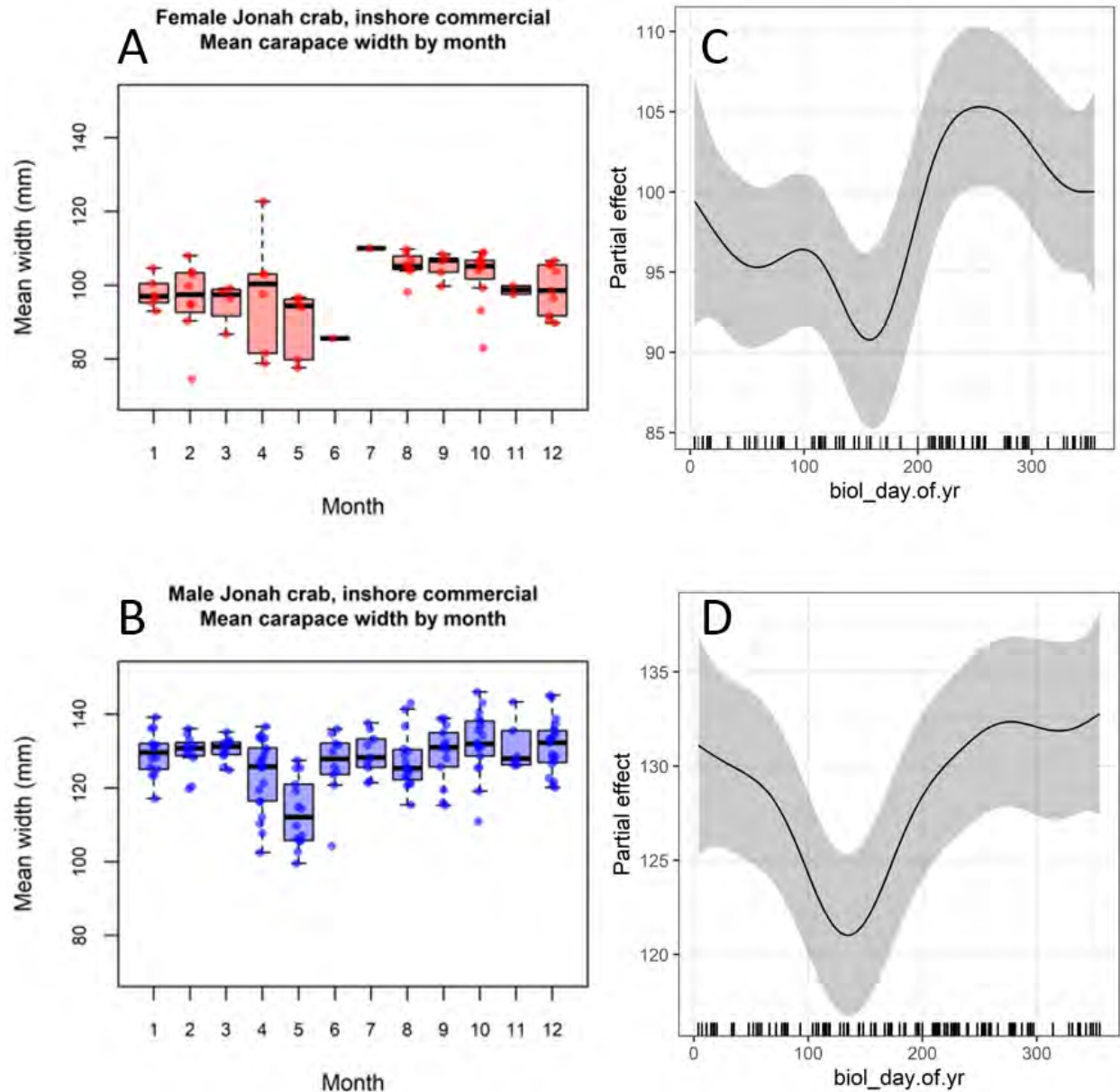


Figure 19: Variation in carapace width of commercially caught Jonah crab from inshore waters. A) Females by month. B) Males by month. C) GAMM fit of female size versus day-of-year. D) GAMM fit of male size versus day-of-year.

Relationships between temperature and proportion of females

Proportion of female lobsters

The overall proportions of female lobsters in the inshore commercial and inshore ventless trap catches were 0.76 and 0.58, respectively. The proportion did not vary significantly by month in commercial inshore catches or the ventless trap inshore catches ($P > 0.1$ using a mixed logistic ANOVA testing month as a fixed factor, with vessel, sampling session, and year included as random intercepts;

Figs. 20A and 20B). Logistic GAMMs were run separately for inshore commercial data and inshore ventless trap data. With each dataset, models were run using data from all months of the year, as well as data separated by seasons. In each model, smooths were fit the proportion of females as a function of carapace length, day-of-year, and temperature anomaly, with random intercepts for vessel, sampling session, and year.

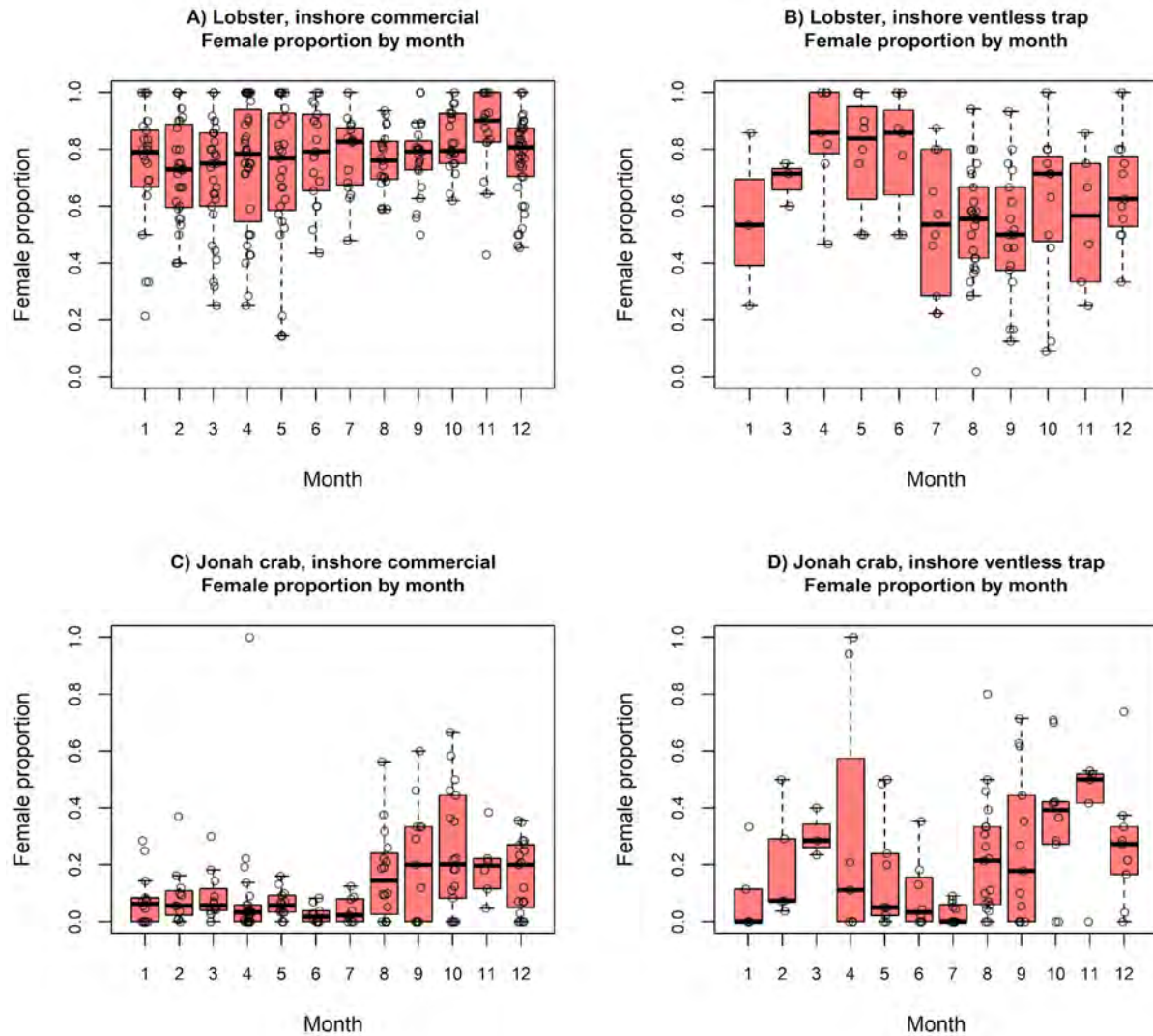


Figure 20: Proportion of individuals that were female. (A) Inshore commercial lobsters. (B) Inshore ventless trap lobsters. (C) Inshore commercial Jonah crab. (D) Inshore ventless trap Jonah crab.

The proportion of females did not vary significantly with day-of-year in the inshore commercial catches ($P = 0.23$, Fig 21A), but it declined with day-of-year in the ventless trap survey ($P < 0.01$, Fig 21B). Carapace length had a significant effect on female proportion in all the models of commercially caught lobsters ($P < 0.0001$), and all the models of the ventless trap lobsters ($P \leq 0.02$), except for the spring model ($P = 0.36$). The proportion of females increased with carapace length (Fig. 21C and Fig. 21D). Temperature anomaly was not significant in any of the models ($0.06 \leq P \leq 0.94$; Fig. 21E and Fig. 21F).

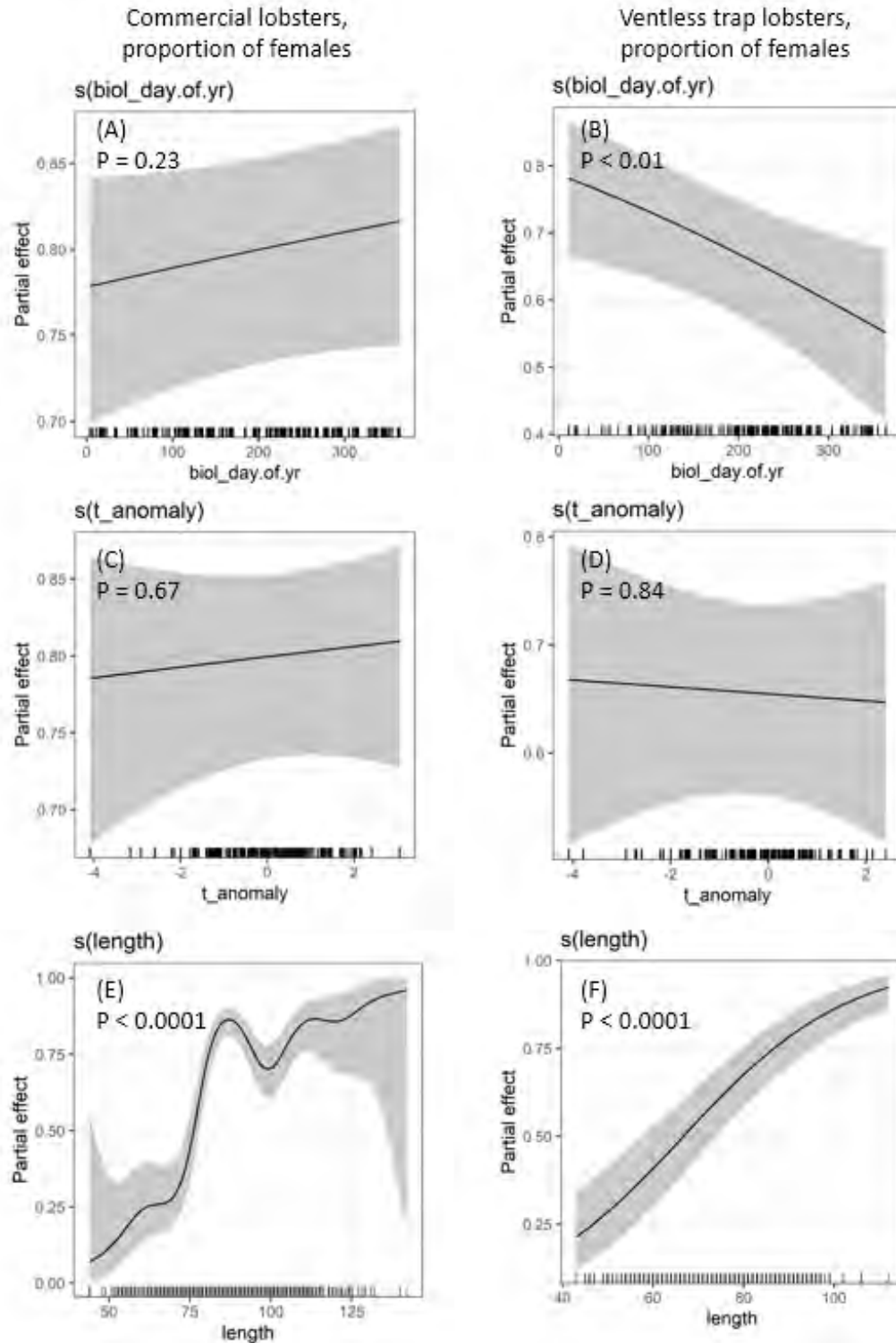


Figure 21: Generalized additive mixed models fitting the proportion of inshore lobsters that were female (y-axis) throughout the year (Jan-Dec). Fitted curves show relationships with (A & B) day-of-year, (C & D) temperature anomaly, and (E & F) carapace length (note different scales in E and F). Left column: commercial lobsters; right column: ventless trap lobsters.

Proportion of female Jonah crab

The overall proportions of female Jonah crab in the inshore commercial and inshore ventless trap catches were 0.10 and 0.22, respectively. (The higher proportion of females in ventless traps was attributable to greater selectivity of smaller, sexually dimorphic females). The proportion of females varied significantly by month in both surveys ($P < 0.03$ using a mixed logistic ANOVA testing month as a fixed factor, with vessel, sampling session, and year as random intercepts). The proportion of females generally peaked in late summer and fall (Figs. 20C and 20D). Logistic GAMMs were run separately for inshore commercial data and inshore ventless trap data. Models were fit to data from all months of the year, as well as separate halves of the year (Jan-Jun and Jul-Dec models). In each model, smooths were fit the proportion of females as a function of carapace width, day-of-year, and temperature anomaly, with random intercepts for vessel, sampling session, and year.

In models using data from all months of the year, the proportion of females varied significantly with day-of-year, with a greater proportion occurring during the second half of the year ($P < 0.001$ for both the commercial and ventless trap models). The proportion of females also decreased significantly at large carapace lengths ($P < 0.0001$ for both the commercial and ventless trap models). None of the commercial models detected an effect of temperature anomaly ($P \geq 0.16$ for the year-round and the seasonal models). However, in the ventless trap survey, the Jan-Dec model and the Jan-Jun model detected a significant decline in the proportion of females with increasing temperature anomaly ($P = 0.019$ and $P < 0.001$, respectively; Fig. 22). This effect was not significant in the Jul-Dec model ($P = 0.9$).

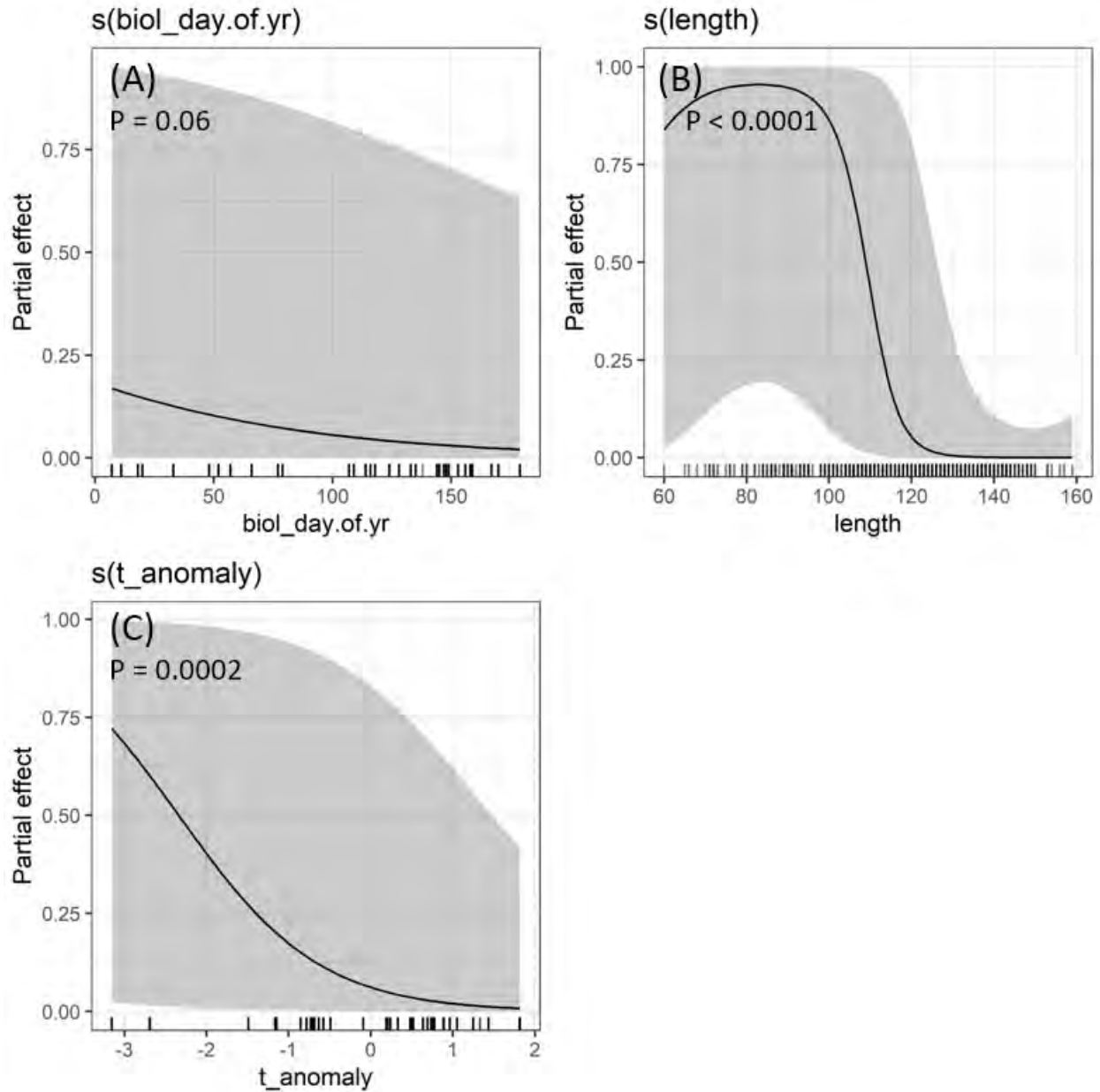


Figure 22: Relationships between proportion of female Jonah crab and: (A) Day-of-year (not significant; $P = 0.06$), (B) Carapace width (“length”, $P < 0.0001$), (C) temperature anomaly ($P < 0.001$). Plots show smoothed relationships from a generalized additive mixed model fit to Jan-Jun ventless trap catches from inshore waters.

Relationships between temperature and proportion of ovigerous females

Proportion of ovigerous female lobsters

The proportion of inshore commercial female lobsters that were ovigerous was 0.33, compared with 0.26 with the inshore ventless trap females. In the offshore catches, proportions were 0.09 and 0.15 for commercial and ventless trap females, respectively. The proportion of ovigerous inshore females varied significantly by month ($P < 0.0001$ for commercial and ventless trap females), with the proportion declining in June and July (coinciding with egg hatching), then increasing in late summer and

fall (Fig. 23A). Less data were available from offshore waters, but the proportion of ovigerous females was generally lower than inshore waters (Fig. 23B).

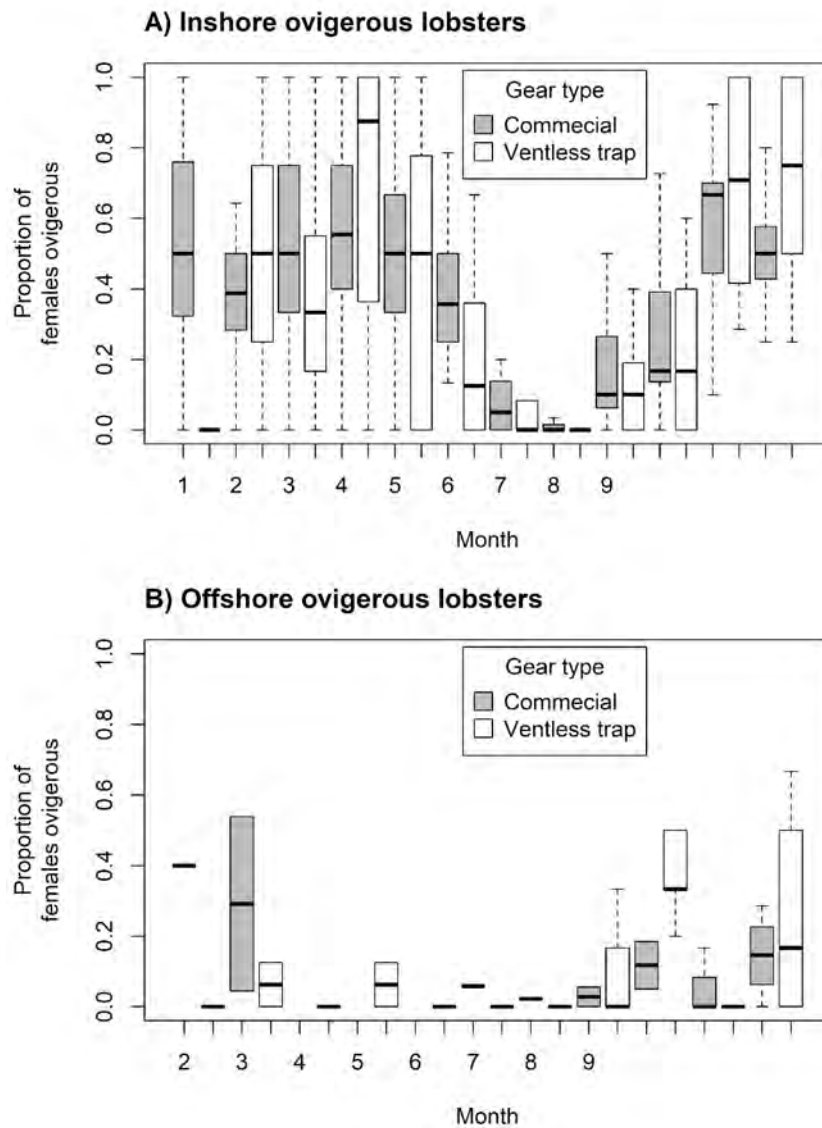


Figure 23: Proportion of female lobsters that were ovigerous in (A) inshore waters, and (B) offshore waters.

Logistic GAMMs were run separately for inshore commercial data and inshore ventless trap data, and were fit to year-round (Jan-Dec) data as well as seasonal data. In each model, smooths were fit the proportion of females as a function of carapace length, day-of-year, and temperature anomaly, with random intercepts for vessel, sampling session, and year. In the models fit using the year-round data, day-of-year was highly significant ($P < 0.0001$ for both the commercial and ventless trap data) due to the sharp decline of ovigerous females that occurred mid-year as eggs hatched. The proportion of ovigerous females also increased significantly with carapace length ($P < 0.0001$ for both the commercial and ventless trap data). Temperature anomaly did not have a significant effect in the year-round models ($P = 0.06$ and 0.23 for the commercial and ventless trap data, respectively), or in the separate winter ($P =$

0.39 and 0.83), spring ($P = 0.19$ and 0.22), or summer models ($P = 0.90$ and 0.35). However, during fall, the proportion of ovigerous females increased significantly with temperature anomaly in both the commercial catches ($P < 0.001$) and the ventless trap catches ($P < 0.001$) (Fig. 24).

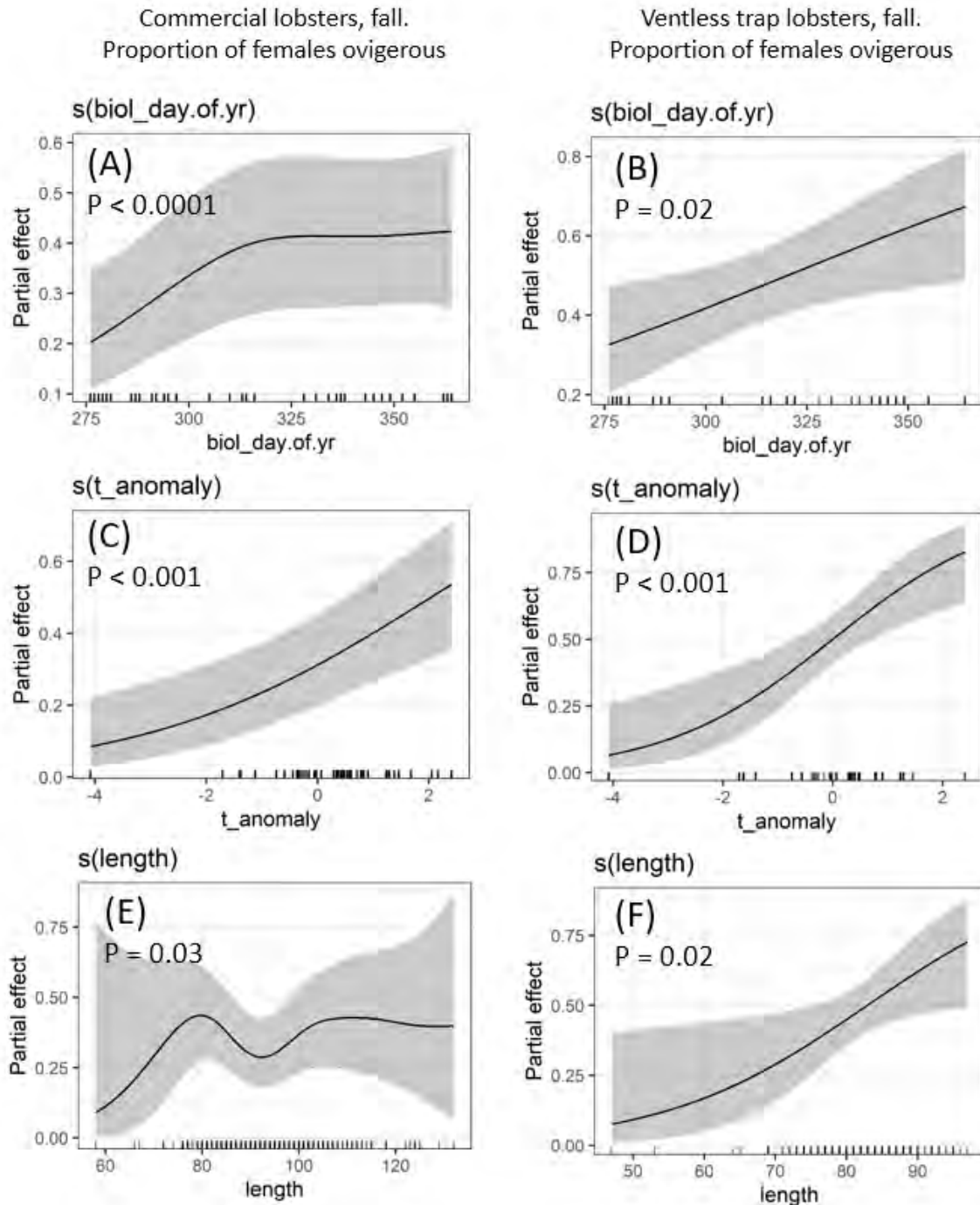


Figure 24: Generalized additive mixed models fitting the proportion of inshore female lobsters that were ovigerous (y-axis) during fall. Fitted curves show relationships with (A & B) day-of-year, (C & D) temperature anomaly, and (E & F) and carapace length (note different scales in E and F). Left column: commercial lobsters; right column: ventless trap lobsters.

Proportion of ovigerous female Jonah crab

Analyses of ovigerous female Jonah crabs were not performed due to the low proportion of egg-bearing females in the survey catches (<1% of females).

Relationships between temperature and lobster shell disease

Lobster shell disease was scored as 0 (no shell disease), stage 1, stage 2, or stage 3 (increasing severity of shell disease). Prevalence of shell disease (any stage, 1-3) was greater in inshore waters than offshore waters ($P < 0.0001$), and greater in ovigerous females compared with non-ovigerous females and males ($P = 0.0001$) (Table 4). Shell disease of the inshore ovigerous females varied significantly by month ($P < 0.0001$), with a peak occurring in late spring, followed by a steep decline in early summer (Figs. 25 and 26), which coincides with the time of egg hatching a molting (i.e., shedding of diseased shells). A similar temporal pattern was discernable in males, although prevalence peaked in mid- rather than late-spring. With non-ovigerous females, the peak in prevalence occurred slightly later than the overvigorous female peak, probably because some of the diseased ovigerous females had hatched their eggs, but not yet molted.

Table 4: Prevalence of shell disease in lobsters from inshore and offshore waters, categorized by sex and female reproductive status.

		Prevalence of shell disease stage (%)						
Shore	Sex	stage 1	stage 2	stage 3	stage 1-2	stage 1-3	Sessions	Lobsters
Inshore	male	4.2	0.8	0.6	5.0	5.6	389	1,852
Inshore	female, no eggs	4.9	1.5	0.4	6.4	6.7	418	3,361
Inshore	female, w/ eggs	24.2	9.9	4.0	34.1	38.2	357	1,570
Offshore	male	0.8	0.2	0.0	1.0	1.0	37	618
Offshore	female, no eggs	0.3	0.0	0.0	0.3	0.3	40	612
Offshore	female, w/ eggs	0.0	0.0	0.0	0.0	0.0	22	65
Total:		7.8	2.7	1.1	10.5	11.6	1,263	8,078

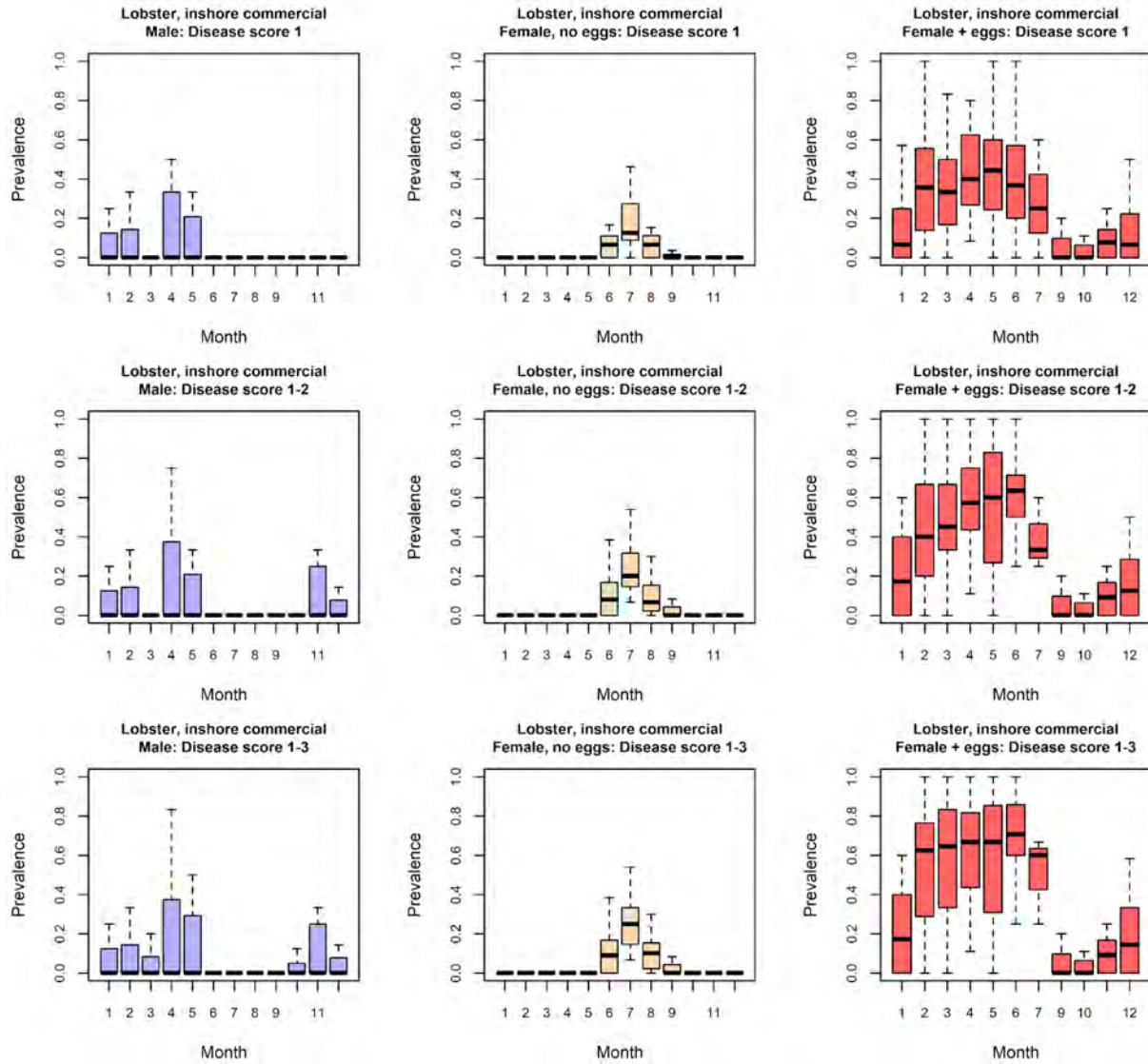


Figure 25: Prevalence of shell disease, by month, in inshore lobsters caught by commercial gear. Left column: males; middle column: non-ovigerous females; right column: ovigerous females. Top row: prevalence of disease stage 1; middle row: prevalence of disease stages 1-2; bottom row: prevalence of disease stages 1-3.

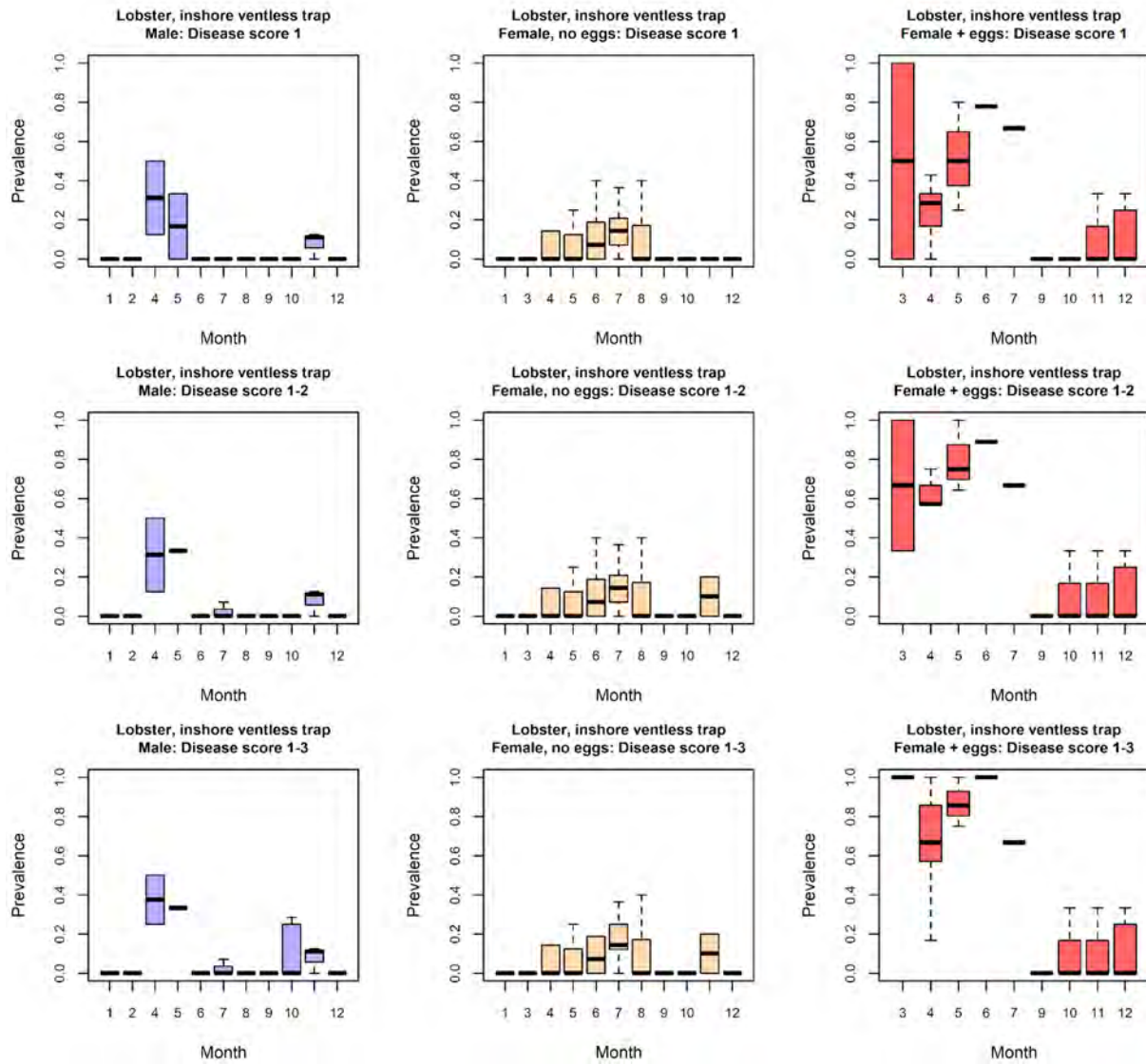


Figure 26: Prevalence of shell disease, by month, in inshore lobsters caught by ventless trap gear. Left column: males; middle column: non-ovigerous females; right column: ovigerous females. Top row: prevalence of disease stage 1; middle row: prevalence of disease stages 1-2; bottom row: prevalence of disease stages 1-3.

Analysis of temperature effects on shell disease focused on the inshore ovigerous females, since prevalence of shell disease was greatest in this group. Logistic GAMMs were run separately for inshore commercial data and inshore ventless trap data using data from either year-round (Jan-Dec), or by season. In each model, smooths were fit the proportion of females that were diseased (any stage, 1 through 3) as a function of carapace length, day-of-year, and temperature anomaly, with random intercepts for vessel, sampling session, and year. In commercially caught inshore ovigerous females, the model fit to the year-round data detected a significant relationship between prevalence of shell disease and both carapace length ($P < 0.001$) and day-of-year ($P < 0.0001$), but there was no relationship with temperature anomaly ($P = 0.48$) (Fig. 27). Models fit by season found a significant increase in the prevalence of shell disease with respect to day-of-year during fall ($P < 0.001$) and winter ($P < 0.001$), and

a significant decrease with day-of-year in summer ($P < 0.001$), but there were no seasonally detectable effects of carapace length ($P \geq 0.07$) or temperature anomaly ($P \geq 0.35$). Similarly, with ovigerous female lobsters caught by ventless trap, temperature anomaly had no significant effect in any of the models ($P \geq 0.58$). Additional models were run exploring relationships with shell disease separated by severity (stages 1-3), but no significant effects of temperature anomaly were detected.

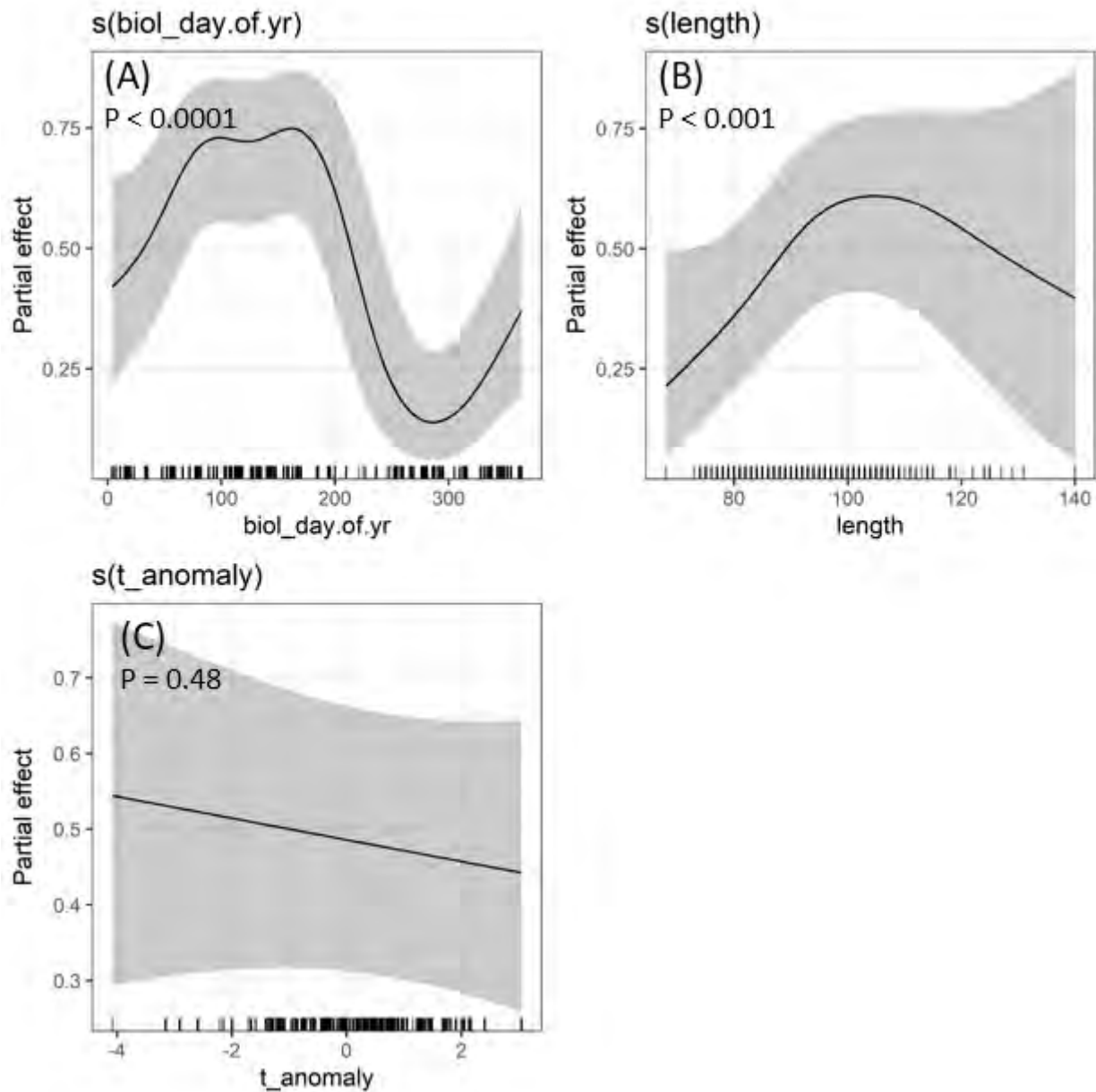


Figure 27: Generalized additive mixed model relating prevalence of shell-disease (all stages, 1-3) in ovigerous female lobsters with (A) day-of-year, (B) carapace length, and (C) temperature anomaly. The model was fit to year-round data (Jan-Dec).

Summary

A variety of relationships were detected between biological traits of lobsters and Jonah crab with respect to size, day-of-year, and temperature anomalies (Table 5). The proportion of female lobsters increased with carapace length, whereas the proportion of female Jonah crab decreased with carapace width. The likelihood of female lobsters being ovigerous increased with size, as did the likelihood of ovigerous female lobsters having shell disease. In both species, all of the traits analyzed varied with day-of year. Temperature was significantly related with lobster carapace length, the proportion of female lobsters that were ovigerous, and the proportion of Jonah crab that were female. With lobsters, there was a weak association between warmer temperatures and smaller carapace lengths in commercially caught males and females, although the magnitude of the effect was small. During fall, the proportion of female lobsters that were ovigerous also increased with temperature in both the commercial and ventless trap surveys. With Jonah crab, there was a decrease in the proportion of females with increasing temperature during the first half of the year, but only in the ventless trap samples. The analyses presented here explored relationships between biological traits and temperature conditions experienced over a six-day period while gear was actively fishing on the seabed. It is possible, however, that catches were also influenced by temperature conditions experienced during the weeks or months prior to a sampling event. Further analyses are needed to explore potential relationships between biological traits and prior temperature conditions, and to determine the importance of lagged temperature effects.

Table 5: Summary of generalized additive mixed model relationships between inshore biological traits and explanatory variables.

Species	Trait	Carapace width or length	Day of year	Temperature anomaly
Lobster	Carapace length	N/A	Mean carapace length of males and females varied with day-of-year (commercial survey).	Weak association between warmer temperatures and smaller carapace lengths during winter (commercial survey, males and females).
	Proportion of females	Proportion of females increased with carapace length (commercial and ventless trap survey).	Decrease in proportion of females with day-of-year (Jan through Dec, ventless trap survey).	No significant effect
	Proportion of females that were ovigerous	Increase in proportion of ovigerous females with carapace length (commercial and ventless trap survey).	Decrease in proportion of ovigerous females during June-July (egg hatching); increase in fall (commercial and ventless trap surveys).	Increase in proportion of ovigerous females with temperature during fall (commercial and ventless trap surveys).
	Prevalence of shell disease in ovigerous females	Increase in prevalence of shell disease with carapace length (commercial survey)	Decrease in prevalence of shell disease during June and July (corresponding with time of molt); increase in fall (commercial survey).	No significant effect
Jonah crab	Carapace width	N/A	Mean carapace width varied with day-or-year (commercial males and females; ventless trap females).	No significant effect
	Proportion of females	Decrease in proportion of females at large carapace widths (commercial and ventless trap surveys).	Greater proportion of females in the second half of the year (commercial and ventless trap surveys).	Decrease in proportion of females with increasing temperature during Jan-June (ventless trap survey).

Conclusions

The CFRF Lobster and Jonah crab Research Fleet has remained a cost-effective sampling program that has been integral in helping shape the management of both lobster and Jonah crab. The fishery-dependent basis of this program has allowed the Research Fleet to collect critical biological data

right where the commercial fishing effort is occurring in areas and times of the year that are often missed by state and federal surveys. These data collected by the Research Fleet helped support both the 2015 and 2020 American Lobster Benchmark Stock Assessments as well as the establishment of 2015 Interstate Fishery Management Plan for Jonah crab and the 2023 Jonah crab Benchmark Stock Assessment. The success of the program is attributed to the collaborative approach between members of the fishing industry, scientists, and managers that was established from the outset. CFRF staff and the participating vessels have updated the sampling protocols to meet the needs of emerging management concerns from both the scientists and industry members alike. Ongoing communication has helped build trust and confidence that the data are credible and used by all parties involved. The success of the Lobster and Jonah crab Research Fleet created a blueprint for the CFRF to develop other successful Research Fleets using similar commercial industry partners to study black sea bass, quahog, scallops, and whelk in New England.

The CFRF hopes to sustain the Lobster and Jonah crab Research Fleet well into the future to continue monitoring lobster and Jonah crab populations to fill data gaps and address research questions; building partnerships with commercial fishing industry members to maintain engagement with data collection efforts and encourage participation within management processes; and, supporting a sustainable future for lobsters and Jonah crabs and the livelihoods of New England fishermen.



CFRF NEWSLETTER

July 2021

ISSUE 15

COMMERCIAL FISHERIES RESEARCH FOUNDATION

The Commercial Fisheries Research Foundation is a non-profit, private research foundation founded and directed by members of the commercial fishing industry. The CFRF's primary mission is to conduct collaborative research and education projects that assist in the achievement of sustainable fisheries and vibrant fishing communities.

MESSAGE CORNER:

Our summer and research are in full swing, especially the 4 surveys (Beam Trawl, Gillnet, Ventless Trap & Fish Pot) in the essential habitat area of Cox Ledge, which are assessing the status of fish stocks as part of the South Fork Fisheries Monitoring Plan. The CFRF staff is working with RI fishermen from Point Judith, Newport and Sakonnet to conduct this significant research, which is critical to measuring impacts during and prior to construction and installation of wind turbines. The research is essential; however, the safety standards, documentation and requirements of Ørsted are imposing and excessive. They have created additional anguish for the CFRF staff and the fishing vessel captains and crews, and they unwarrantedly exceed United States Coast Guard fishing vessel regulations in US territorial waters. We are striving to establish some common ground with the offshore wind developers to standardize the safety regulations. We will succeed in time. I wish you ALL a productive, healthy and safe summer season.

Fred Mattera, CFRF President

NEW PROJECT: SOUTH FORK WIND FARM FISHERIES MONITORING—GILLNET SURVEY

This past May and June, we partnered with local fishermen (F/V Cailyn and Maren of Little Compton, RI and F/V More Misery of Newport, RI) to conduct a spring pre-construction fishery monitoring gillnet survey of the South Fork Wind Farm near Cox Ledge off the coast of Rhode Island. The South Fork Wind Farm is an offshore wind energy project located in federal waters and includes up to 15 wind turbine generators, submarine cables between turbines and an offshore substation. Five gillnet strings of 12-inch mesh and tie-downs are hauled in the development area, and two reference areas to the east and west of the development area. The survey



was conducted twice per month to document the abundance, distribution, and size of monkfish and winter skate in each area prior to construction. In addition, we are investigating prey composition for these species through stomach content analysis.

The top five commercial species caught in our spring survey were winter skate, monkfish, little skate, barndoor skate and summer flounder. Catch rates steadily increased throughout May and June. The proposed wind farm area had the highest number of winter skates, followed by the western reference area. Monkfish rates were highest in the

proposed wind farm area, with an almost even distribution of monkfish caught in the two reference areas. These results will be used in conjunction with future surveys to help determine if changes occur after the wind farm is constructed. Stay tuned to see what our fall survey will bring, starting October 2021! Please visit the CFRF South Fork Wind Farm Fisheries Monitoring [website](#) to stay up to date on all the surveys and the [gillnet survey webpage](#) for this project. Funding for this monitoring is provided by South Fork Wind LLC.



Learn more about CFRF at www.cfrfoundation.org



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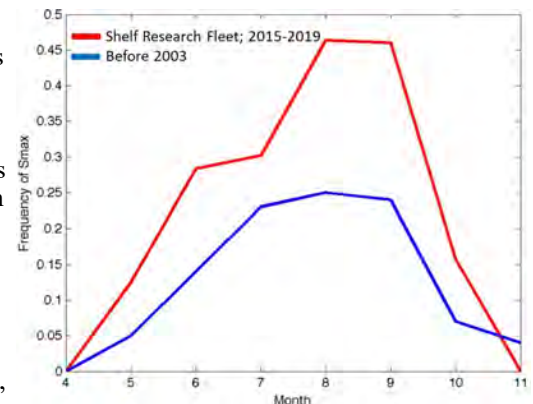
PROJECT UPDATE: LOBSTER AND JONAH CRAB RESEARCH FLEET

Over the last four months, the Lobster and Jonah Crab Research Fleet continued to sample biological and environmental data from over 4,500 lobsters and 3,900 Jonah crabs. This sampling effort brings the total number sampled by the Research Fleet since June 2013 to almost 169,000 lobsters and over 100,000 Jonah crabs! Thank you to all our current and past members for their involvement. We are excited to announce the Research Fleet has welcomed two new vessels: F/V Anna Mary out of Montauk, NY and F/V Rachel Leah out of Newington, NH. The addition of these two new vessels is an important step in expanding the Research Fleet to areas of significant importance offshore (eastern Georges Bank, and offshore Southern New England). This May, with funding from the Atlantic States Marine Fisheries Commission, we released a new version of our sampling app to improve biological data collection and our understanding of female lobster reproductive dynamics and seasonal cycles. Fishermen can now record their gear type (lobster or crab), lobster egg stage, and lobster shell hardness. At the beginning of July, we started a collaboration with the Rhode Island Department of Environmental Management (RI DEM) to leverage ongoing efforts by the Research Fleet to increase our understanding of Jonah crab growth. Crabs are being collected by members of the fleet, and monitored for molting over a 30-day period at the RI DEM laboratory in Jamestown. So far, over 150 Jonah crabs from two inshore and two offshore boats have been collected. Please visit our project [webpage](#) to find more information about this project and the Lobster and Jonah Crab Research Fleet.



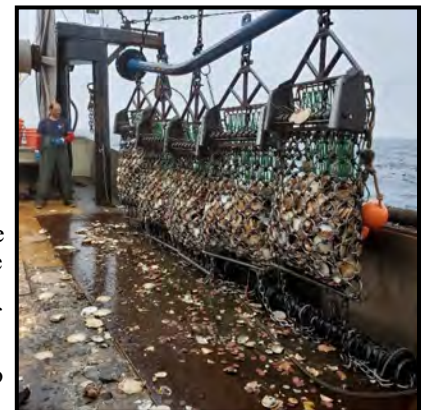
PROJECT UPDATE: SALINITY MAXIMUM INTRUSIONS

We are working with partners from several institutions to better understand influxes of warm, salty water (salinity maximum intrusions) from the continental shelf to waters closer to shore. These intrusions generally occur from May to October. The Shelf Research Fleet data was used to investigate the occurrence of these intrusions over the past few years. By comparing conductivity, temperature, and depth profiles collected by the Shelf Research Fleet from 2015-2019 to data before 2003, the team found a nearly 70% increase in these events (see pictured graph). A research cruise, in June, to find and collect data on salinity maximum intrusions was successfully completed. During the cruise numerous intrusions were tracked. Several locations had profiles with multiple intrusions occurring simultaneously at different depths. New techniques, including the use of autonomous underwater vehicles, to track these intrusions were developed. Initial observations of squid on the trip occurred only where these intrusions were present, fueling speculation that squid are “riding” these intrusions inshore. A follow up cruise is planned for September when a fishing vessel, following the research vessel, will tow within intrusions. Before that, CFRF will hold an informational session for those interested in learning more about this trip. Check out the [blog](#) and our [website](#) for more information and stay tuned for the meeting announcement.



PROJECT RESULTS/NEW PROJECT: PILOTING A N-VIRO DREDGE IN THE SCALLOP FISHERY

CFRF staff and participating vessels (F/V Brooke C, F/V Harvest Moon, F/V Karen Elizabeth, and F/V Mister G) completed all research trips for the project between February–September 2020. The at-sea trials consisted of 120 paired tows with the N-Viro dredge (pictured) and New Bedford style dredges on Limited Access General Category (LAGC) vessels around Cox Ledge and 80 paired tows on a Limited Access (LA) vessel in open bottom around Cox Ledge as well as the Nantucket Lightship Access Areas. Final results from both LAGC and LA vessel data show improved fuel efficiency and reduced bycatch rates for the N-Viro dredge compared to New Bedford style dredges, but reduced scallop catch rates were also observed for the N-Viro dredge. This low scallop catch rate offsets the other gains, but provided evidence for a niche use of the N-Viro dredge. In areas with high densities of small (<4") scallops, the N-Viro dredge catch rate was much lower than the New Bedford style dredge, but in areas with lower densities of large (>5") scallops, the N-Viro dredge catch rate was much closer to the catch rate of the New Bedford style dredge. These areas of low densities of large scallops also had high densities of sand dollars, and the N-Viro dredge was much more efficient at reducing their catch compared to the New Bedford style dredge. This suggests the N-Viro dredge could be used to extract large scallops from areas with high densities of both large and small scallops. Based on these results, the project team has received a second Sea Scallop Research Set-Aside award for 2021. We will have the opportunity to conduct Phase II field trials in the coming year. The second round of field trials will involve LAGC vessels to test modifications to the N-Viro dredge and a LA research trip that will apply the best modifications to the N-Viro dredge and specifically target areas of mixed scallop year classes. To follow along with the N-Viro dredge project and read the Phase I project report, visit the CFRF [website](#).



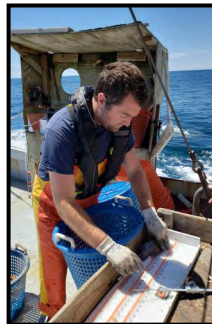
NEW PROJECT: SEA SCALLOP RESEARCH FLEET

Development of a Sea Scallop Research Fleet is underway! The main goal of this pilot Research Fleet is to develop and test methods of collecting individual weights and spawning condition of scallop during normal fishing operations. Despite being a well surveyed stock, there remain uncertainties surrounding the seasonal and spatial changes to scallop meat quality and the timing of spawning across the region. If practical methods are found, the Research Fleet could provide data to support fisheries management and stock assessment. This project is funded through the Sea Scallop Research Set-Aside Program and would not be possible without support from the industry. We would like to thank all the vessels who applied to be a part of this Research Fleet. Due to the scope of the project, we were limited to working with 6 vessels representing different sectors of the fishery; F/Vs Georges Banks and Yankee Pride (Limited Access), F/Vs Glutton and Midnight Our (Limited Access General Category), and F/Vs Clean Sweep and Northern Light (Northern Gulf of Maine). We're excited to work with these vessels, and the project steering committee. The steering committee is comprised of five members from the management and scientific communities to help us develop a sampling technique that is practical and has scientific integrity. An initial meeting with the steering committee gave us great leads to less burdensome sampling approaches, such as extracting data onshore from standardized photographs of freshly cut scallops (see picture). Our goal is to have the Sea Scallop Research Fleet begin testing the data collection methods in January. For more information and project updates visit the [webpage](#).



NEW PROJECT: SOUTH FORK WIND FARM FISHERIES MONITORING— FISH POT SURVEY

The fourth, and final, South Fork Wind Farm fishery monitoring survey kicked off in June with the commencement of the fish pot survey. The fish pot survey will be in operation for the next two years from June through December of each year. We will be working with the F/V Harvest Moon out of Point Judith, RI to complete the fish pot survey. The survey is designed to investigate the impact the wind turbines will have on fish in the immediate area around the installation. Eight trawls of 18 ventless fish pots have been deployed with the first pot of each trawl near the location of a potential turbine. The goal is to monitor structure-associated fin fish species such as black sea bass and scup to see if the turbines have the potential to create artificial reefs which may alter the abundance, distribution, or size-structure at increasing distances from the turbines. Throughout the first two months of survey activities the area seems to be predominately occupied by crabs, both Jonah and rock crabs, with the most abundant fish species being cunner, black sea bass, conger eels, and red hake. Stay tuned to the [project webpage](#) for survey updates and catch summaries! Funding for this monitoring is provided by South Fork Wind LLC.



NEW PROJECT: SOUTH FORK WIND FARM FISHERIES MONITORING — VENTLESS TRAP SURVEY

The South Fork Wind Farm Ventless Trap Survey commenced in May 2021. The survey is conducted in partnership with the F/V Amelia Anne, F/V Ashley Ann II, and F/V Erica Knight of Point Judith, RI and Dr. Jeremy Collie's lab of the University of Rhode Island. This survey is designed to assess the seasonal abundance, distribution, movement, and habitat use of lobster and Jonah crab in the South Fork Wind Farm area and two reference areas to the east and west of Cox Ledge for two years prior to the construction of the South Fork Wind Farm. Sampling will happen twice per month from May–November of 2021 and 2022 at 30 survey stations with trawls consisting of 10 traps (6 ventless traps and 4 standard traps). Biological data is collected for lobsters, Jonah crabs, and all bycatch species, and 3,000 lobsters will be tagged with green T-bar tags throughout the course of the two-year survey. The first three months of the survey have been completed and catches have increased as the survey progresses into summer. The South Fork Wind Farm area and western control area catches have been a mix of lobsters, Jonah crab, and rock crab, while the eastern control area was dominated by rock crab. To find out more about the survey, visit the [webpage](#). Funding is provided by South Fork Wind LLC.



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MORE ON-GOING PROJECTS:

- **A Pro-Seafood Climate Action Agenda:** A group of RI and MA fishing organizations initiated a process to craft a narrative on climate solutions that places wild seafood production at its core. Contact Sarah Schumann (schumannsarah@gmail.com) for more information.
- **Assessing the Vulnerability of the Atlantic Sea Scallop Social-Ecological System:** This project looks at how vulnerable sea scallop fishing communities are to ocean acidification and warming water temperatures, and develops recommendations on how to build resiliency to these changes. Visit our [website](#) for more information on this project and stay tuned to learn about the upcoming workshops.
- **Black Sea Bass Research Fleet:** In partnership with RI DEM, the Black Sea Bass Research Fleet produces year-round estimates of black sea bass catch, bycatch, and biological data for seven different gear types in the Southern New England and Mid-Atlantic regions. More information can be found on our black sea bass project [webpage](#).
- **Catalyzing the Restoration of the Bay Scallop:** This project seeks to help develop a restoration plan for bay scallops in Rhode Island. Information on this project can be found [here](#).
- **Development of a Marketable Seafood Product from Scup:** This project is developing a frozen scup fillet product that meets consumer, fisherman, fish processor, and chef needs. More information can be found at the project [webpage](#).
- **Mapping Hotspots and Piloting Underwater Video Technology:** The goal of this project is to create a map of ghost gear “hot spots” within Narragansett Bay and test a drop camera-grapple approach to target and remove ghost gear. Visit the [website](#) to learn more about the project.
- **Piloting a Low-Bycatch Automatic Squid Jig Fishery in SNE:** In partnership with The Town Dock, this project pilots the use of automatic jigging gear as a low bycatch method to harvest squid. More information on this project can be found on our [website](#).
- **Shelf Research Fleet:** In partnership with Woods Hole Oceanographic Institution the Shelf Research Fleet collects oceanographic data along the continental shelf. More information can be found on the shelf research fleet [webpage](#).
- **South Fork Wind Farm Fisheries Monitoring—Beam Trawl Survey:** The South Fork Wind Farm beam trawl survey collects data on the benthic communities of the South Fork windfarm development area and two nearby reference areas. More information on this project can be found [here](#).

EDUCATION AND OUTREACH:

- In May, Joshua Nooij from Northeastern University joined CFRF as the student intern for our Bay Scallop project. Joshua is playing a key role in the research and writing for this project. The internship will fulfill Joshua’s co-op requirement for his Master of Science degree.
- In June, Jessica Ruggieri from the University of Rhode Island joined CFRF as the Campbell Foundation supported summer intern. She spent the month of June learning about our research and is now working on a project that supports our wind farm surveys. The project will count towards her Graduate Certificate in Fisheries Science.
- David Bethoney served as one of several mentors to the student comprised “Team SCUPPERS” as they competed in the BlueGreen Innovation Challenge. In June, it was announced they had won first place for their idea of *Shellfish Aquaculture on Offshore Wind Farms!* Congratulations to the team and watch their pitch [here](#).
- Michael Long presented “Piloting the fuel efficient, low bycatch, and habitat friendly N-Viro dredge in the Southern New England Sea Scallop Fishery” to share project results at the results from the N-Viro project Sea Scallop Research Set-Aside Program Share Day in May.
- Aubrey Ellertson presented “Size at Maturity of Female American Lobsters from Offshore Southern New England and Eastern Georges Bank” to the Southern New England Chapter of the American Fisheries Society in June.

RECENT RELEASES, PUBLICATIONS, AWARDS AND UPCOMING EVENTS:

- An informational brochure for the Salinity Maximum Intrusions project was distributed and can be viewed [here](#).
- The Assessing the Vulnerability of the Atlantic Sea Scallop Social-Ecological System project was featured in the NOAA Fisheries Navigator, “Scientists Seek Input From Scallop Industry for Study on Ocean Acidification Impacts” The article and other CFRF press releases can be viewed from [here](#).

COMMERCIAL FISHERIES RESEARCH FOUNDATION

The Commercial Fisheries Research Foundation is a non-profit, private research foundation founded and directed by members of the commercial fishing industry. The CFRF's primary mission is to conduct collaborative research and education projects that assist in the achievement of sustainable fisheries and vibrant fishing communities.

MESSAGE CORNER:

For decades we've tried to sort out a means to improve the value of scup to fishermen. A goal has been to diminish the reliance of the consignment market in the cities (New York City, Jessup/Baltimore and Philadelphia) to allow supply and demand to dictate the pricing. CFRF took on the incredible challenge to seek such a solution by enhancing marketing of scup. Fortunately, scup stocks are sustainable for the long term, but the challenges were many: fillet machines for volume, fresh vs. frozen, fish size, fillet size, vacuum packs, fresh/frozen finish fillets and marketing outlets. We agreed to collaborate with Pier Fish Company to process and market, Johnson & Wales University and local chefs to provide exquisite recipes, tastings and nutritional value, and RI fish dealers for quality product. For over four years this partnership was all led at CFRF by research biologist Mike Long. Mike toiled with the team, experimenting and confronting trials until a viable fillet was available. Earlier this month, the entire team displayed their fillets at the Seafood Expo North America with chefs producing delicious "scup tacos" to a receptive audience of fish buyers. Pier Fish salesmen cultivated interest of potential buyers from supermarket chains and institutional markets. The future is brighter due to the tenacious effort of Mike and the collaborators.

Fred Mattera, CFRF President

PROJECT RESULTS: DEVELOPMENT OF A MARKETABLE SEAFOOD PRODUCT FROM SCUP



Our scup processing and marketing project finally came to its culmination this month. The goal of the project was to develop a frozen scup fillet product that met consumer demand, improved prices, and justified expanded harvest of this underutilized species. In achievement of that goal, we debuted vacuum sealed, boneless and skinless frozen scup fillets in an exhibitor booth and the New Product Showcase at the Seafood Expo North America in Boston. This is the biggest seafood show in the country, bringing together more than 1,300 suppliers from 49 countries to provide North America's seafood buyers access to their products. At the booth, CFRF and Commercial Fisheries Center of Rhode Island staff relayed the sustainability of the scup fishery, fishermen perspectives and the market challenges scup faces. Pier Fish Company staff met with potential retail and food service buyers. Chef Josh Berman of JB Cuisine and Johnson and Wales University students

served nearly 1,000 free fried scup tacos to potential buyers and Expo attendees. Dodge Associates produced great outreach materials for the booth, while the Sustainability Incubator set the stage with a press release prior to the event. A true example of teamwork! Feedback throughout the Expo was extremely positive, and Pier Fish staff received many promising sales inquiries that will likely lead to expanding the market for scup in its new frozen fillet form. This project originally started in 2018, but due to Covid-19 delays, the project was extended several times to ensure that the final frozen fillet product could be presented at the Seafood Expo. We are thankful to the NOAA Saltonstall-Kennedy program for funding this project and working with us to extend it.

We are now preparing the final project report, which will be available on the project website when completed. If you'd like to read the final report once released and find out more about the project, visit the project webpage [here](#).



PROJECT UPDATE: LOBSTER AND JONAH CRAB RESEARCH FLEET

Even in the face of rough weather and storms this fall, the Lobster and Jonah Crab Research Fleet was hard at work sampling over 5,000 lobsters and 2,900 Jonah crab since November. This brings the total number of lobster and Jonah crabs sampled since 2013 to over 181,500 and 107,400, respectively. This is impressive and we would like to thank all the fishermen involved for their time and effort! The data collected by the Research Fleet are incorporated into the lobster and Jonah crab biosamples databases at the Atlantic Coastal Cooperative Statistics Program and used extensively in the lobster stock assessment and upcoming Jonah crab stock assessment. The effort from the Research Fleet has also been used to support several supplemental projects to help better understand the lobster and Jonah crab resource. One includes working with Jim Manning at the Northeast Fisheries Science Center to incorporate CFRF's bottom water temperature data into his larger data set. Another, in collaboration with Jessica Waller (ME DMR) and Dr. Tracy Pugh (MA DMF), led to a publication in *Fisheries Research* about lobster size at maturity in offshore areas (see the publications section at the end of the newsletter).

The Research Fleet will continue data collection, with support by the Campbell Foundation, the Atlantic States Marine Fisheries Commission, and NOAA's Saltonstall-Kennedy Program. We are looking to bring on additional offshore vessels. Please visit the project webpage [here](#) to find more information about this project and an application form to join the fleet.



PROJECT UPDATE: SOUTH FORK WIND FARM FISHERIES MONITORING—FISH POT SURVEY



Year-1 of the South Fork Wind Farm Fish Pot survey came to a close with the final survey trip occurring on December 29th. The survey is designed to determine the spatial scale of potential impacts of wind farm turbine construction on the abundance and distribution of structured associated finfish species. A huge thanks go out to Joe Baker and Evan Adams of F/V Harvest Moon for their attention and dedication throughout the first year of the survey! Catch throughout the sampling season fluctuated but was dominated by Jonah crabs and black sea bass. Crab catch peaked in August and December. Black sea bass catch increased through the initial survey months and peaked in October and remained high through December. Scup catches were consistent throughout the survey, but were only a fraction of the amount of black sea bass. Other species of fish such as cunner and conger eels were common in some months but never in the abundances of black sea bass or even scup.

More information on this project can be found [here](#). Funding for this monitoring is provided by South Fork Wind LLC.

PROJECT UPDATE: SOUTH FORK WIND FARM FISHERIES MONITORING—GILLNET SURVEY

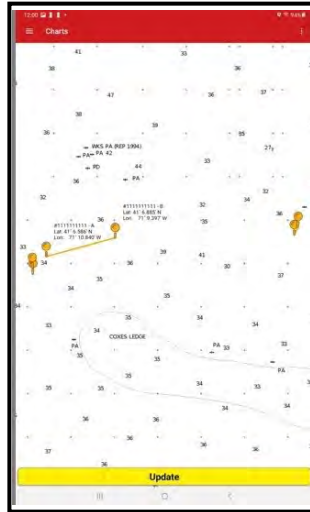
This December marked the completion of the first year of the gillnet survey. The survey is conducted in partnership with the F/V Cailyn and Maren and F/V More Misery, and is designed to assess the seasonal abundance, distribution, movement and habitat use of winter skate and monkfish in the South Fork Wind Farm area and two reference areas to the east and west of Cox Ledge. The eastern reference area encountered 20 different species and was dominated by skates (both winter and little skates), monkfish, bluefish, summer flounder and spiny dogfish. The proposed wind farm area encountered 23 different species and was dominated by skates, monkfish, bluefish, Jonah crab and spiny dogfish. Finally, the western area had the most species encountered (27!) and was dominated by winter skate, sea scallops, monkfish, bluefish, little skate and Atlantic menhaden. The second year of the survey will kick off next month.

More information on this project can be found [here](#). Funding for this monitoring is provided by South Fork Wind LLC.



NEW PROJECT: ELECTRONIC GEAR LOCATION MARKING

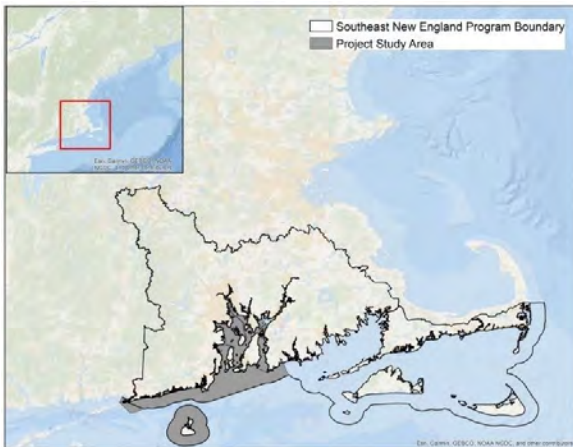
We are in the planning stages of a new project supported by the National Fish and Wildlife Foundation to test an electronic gear location marking application (app). To reduce gear entanglement by North Atlantic Right Whales, there has been a movement towards buoyless fishing systems. Less attention than needed has been given to the fact that without an adequate marking tool conflicts with mobile gear threaten the viability of several fisheries in shared fishing grounds. There is a crucial need for reliable technology that allows fishermen to identify the location of gear that does not have buoys. In collaboration with NOAA, this project will leverage our South Fork Wind Farm fisheries monitoring surveys and recruit additional fishermen to test the accuracy and utility of the Track Tracker app that was developed to fill this need, but has not been sufficiently tested. Our goals are to identify how accurately this app reflects the true location of marked gear, as well as to determine the usefulness of this app to fishermen. Stay tuned for project updates [here!](#)



Sample Track Tracker App Chart

NEW PROJECT: RHODE ISLAND GHOST GEAR REMOVAL PLAN

Ghost gear, or derelict fishing gear, impacts coastal Rhode Island waters. This new project builds on the results of a recently completed project which mapped ghost gear locations in Narragansett Bay. Now, with the support of commercial fishers and other regional stakeholders we will develop a cohesive, sustainable ghost gear management and removal plan to remove this gear and more from Rhode Island waters. As part of this project, we are



organizing regional partnerships to help develop and implement the plan, and will host a workshop in late summer that will bring together local stakeholders and international experts to discuss and evaluate the planning document. The project will conclude with outreach to the public on this plan and the issue of ghost gear. See our project webpage [here](#) for workshop, public meeting announcements and outreach materials. This project is funded by the Southeast New England Program watershed grants.

NEW BOARD MEMBER: KATIE ALMEIDA, THE TOWN DOCK:

We are excited to publicly welcome our newest board member, Katie Almeida. Katie is the Senior Representative of Government Relations and Sustainability for the Town Dock located in Point Judith, Rhode Island. The Town Dock is the largest supplier of calamari in the United States. They own six otter trawl vessels that fish for longfin squid, illex squid, whiting, butterfish, fluke, scup, black sea bass, herring, and a mix of groundfish. Katie is responsible for following all state and federal regulations that pertain to the species on which the Town Dock relies. She sits on the Squid/Mackerel/Butterfish, Fluke/Scup/Black Sea Bass, River Herring/Shad, and Small Mesh Multispecies Advisory Panels. She also is a part of the New Bedford working group for Wind Industry Issues and the Rhode Island Industry Advisory Committee. Further, she is a board member of the Responsible Offshore Development Alliance and Responsible Offshore Science Alliance. She brings a lot of valuable experience and connections to help guide CFRF.



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Carl Huntsberger
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Susan Inglis, PhD
Research Associate

Michael Long
Research Biologist

Noelle Olsen
Research Biologist

Hannah Verkamp
Research Biologist

Katie Viducic
Research Biologist

MORE ON-GOING PROJECTS:

- **A Pro-Seafood Climate Action Agenda:** A group of RI and MA fishing organizations initiated a process to craft a narrative on climate solutions that places wild seafood production at its core. Contact Sarah Schumann (schumannsarah@gmail.com) for more information.
- **Assessing the Vulnerability of the Atlantic Sea Scallop Social-Ecological System:** This project looks at how vulnerable sea scallop fishing communities are to ocean acidification and warming water temperatures and develops recommendations on how to build resiliency to these changes. For more information on this project visit [here](#).
- **Black Sea Bass Research Fleet:** In partnership with RI DEM, the Black Sea Bass Research Fleet produces year-round estimates of black sea bass catch, bycatch, and biological data for seven different gear types in the Southern New England and Mid-Atlantic regions. More information can be found [here](#).
- **Catalyzing the Restoration of the Bay Scallop:** This project seeks to help develop a restoration plan for bay scallops in Rhode Island. Information on this project can be found [here](#).
- **Phase II Piloting a N-Viro Dredge in the Scallop Fishery:** This project builds on previous work to utilize this dredge to reduce bycatch, including small scallops, in the sea scallop fishery. To follow along with the N-Viro dredge project and read the Phase I project report, visit the CFRF project webpage [here](#).
- **Piloting a Low-Bycatch Automatic Squid Jig Fishery:** This project investigates the feasibility of automatic squid jigging machinery, used in other large-scale squid fisheries worldwide, in the southern New England Longfin squid fishery. Check out the project [here](#) for more information and updates.
- **Salinity Maximum Intrusions:** This project will map intrusions of warm, salty water that may influence fish distributions in Southern New England. Check out the blog at <https://sirates.sites.umassd.edu/> and our project webpage [here](#) for more information.
- **Sea Scallop Research Fleet:** This project seeks to develop and test methods of collecting individual weights and spawning condition of scallops during normal fishing operations. For project updates visit [here](#).
- **Shelf Research Fleet:** In partnership with Woods Hole Oceanographic Institution the Shelf Research Fleet collects oceanographic data along the continental shelf. More information can be found [here](#).
- **South Fork Wind Farm Fisheries Monitoring— Beam Trawl Survey:** This survey is designed to help determine potential impacts of wind farm development on bottom dwelling animals. More information can be found [here](#).
- **South Fork Wind Farm Fisheries Monitoring—Ventless Trap Survey:** The goal of the survey is to assess the seasonal abundance, distribution, movement, and habitat use of lobster and Jonah crab in the South Fork Wind Farm area and two reference areas to the east and west. More information can be found at [here](#).
- **Whelk Research Fleet:** In partnership with RI DEM, this project seeks to fill data gaps in the combined Knobbed and Channeled Whelk fishery across southern New England through fishermen collected data. Please visit the webpage for more information [here](#).

EDUCATION AND OUTREACH:

- In January, David Bethoney presented results from our ghost gear work at the Land to Sea Speaker Series.
- In February, Aubrey Ellertson joined fellow members of the Sea Grant American Lobster Initiative for a network-wide meeting to discuss ways to foster collaboration and a sense of community across the expanding research program.
- In March, Aubrey Ellertson attended the virtual Ocean Science Meeting and presented “*Fishermen on the Front Lines of a Warming Ocean: The Shelf Research Fleet*”.

RECENT RELEASES, PUBLICATIONS, AWARDS AND UPCOMING EVENTS:

- **Event:** Research Workshop on Jonah Crab Management, April 6th, 3-7pm. For information and to RSVP, visit [here](#).
- **Article:** “[Scientists, Shellfishermen Seek Strategies to Sustain Ocean State’s Dwindling Bay Scallop Populations](#)” - ecoRI News, January 2022
- **Recent Publication:** “[Differences in the size at maturity of female American lobsters \(*Homarus americanus*\) from offshore Southern New England and eastern Georges Bank.](#)” (Ellertson et al. 2022), Fisheries Research, Volume 250
- **Press Release:** “[SENA Launch Sustainable Wild Atlantic Scup for Food Service](#)”, March 2022

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OFFICE LOCATION:

2nd Floor, Building #61B
Commercial Fisheries Ctr of RI
East Farm Campus, URI, Kingston, RI 02881

Progress and New Directions: CFRF's Lobster Crab Fleet



Aubrey Ellertson, Dr. N. David Bethoney

Fleet Meeting

Wednesday, December 8th (4-6pm)



The Research Team



Aubrey Ellertson

**Lobsters and Crabs
Gillnet survey
Oceanography**



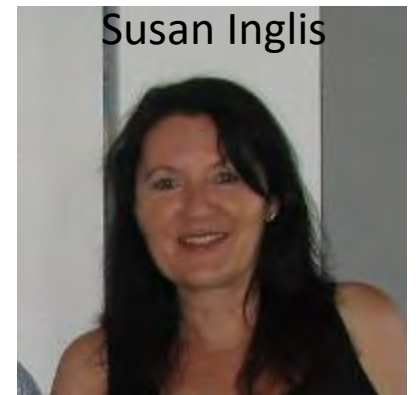
Thomas Heimann

**Squid
Whelks
Fish pot survey**



Carl Huntsberger

**Lobsters and Crabs
Sea scallops
Beam trawl survey**



Susan Inglis

**Lobster disease
Sea scallops
Ghost Gear**



Mike Long

**Scup
Ventless trap survey
Sea scallops**



Noelle Olsen

**Crabs
Squid
Oceanography**



Hannah Verkamp

**Black sea bass
Bay scallops
Wind farm surveys**

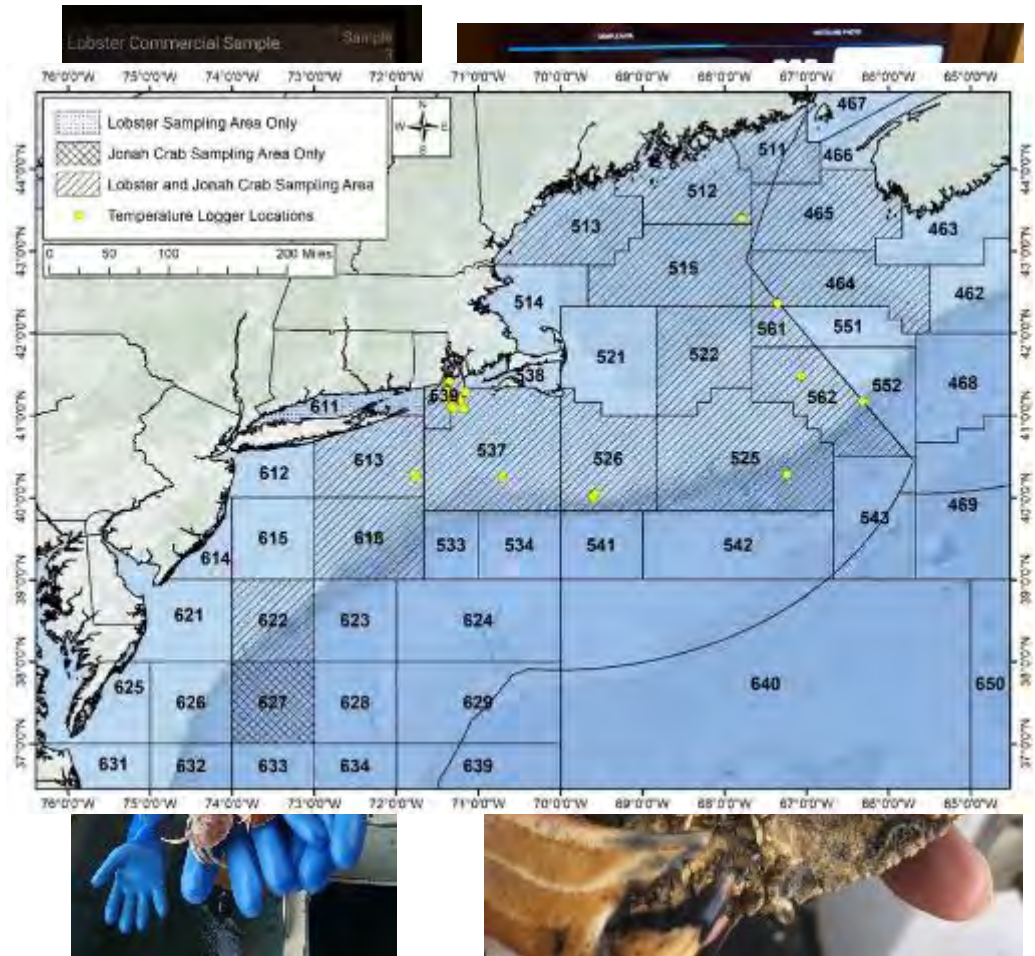


Terry Winneg

**Business Manager
Budgets!**

Research Fleets: Lobster-Crab

- The Progress
 - 21 vessels
 - Time series
 - Lobster: 2013
 - Crab: 2014
 - Nearly 300,000 biological samples
 - Millions of temperature readings
 - Additional data fields
 - Key part:
 - Lobster stock assessment
 - Jonah crab Manag. Plan





Currently we are at:



> *175,852 lobsters*
> *105,045 Jonah crabs*

The Research Fleet started in 2013 and has sampled lobsters and Jonah crabs from 17 statistical areas (464, 465, 511, 512, 513, 515, 522, 525, 526, 537, 539, 561, 562, 611, 613, 616, 622, and 627), including five identified as high priority areas for lobster sampling by the Atlantic States Marine Fisheries Commission's Addendum XXVI (522, 525, 526, 561, 562, and 616).

Current Project Timeline

We are currently funded through NOAA S-K and the Campbell Foundation, and Appropriations Funding through December 2022



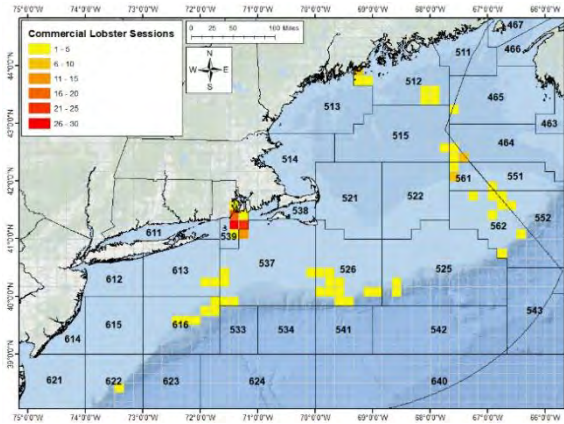
Research Fleets: New Fleet Participants

- F/V Linda and Laura (Block Island, RI)
- F/V Timothy Michael (New Bedford, MA)
- F/V Endeavour (Newport, RI)
- F/V Kristin and Michael (Portland, ME)
- F/V Dilligaf (Scituate, MA)
- F/V Anna Mary (Montauk, NY)
- F/V Rachel Leah (Newington, NH)

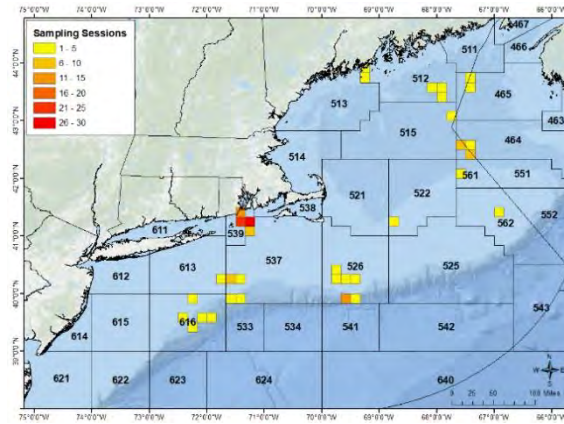


Map of the distribution and density of commercial lobster sampling sessions by fleet

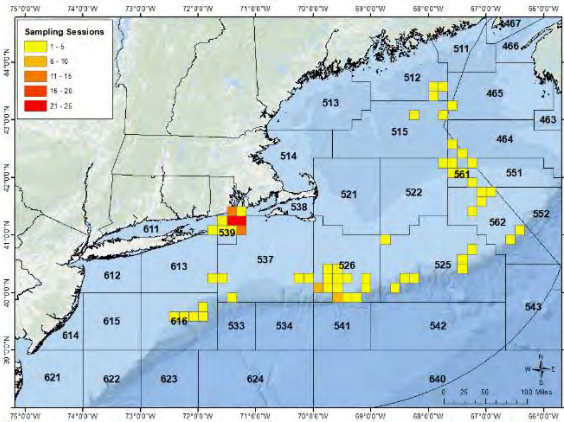
April 1, 2019
to September
30, 2019



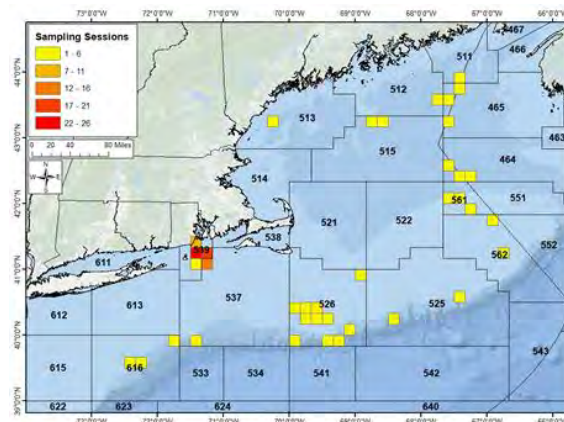
Oct 1, 2019
to March 31,
2020



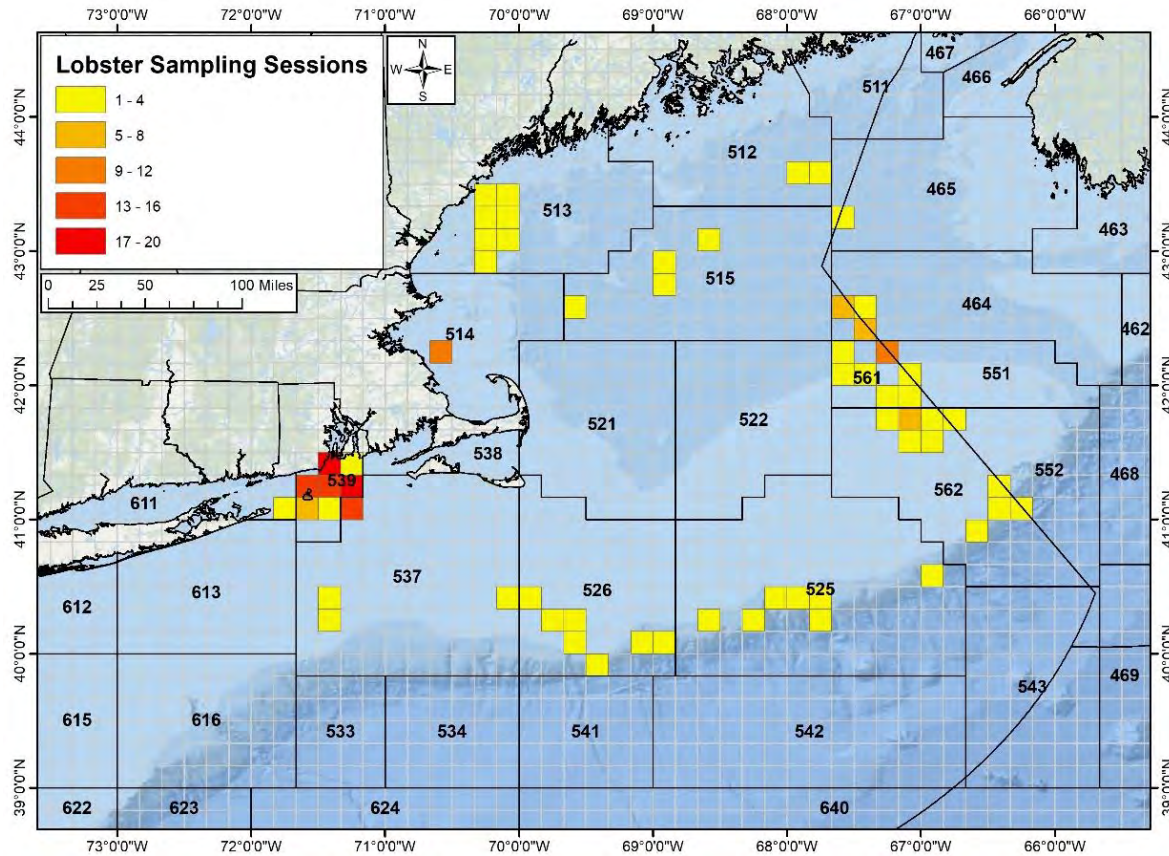
April 1, 2020
to Sept 30,
2020



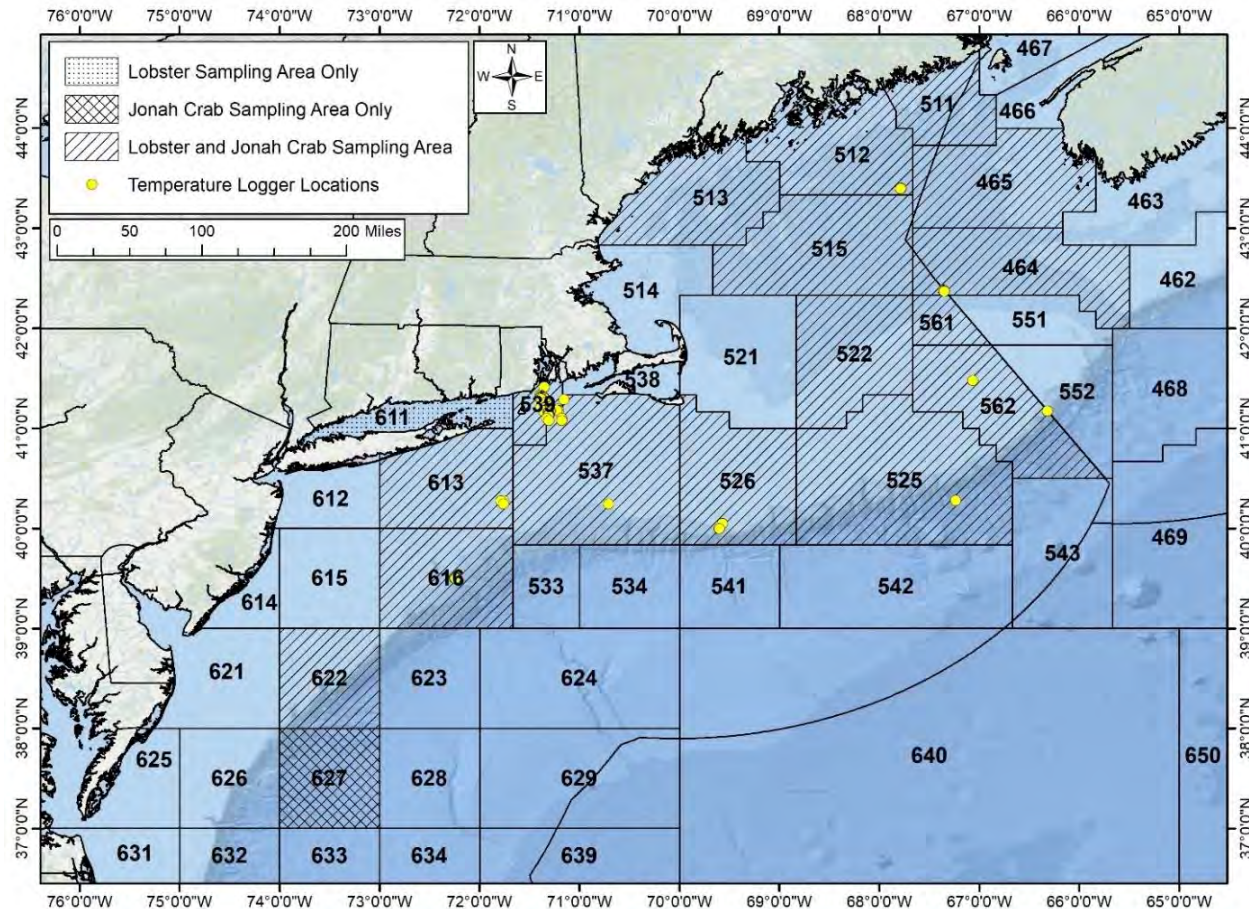
Oct 1,
2020 to
Dec 31,
2020



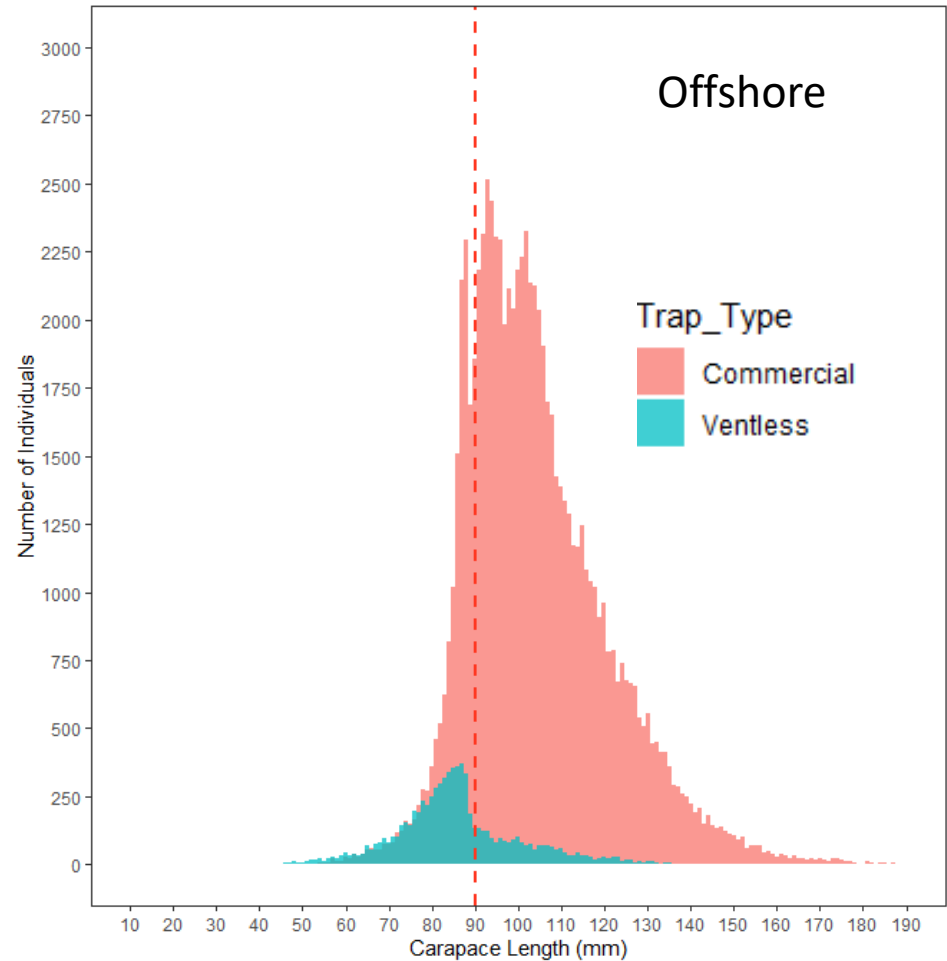
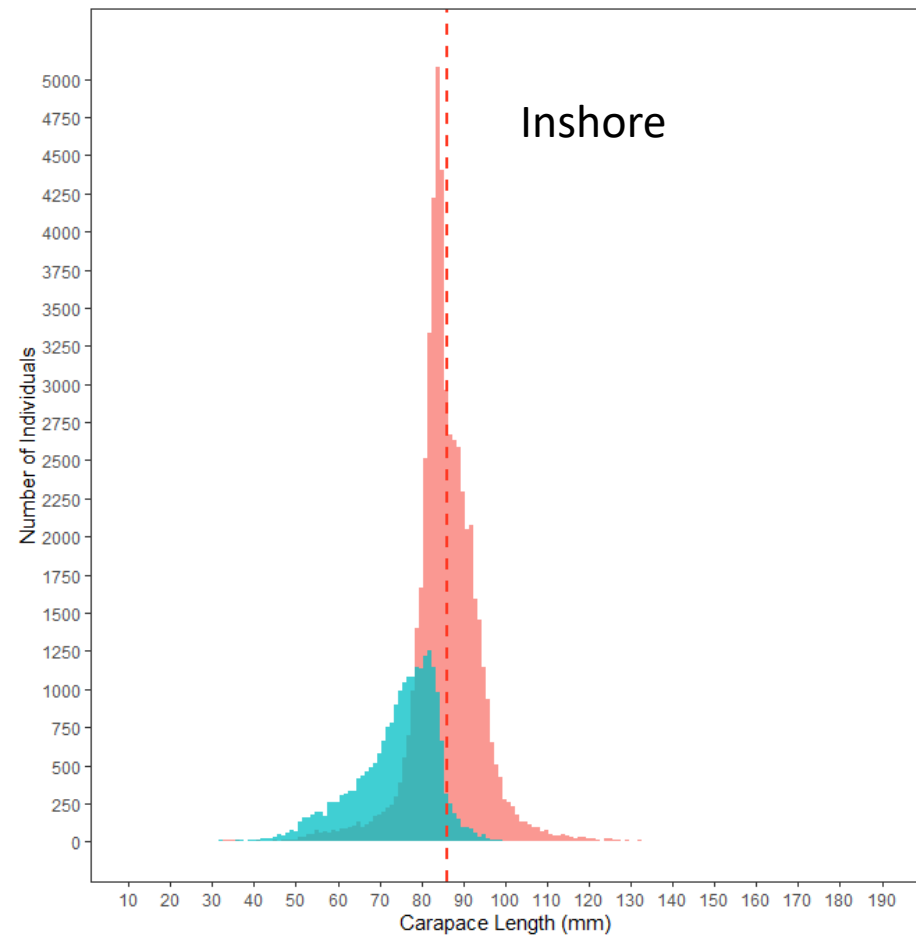
Map of areas sampled for commercial lobster sessions April 1 -Sept 30, 2021



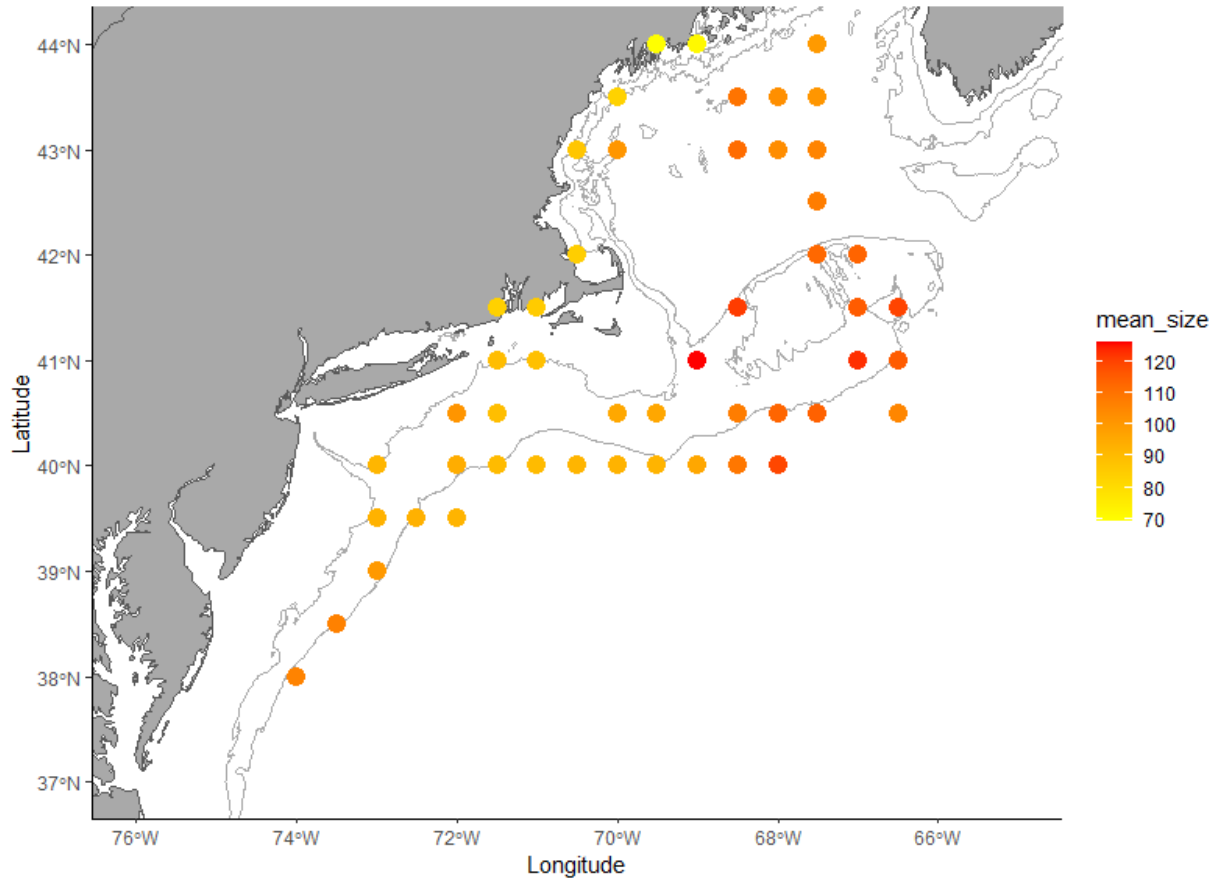
Map of areas sampled by fleet and bottom water temp monitoring locations



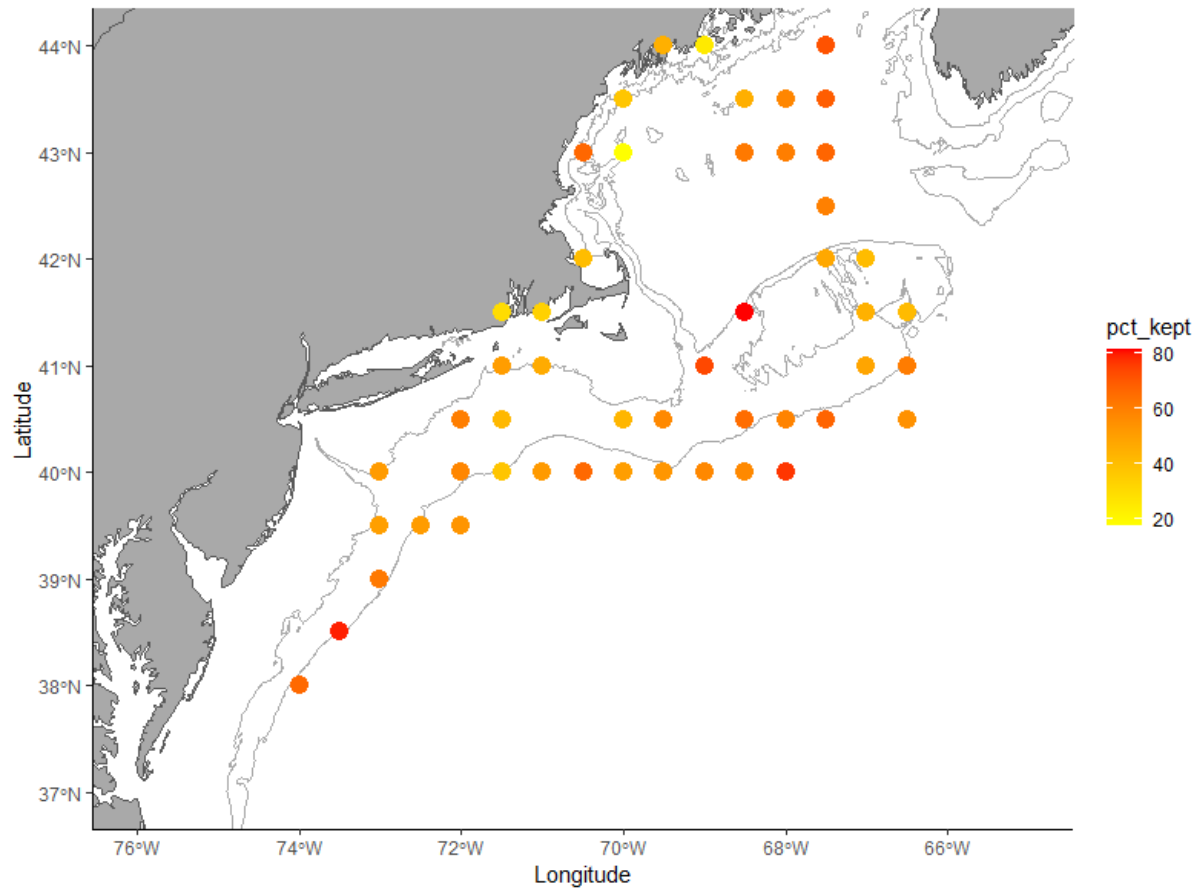
Lobster Length/Sex Distributions of Catch



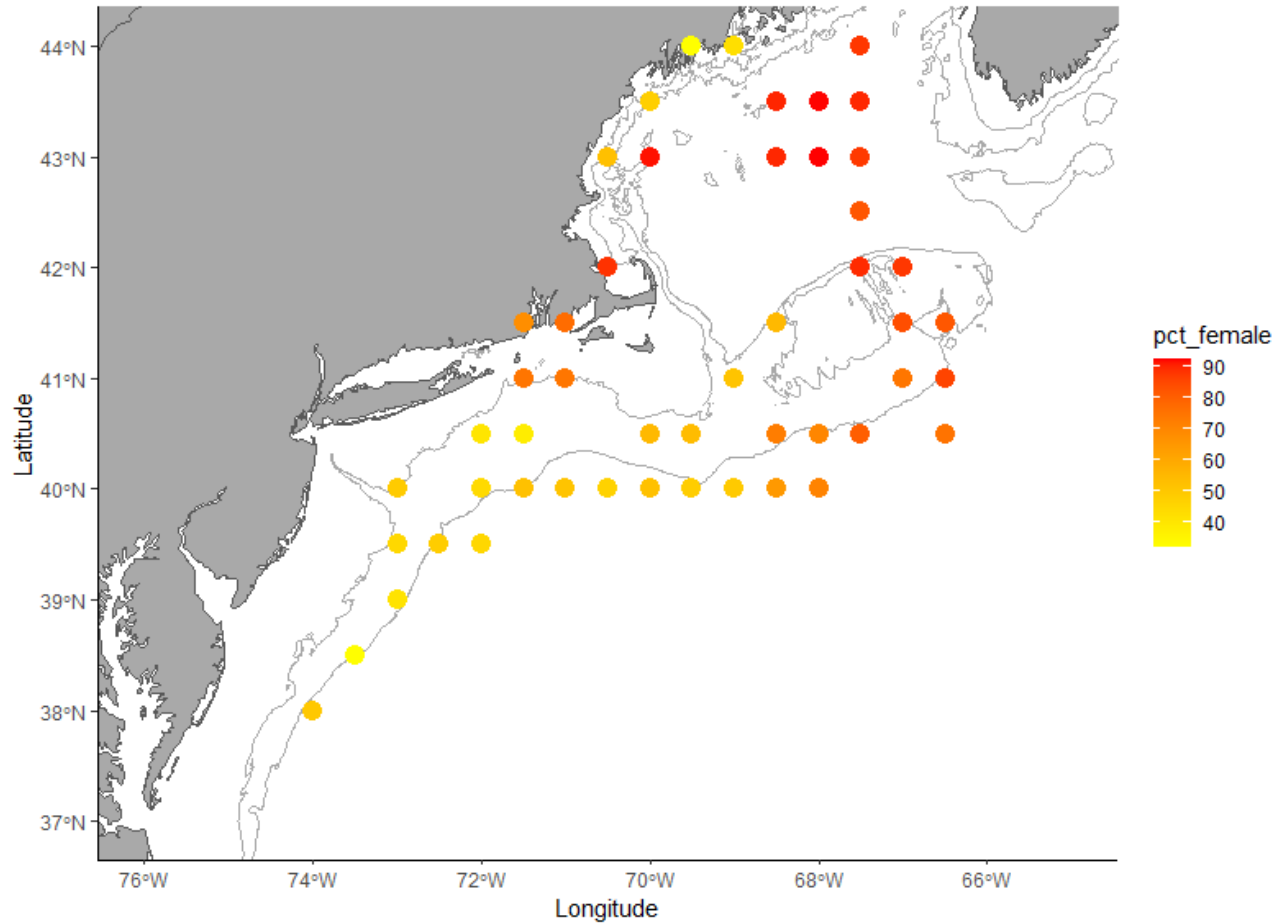
Mean carapace length (mm) of lobsters sampled by the Research Fleet



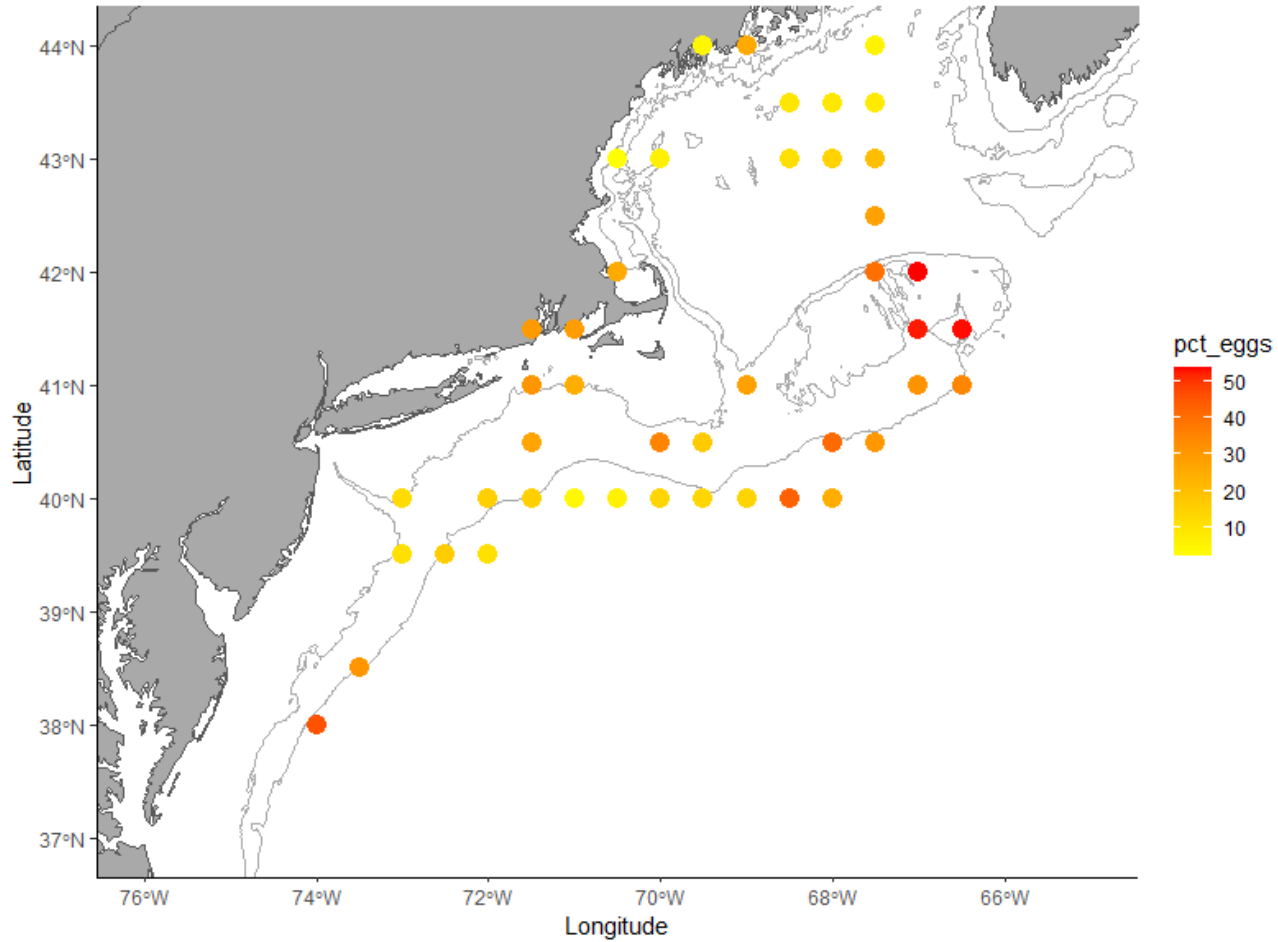
Map of lobster retention dynamics (% kept)



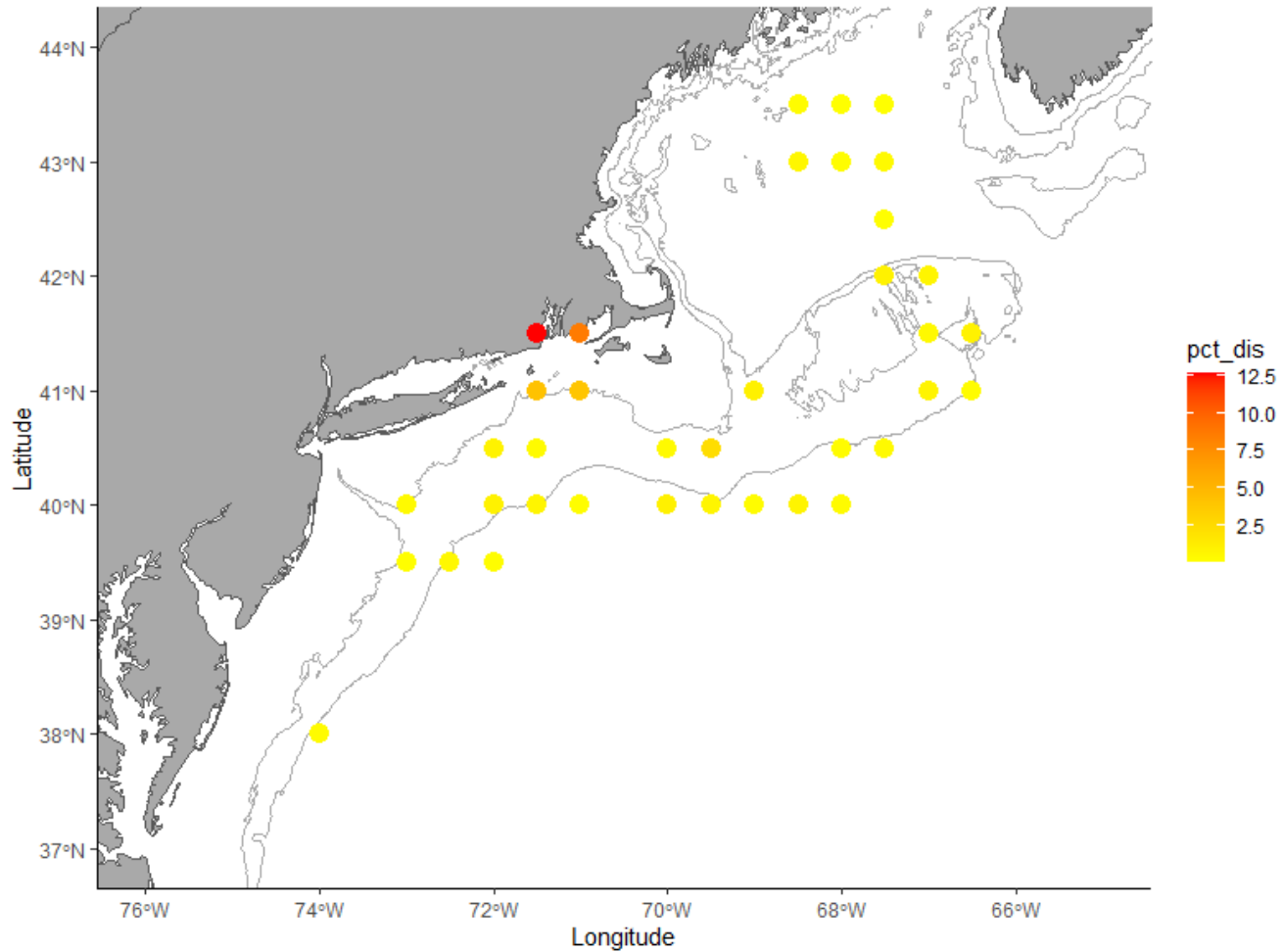
Percent of female lobsters sampled by Fleet



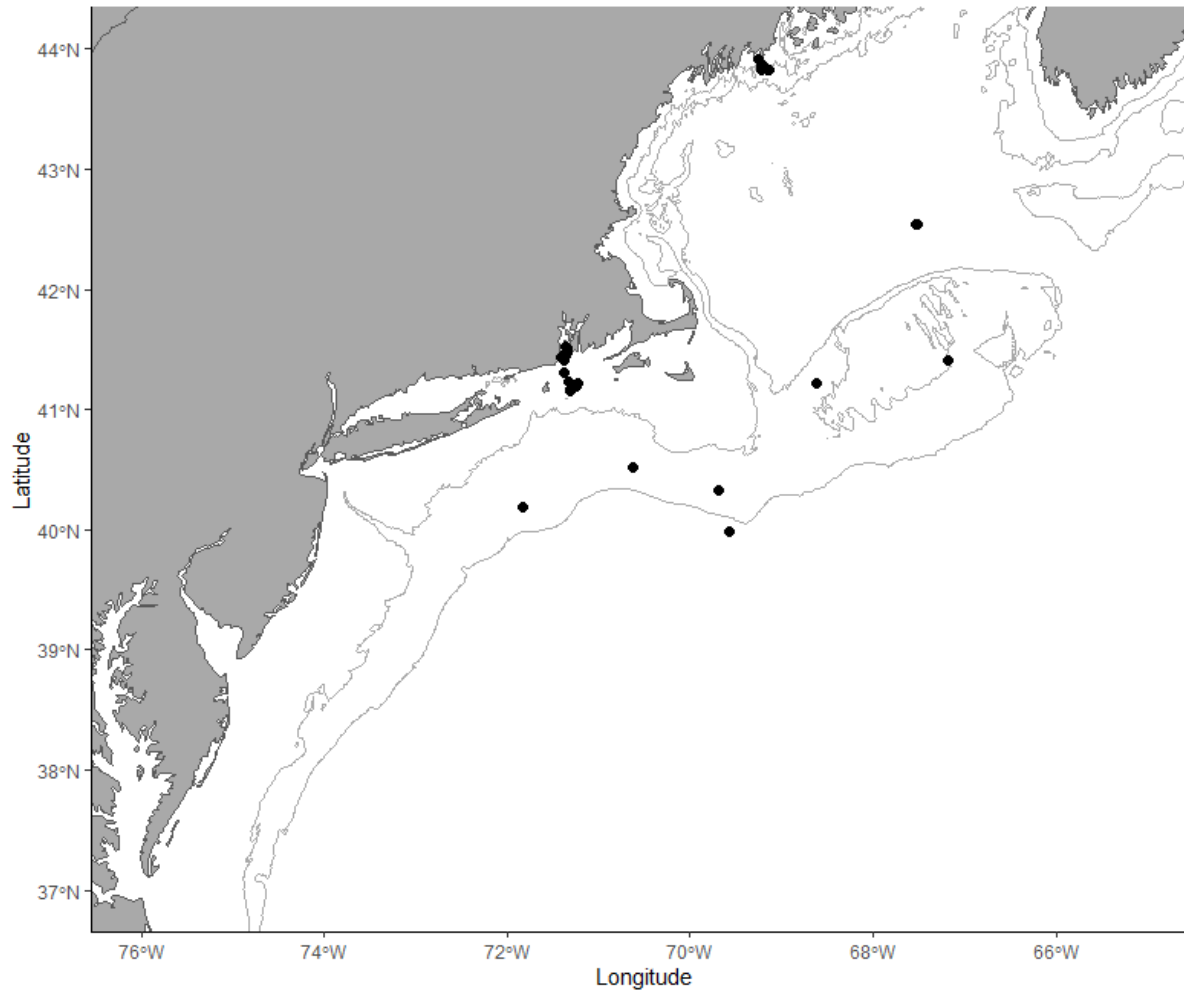
Spatial distribution of egg-bearing lobsters



Spatial distribution of shell disease

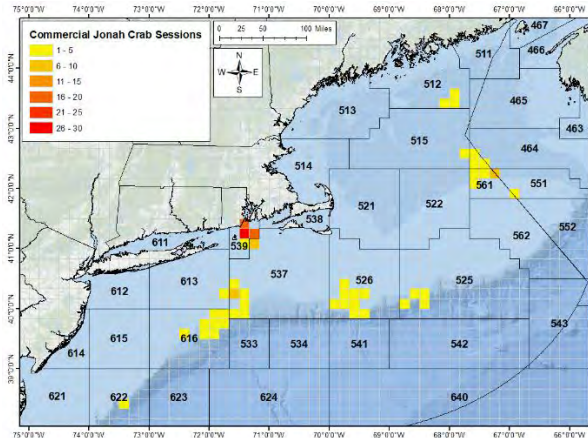


Spatial distribution of <50 mm lobsters

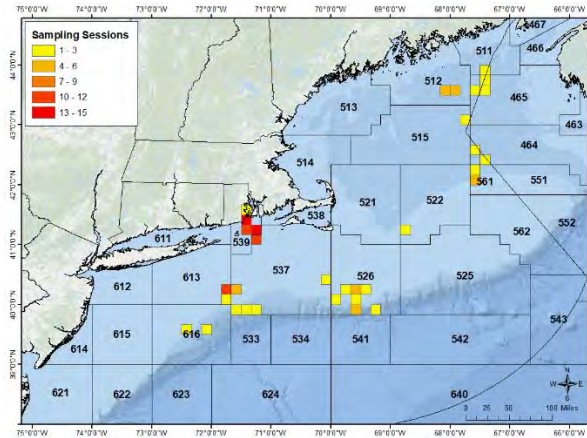


Map of the distribution and density of commercial crab sampling sessions by fleet

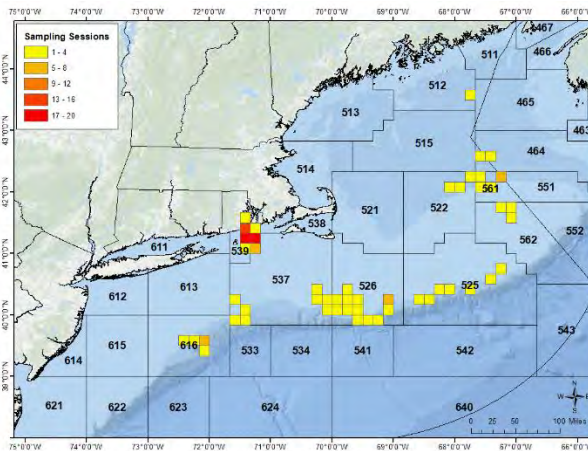
April 1, 2019
to September
30, 2019



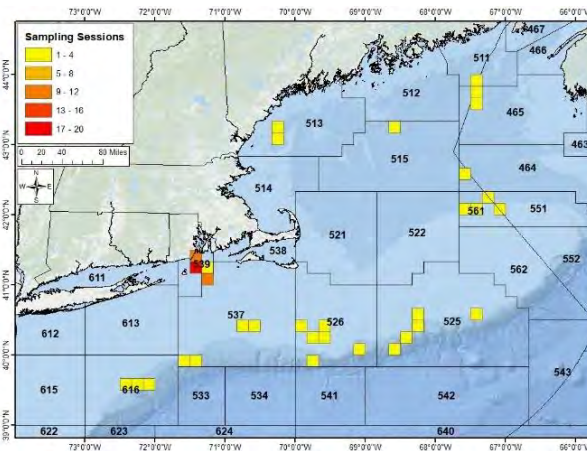
Oct 1, 2019
to March 31,
2020



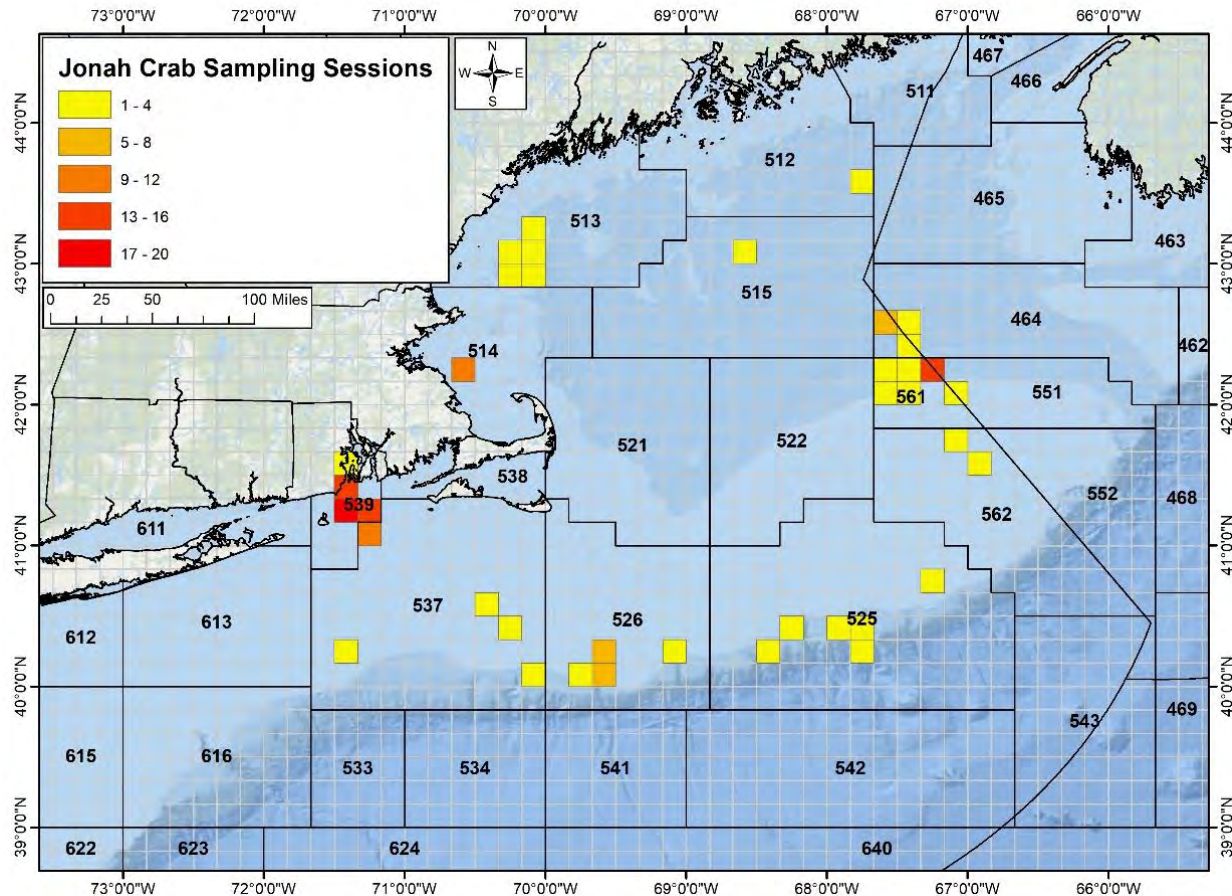
April 1, 2020
to Sept 30,
2020



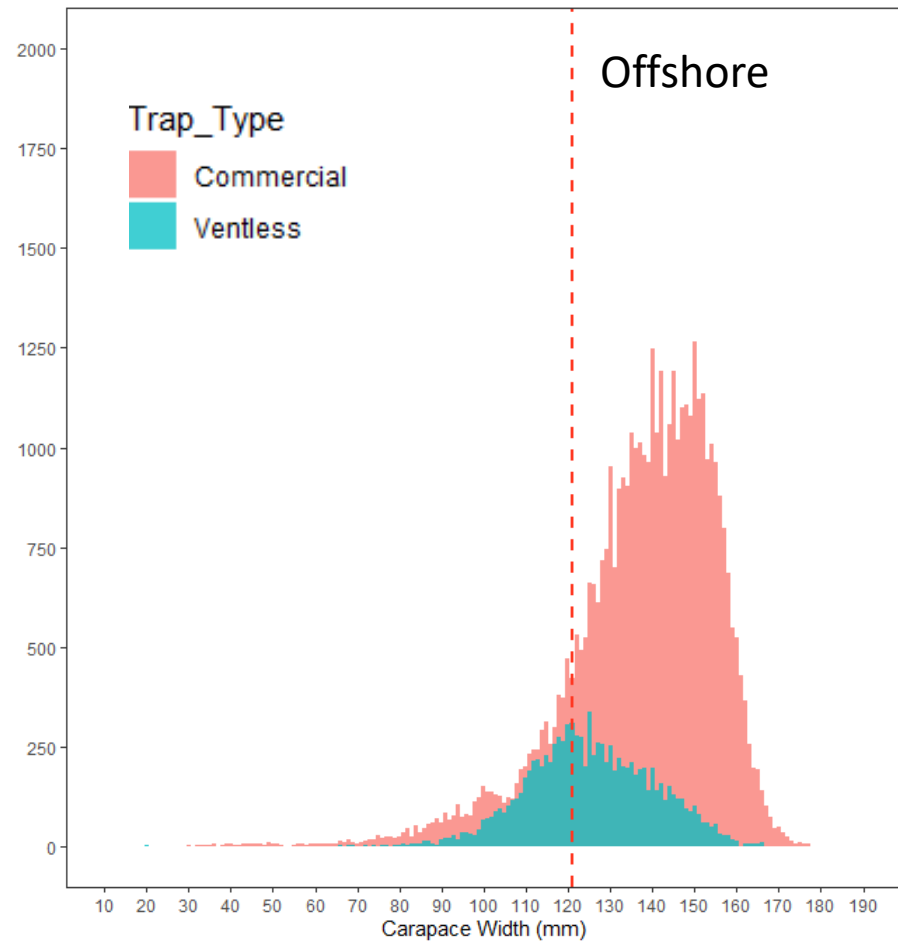
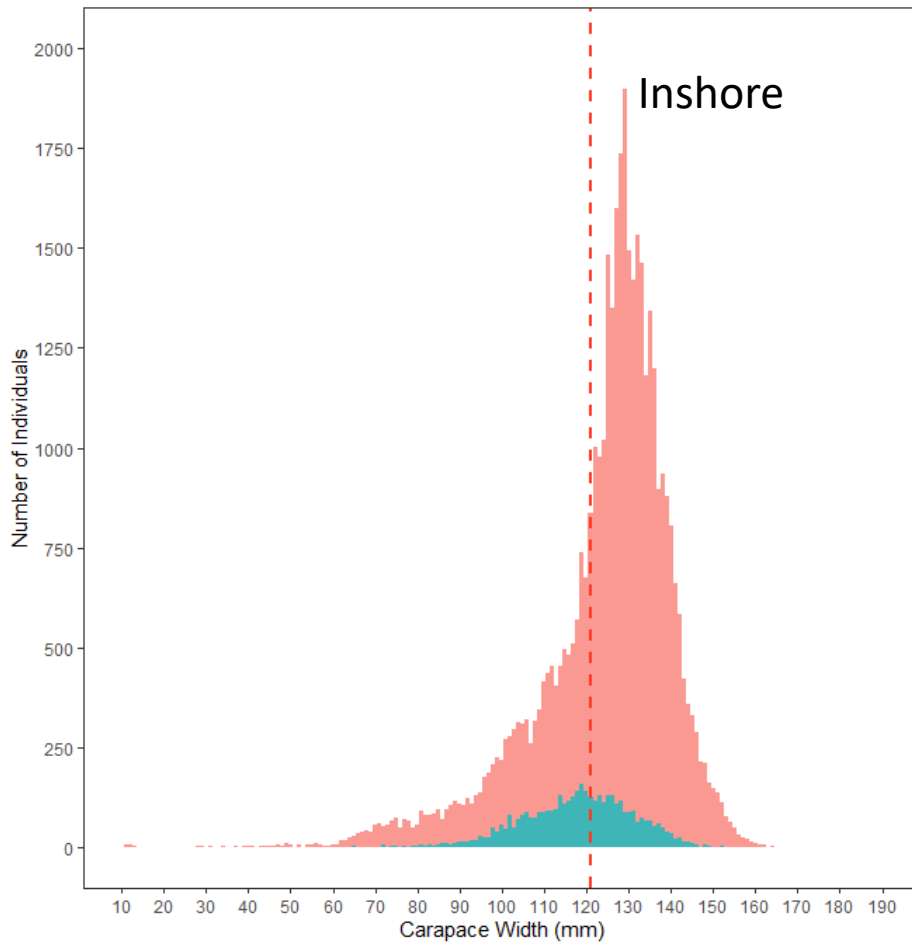
Oct 1,
2020 to
Dec 31,
2020



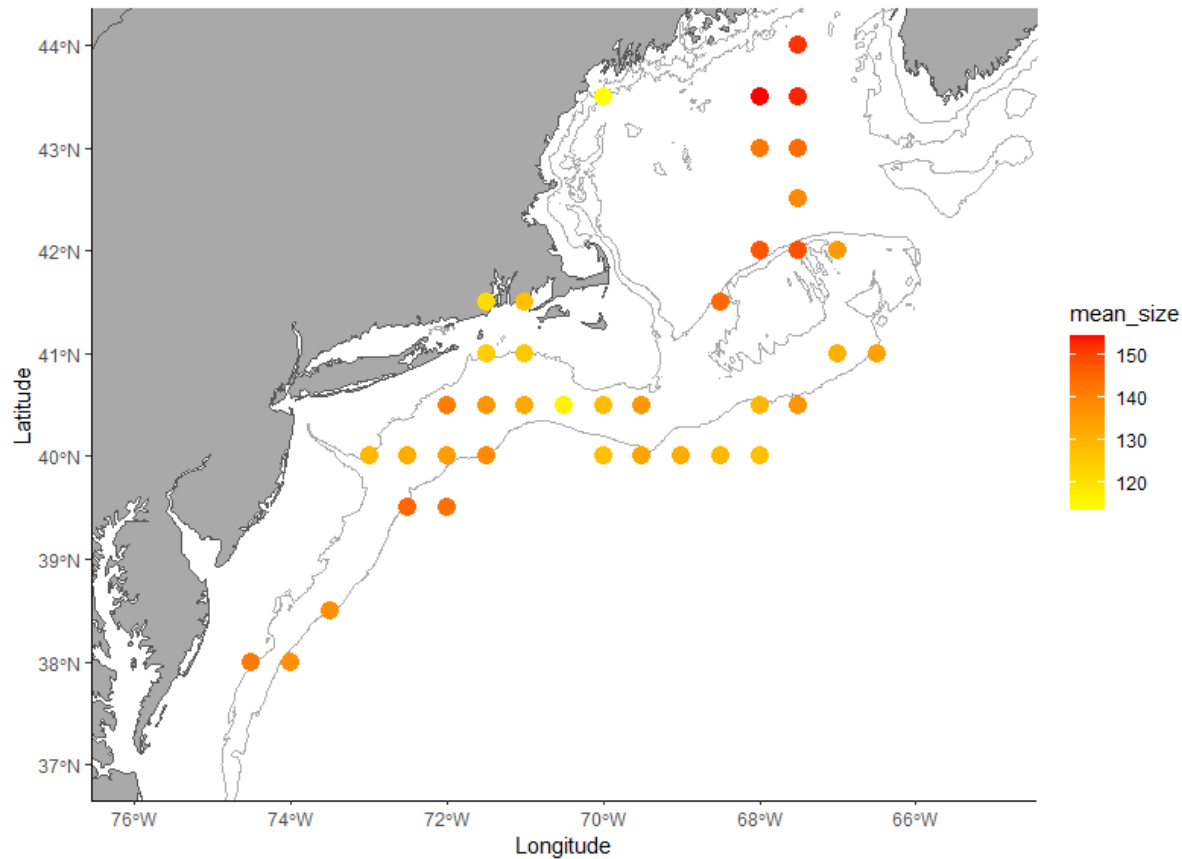
Map of areas sampled for commercial crab sessions April 1 -Sept 30, 2021



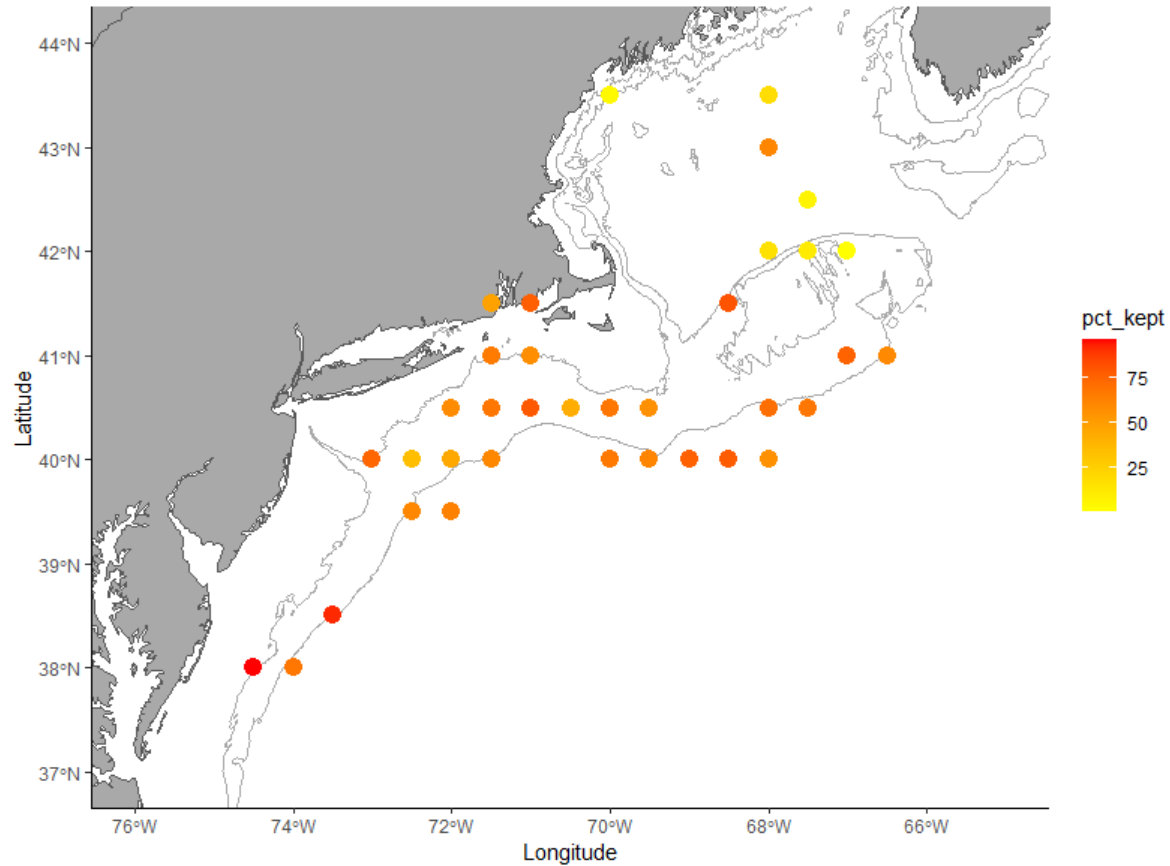
Crab Length/Sex Distributions of Catch



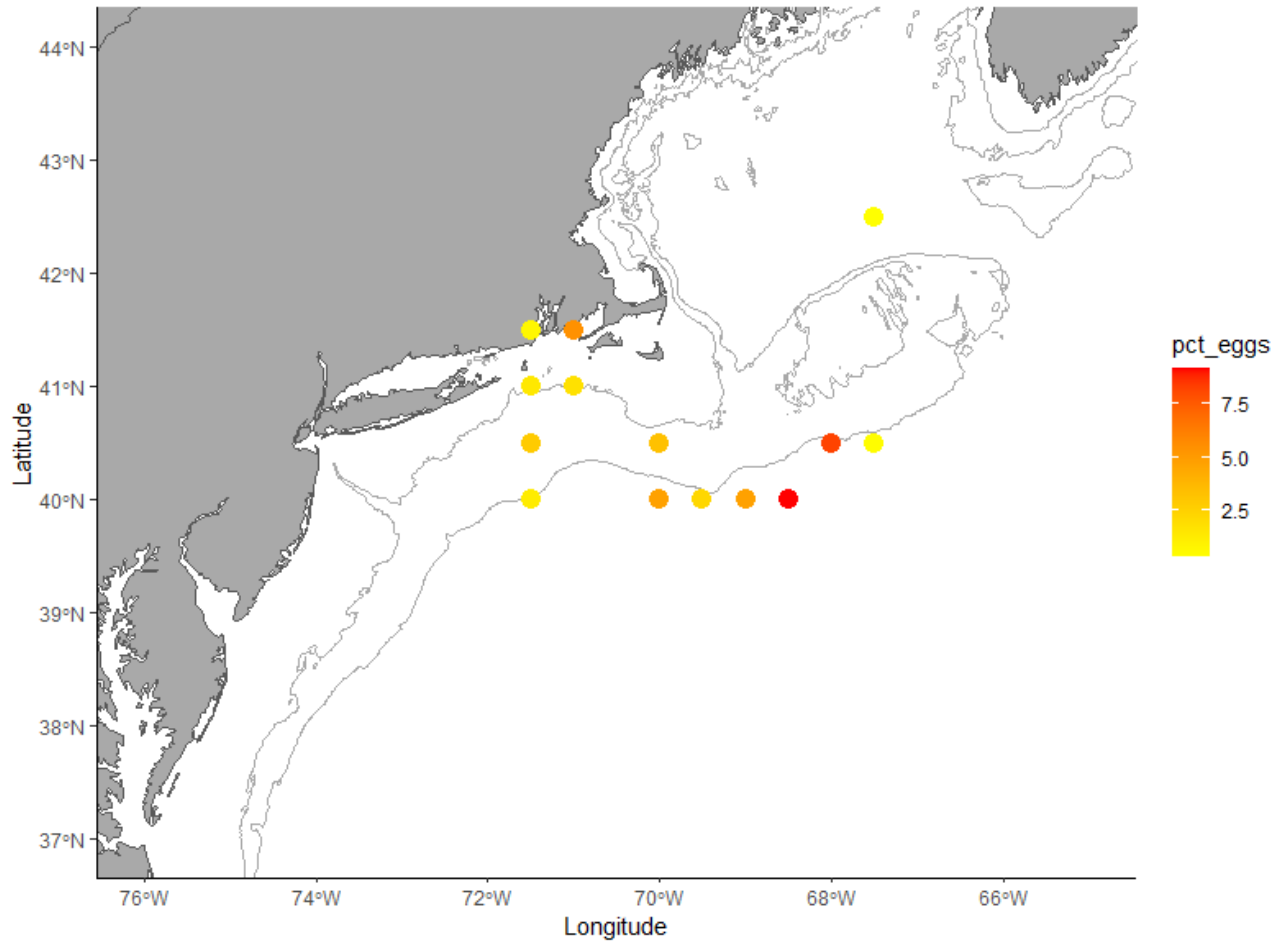
Mean carapace width (mm) of crabs sampled by the Research Fleet



Map of crab retention dynamics (% kept)

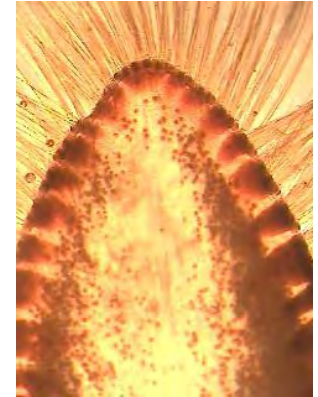
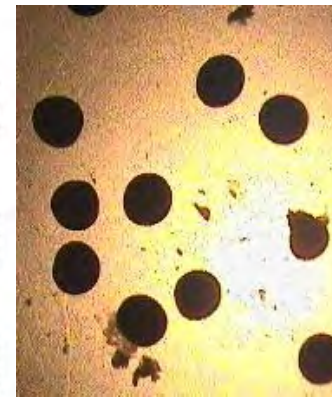
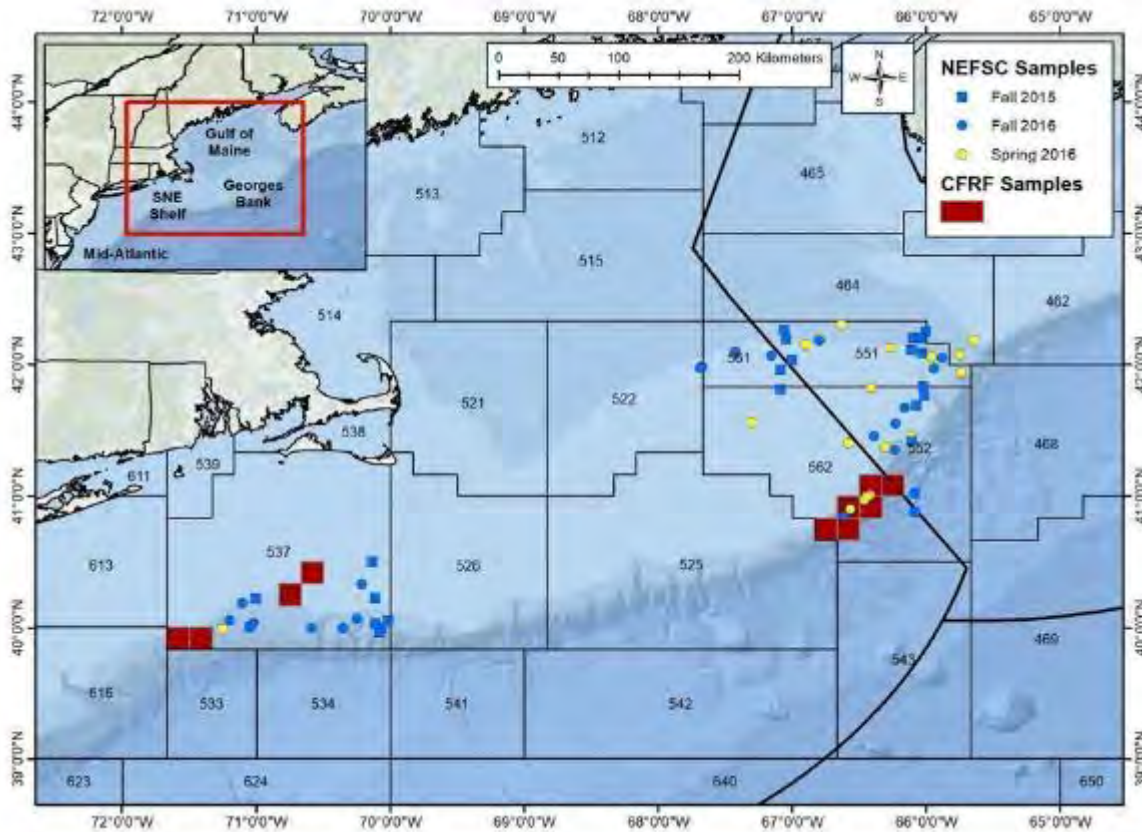


Spatial distribution of egg-bearing crabs



DINNER BREAK

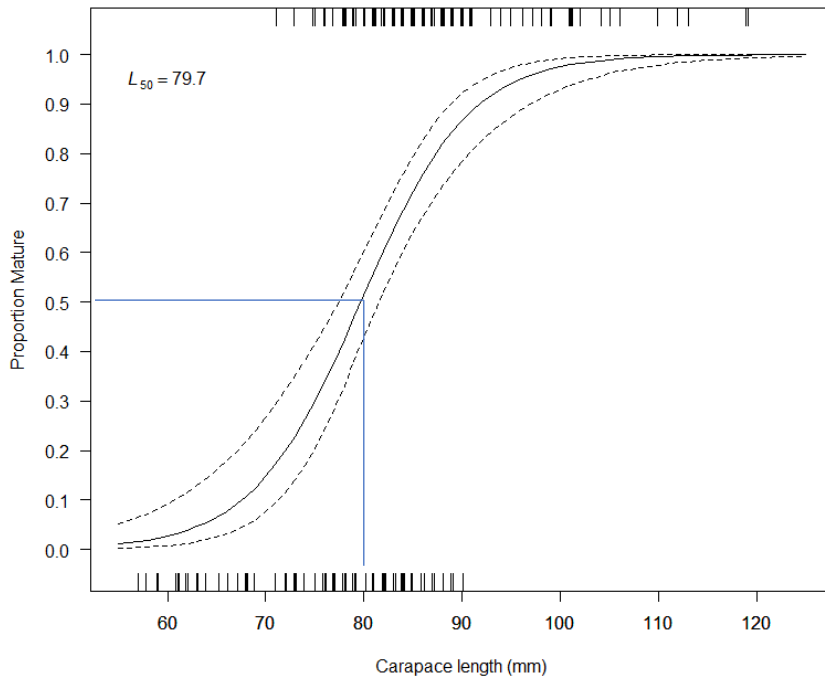
Extension Work: Lobster Maturity



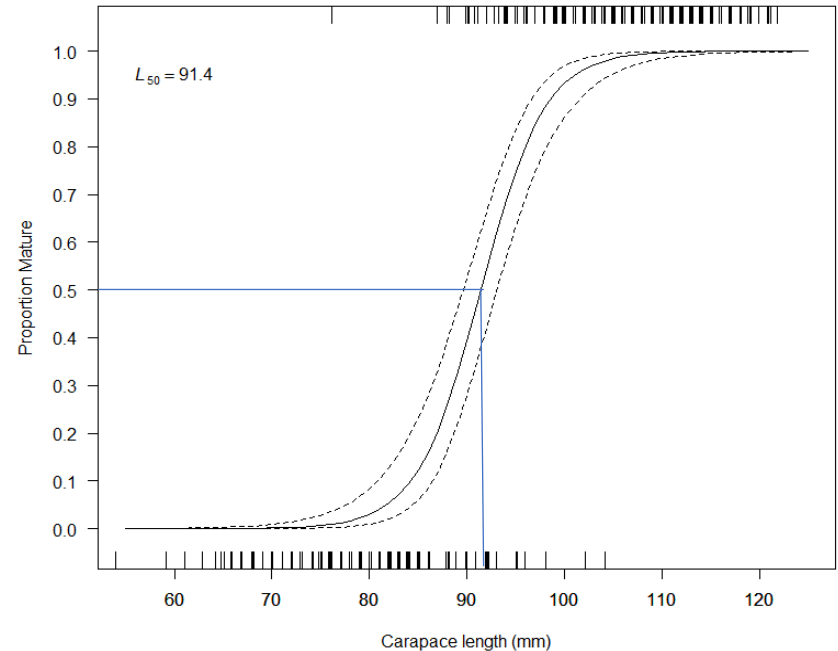
Huge thank you to
F/V Direction, F/V
Excalibur, F/V Lady
Clare

Extension Work: Lobster Maturity

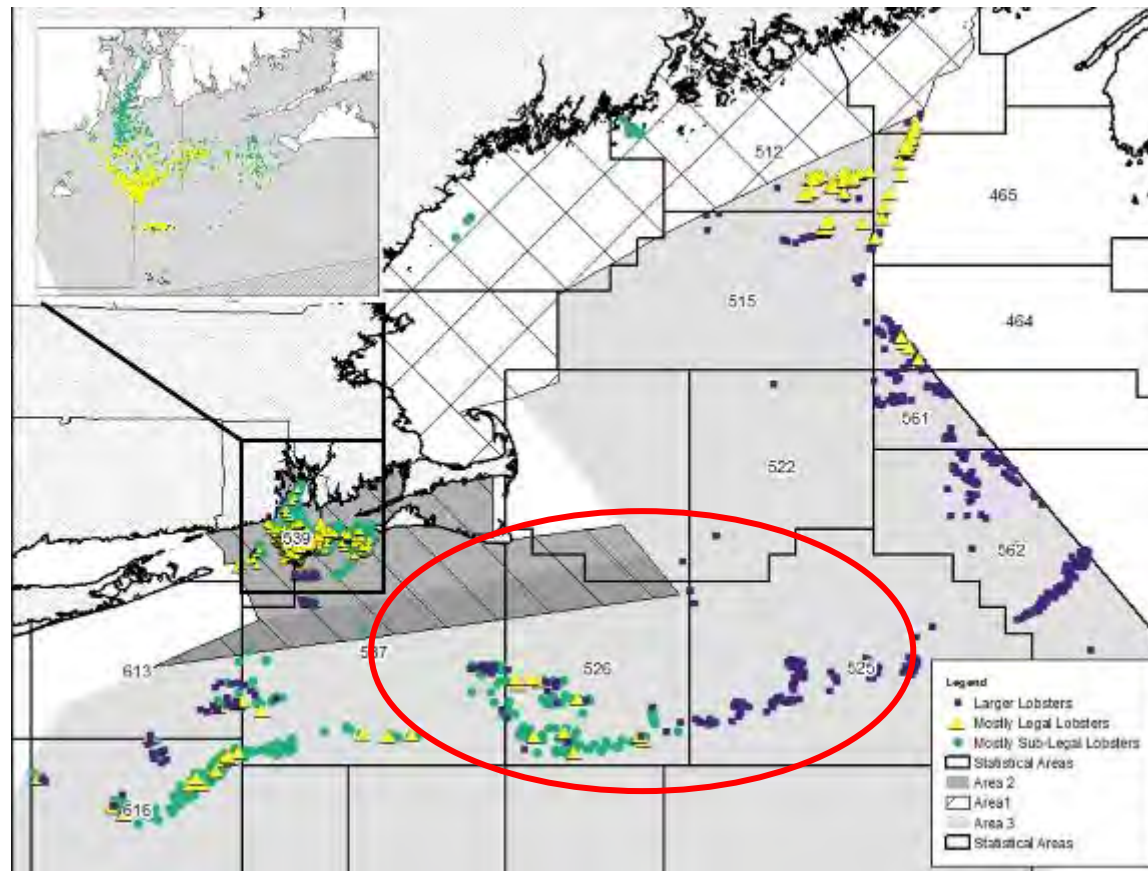
Offshore SNE (Stat area 537)



Eastern Georges Bank (Stat Area 562)



Extension Work: Spatial Patterns



Extension Work: Shell Disease

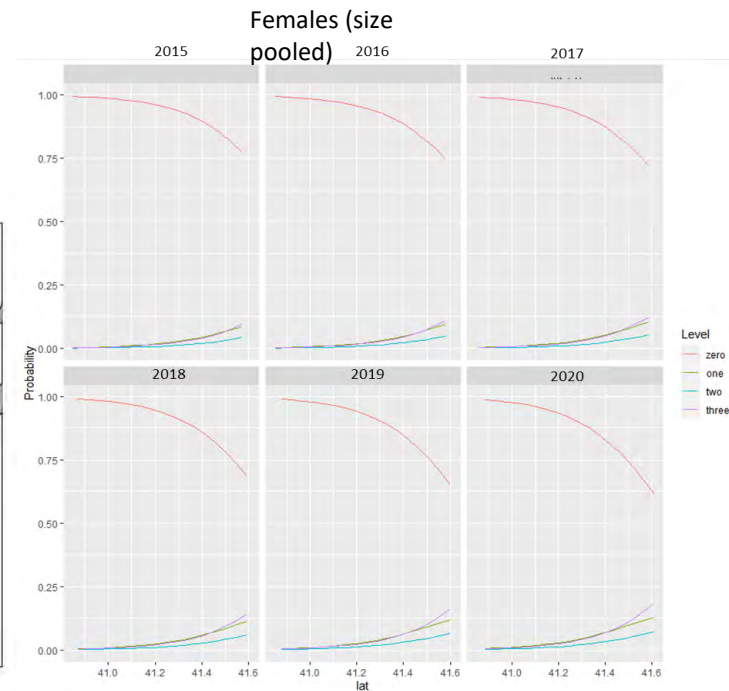
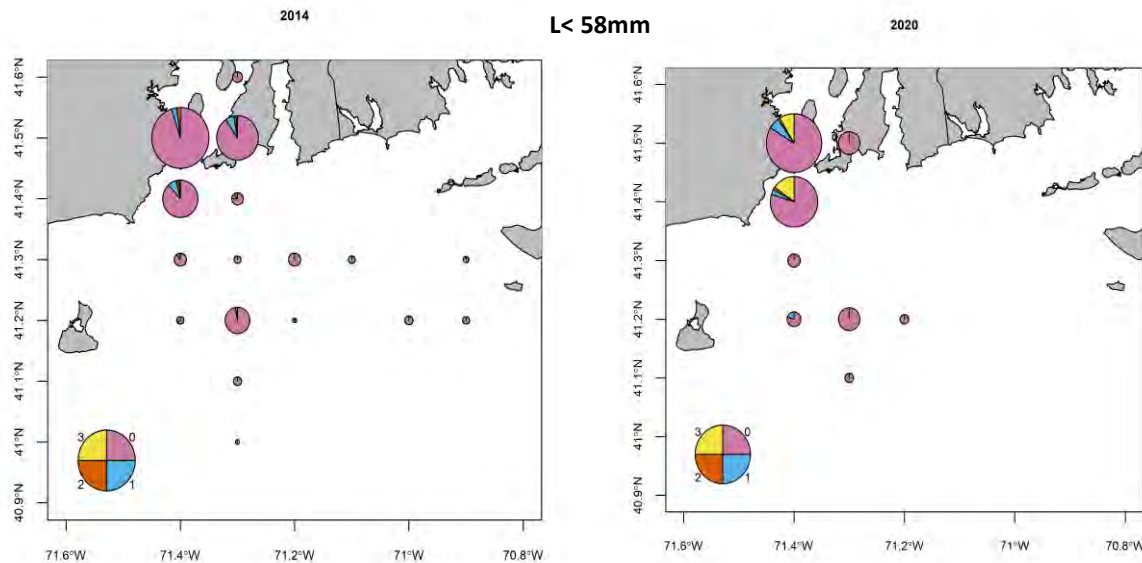


Are more small lobsters (sublegal) exhibiting shell disease? Is it more severe?

If so, what variables are contributing to the result: e.g. size, location, sex, presence of eggs, month, year



The probability of females having more severe shell disease within Narragansett Bay has increased over time.



Extension Work: Jonah Crab Growth

Fisheries Research 211 (2019) 13–20



ELSEVIER

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres



Growth and molting characteristics of Jonah crab (*Cancer borealis*) in Rhode Island Sound



Corinne L. Truesdale^{a,*}, M. Conor McManus^b, Jeremy S. Collie^a

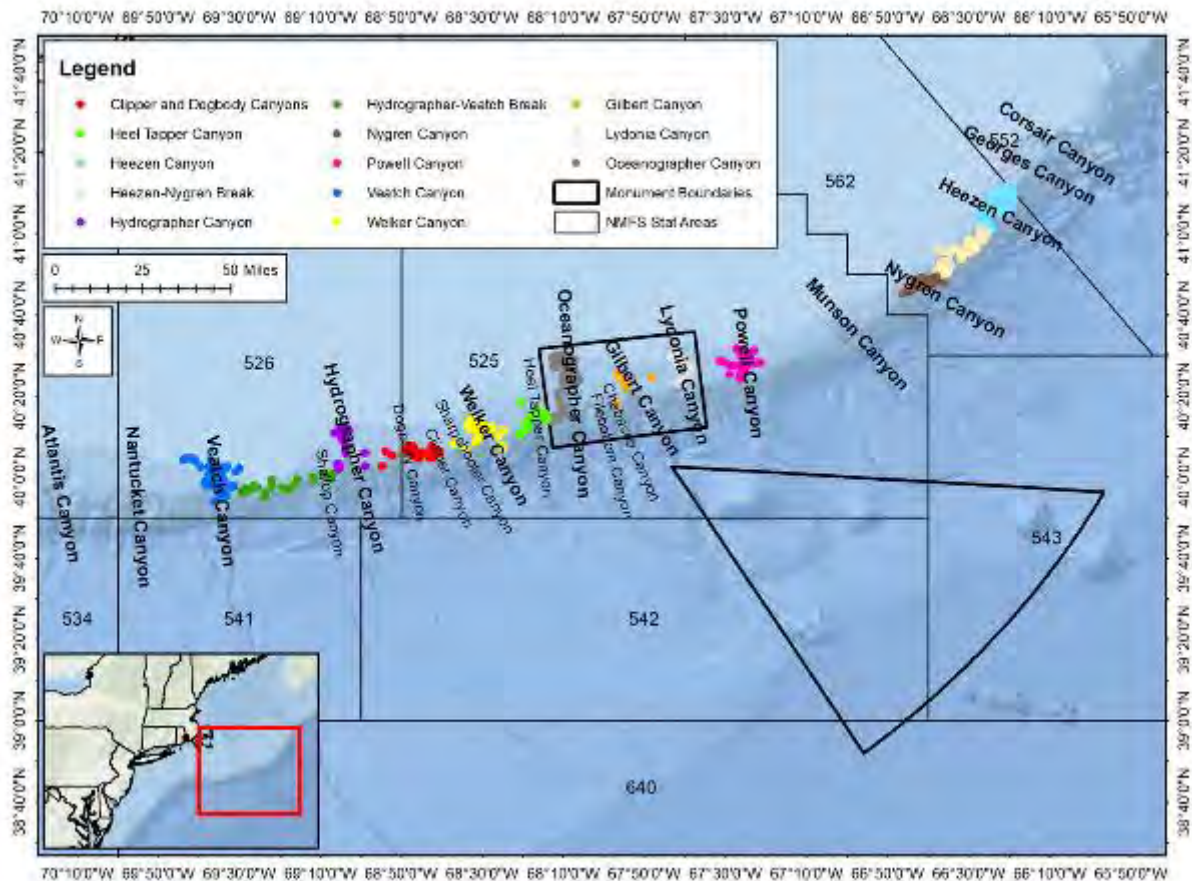
^a Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, 02882, United States

^b Rhode Island Department of Environmental Management, Division of Marine Fisheries, Jamestown, RI, 02835, United States

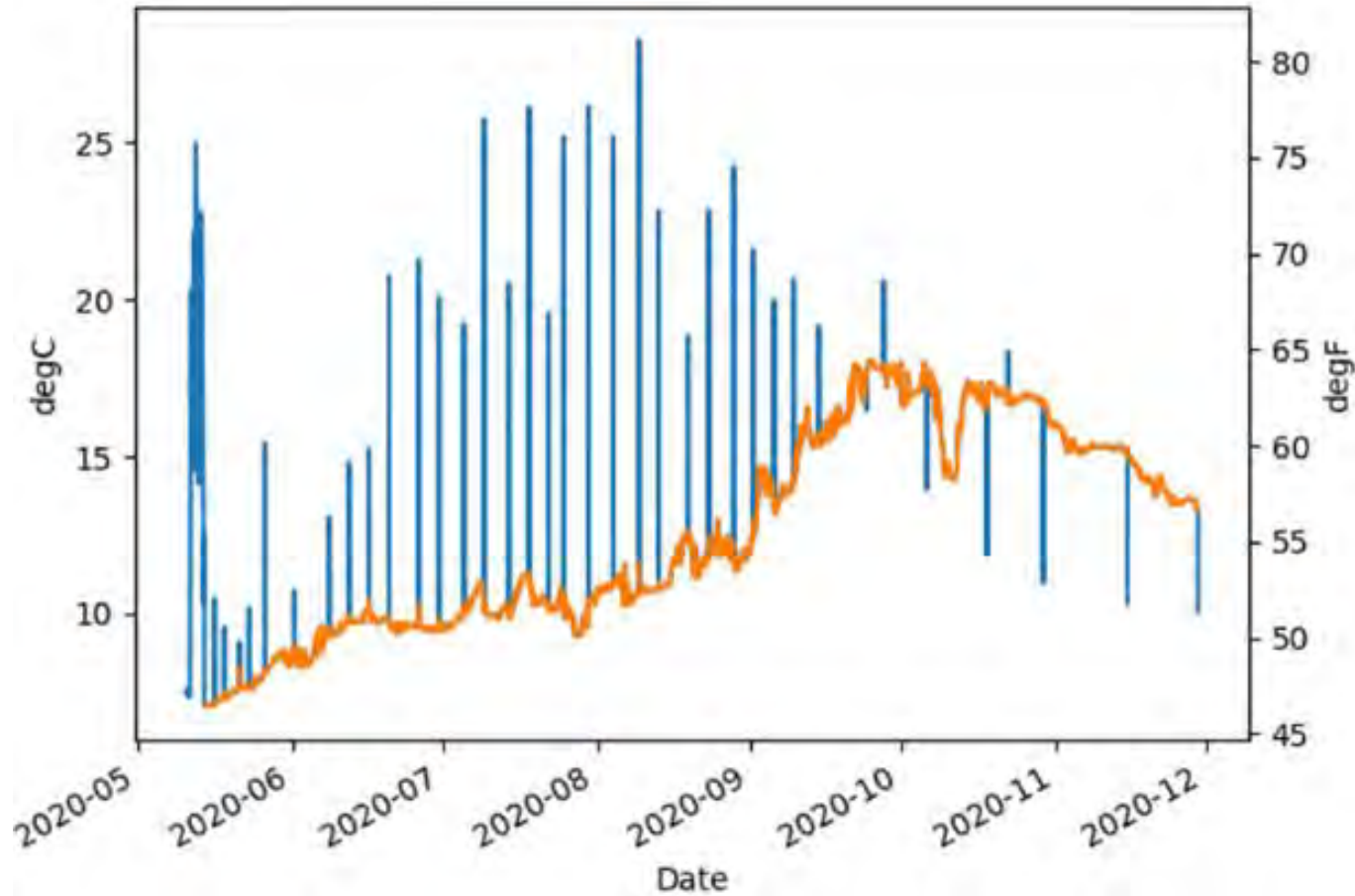


Extension Work: Marine Monument

CFRF Lobster and Jonah Crab Research Fleet - Monument Analysis Sampling Coverage



Extension Work: Using Temp Data



Lobster and Jonah Crab Data Parameters:

Lobster Biological Data:

- Carapace Length (mm)
- Sex (M/F/U)
- Shell Disease Severity
- Shell Hardness
- Eggs (Y/N)
- V-notch (Y/N)
- Disposition
(Kept/Discarded)

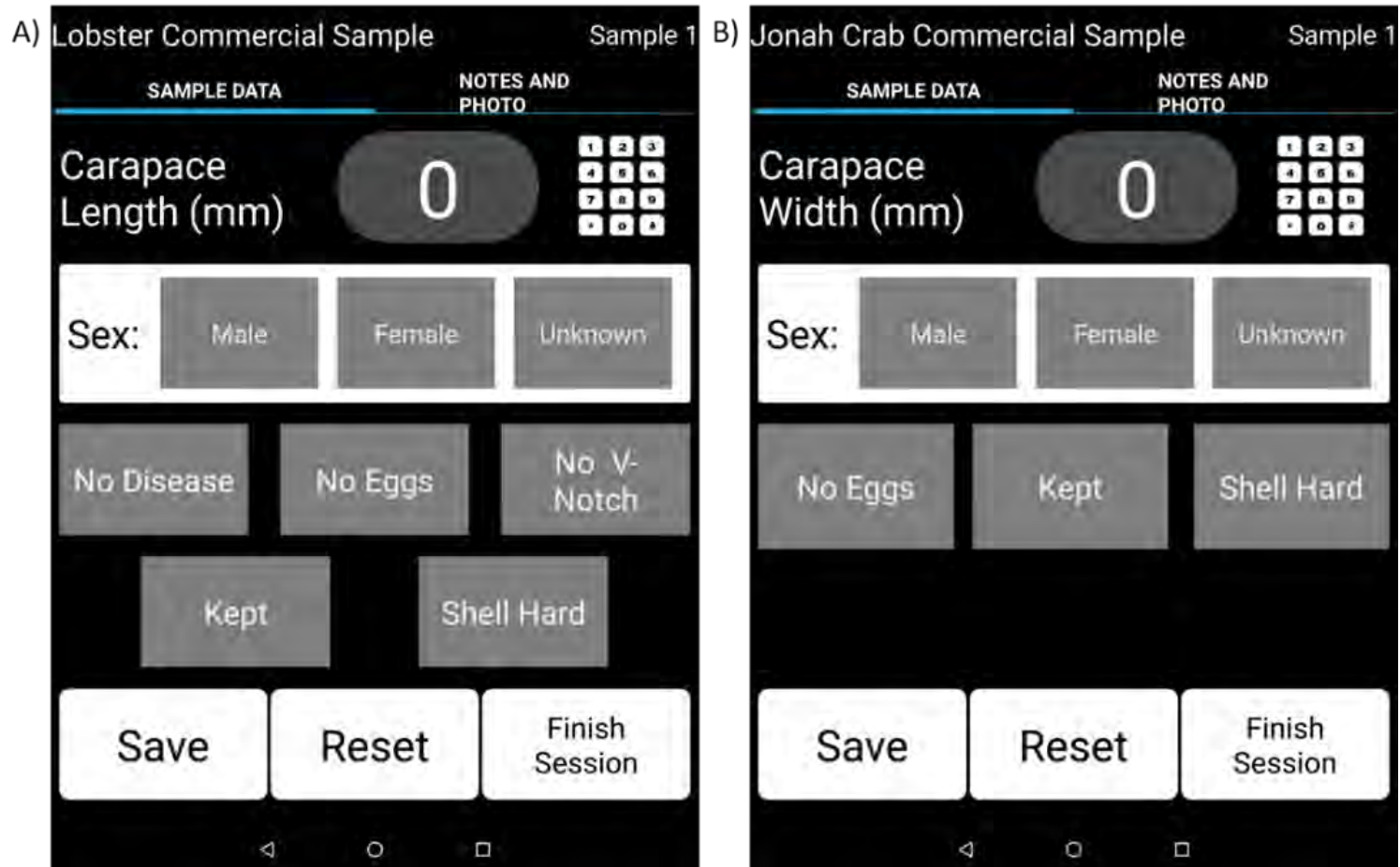


Jonah Crab Biological Data:

- Carapace Width (mm)
- Sex (M/F/U)
- Shell Hardness
- Eggs (Y/N)
- Disposition
(Kept/Discarded)



Research Fleets: On Deck Data Application



New changes to On Deck Data: Crab Shell Condition

0 = No Disease



1 = Mild
($< 10\%$ of shell)



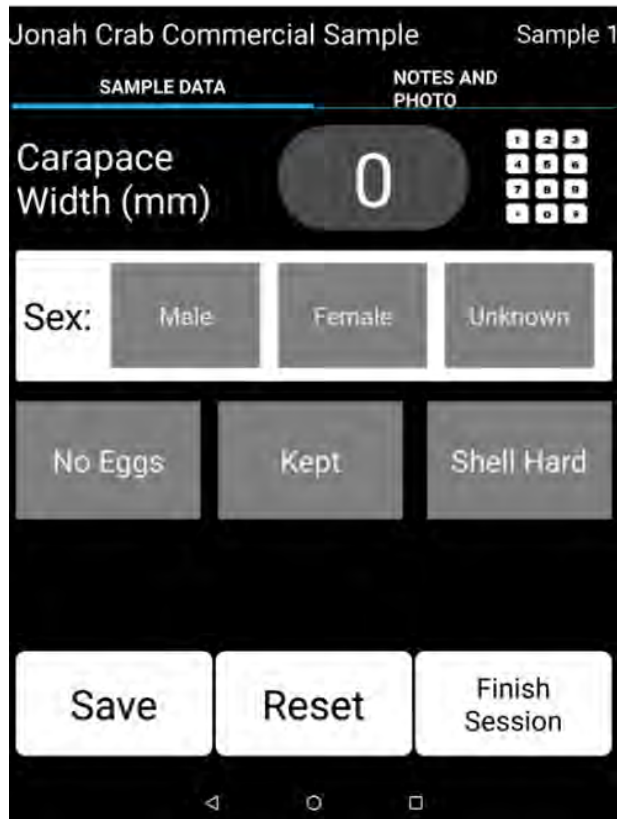
2 = Moderate
($10-50\%$ of shell)



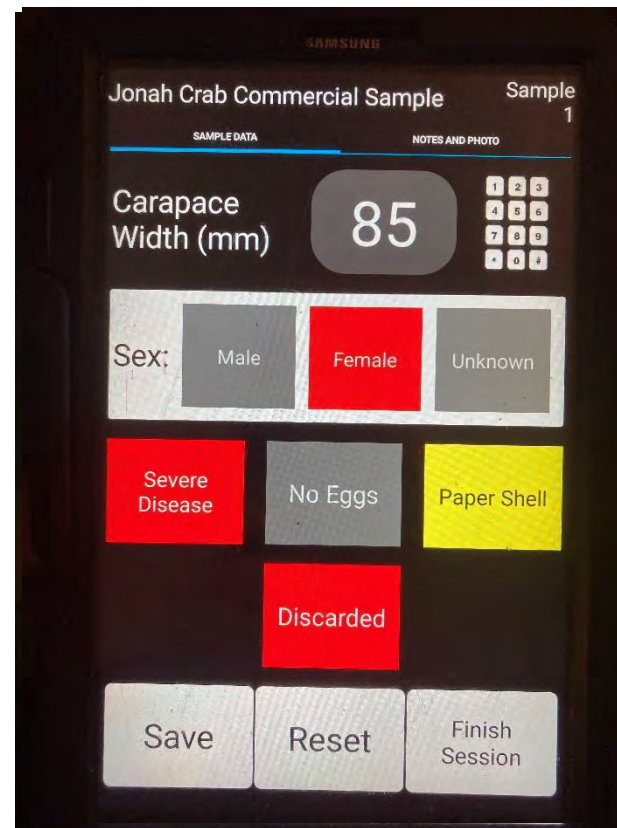
3 = Severe
($>50\%$ of shell)



How the app will look now:



Old screen



New screen

New changes to On Deck Data: Molt Condition Codes

Jelly: just molted, shell is soft and squishy

Paper shell: recently molted, shell is brittle, pale underside

Hard: no evidence of a recent molt

Jonah Crab Commercial Sample Sample 1

SAMPLE DATA NOTES AND PHOTO

Carapace Width (mm) 85

Sex: Male Female Unknown

Severe Disease No Eggs Paper Shell

Discarded

Save Reset Finish Session

Jonah Crab Commercial Sample Sample 2

SAMPLE DATA NOTES AND PHOTO

Carapace Width (mm) 125

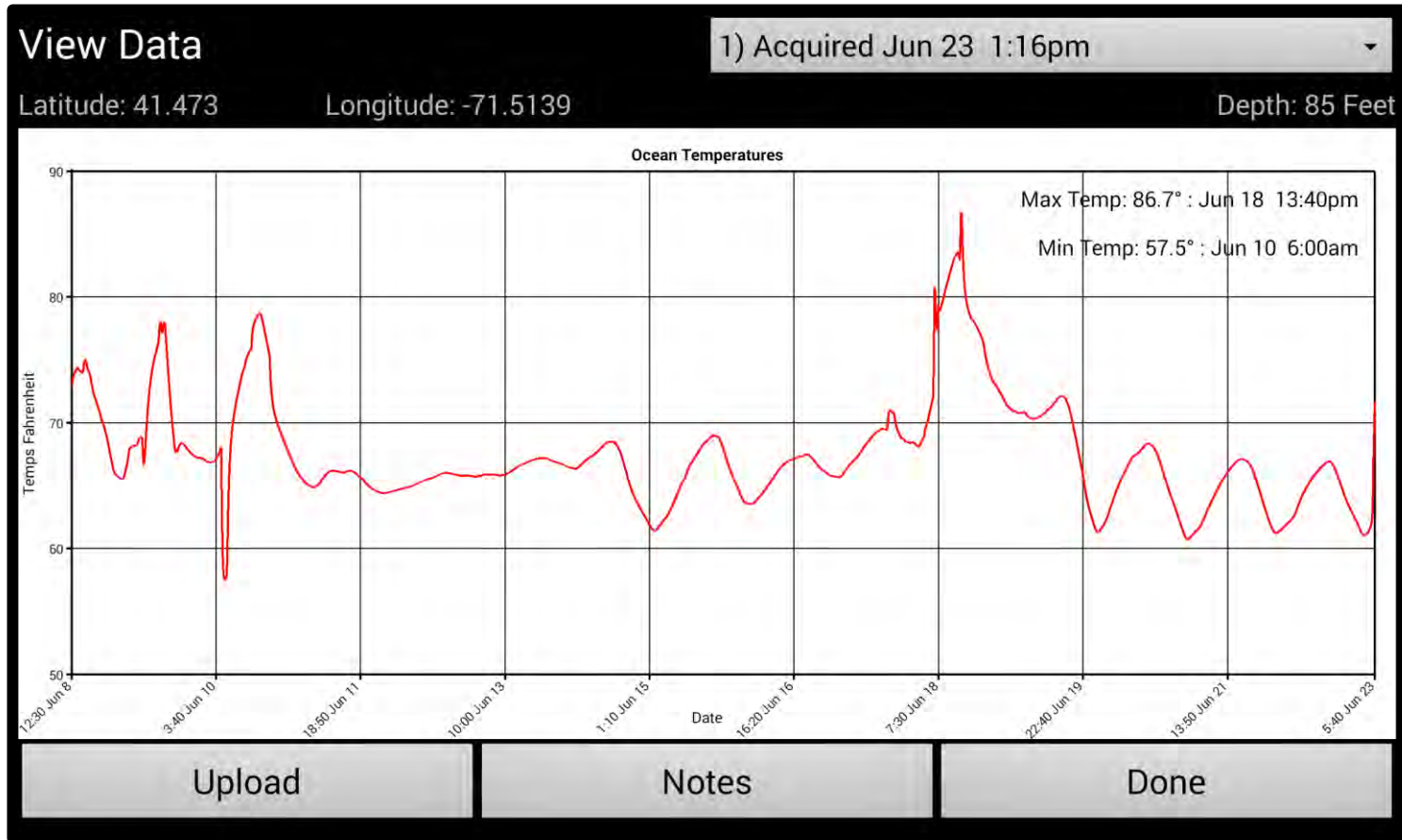
Sex: Male Female Unknown

No Disease No Eggs Jelly Shell

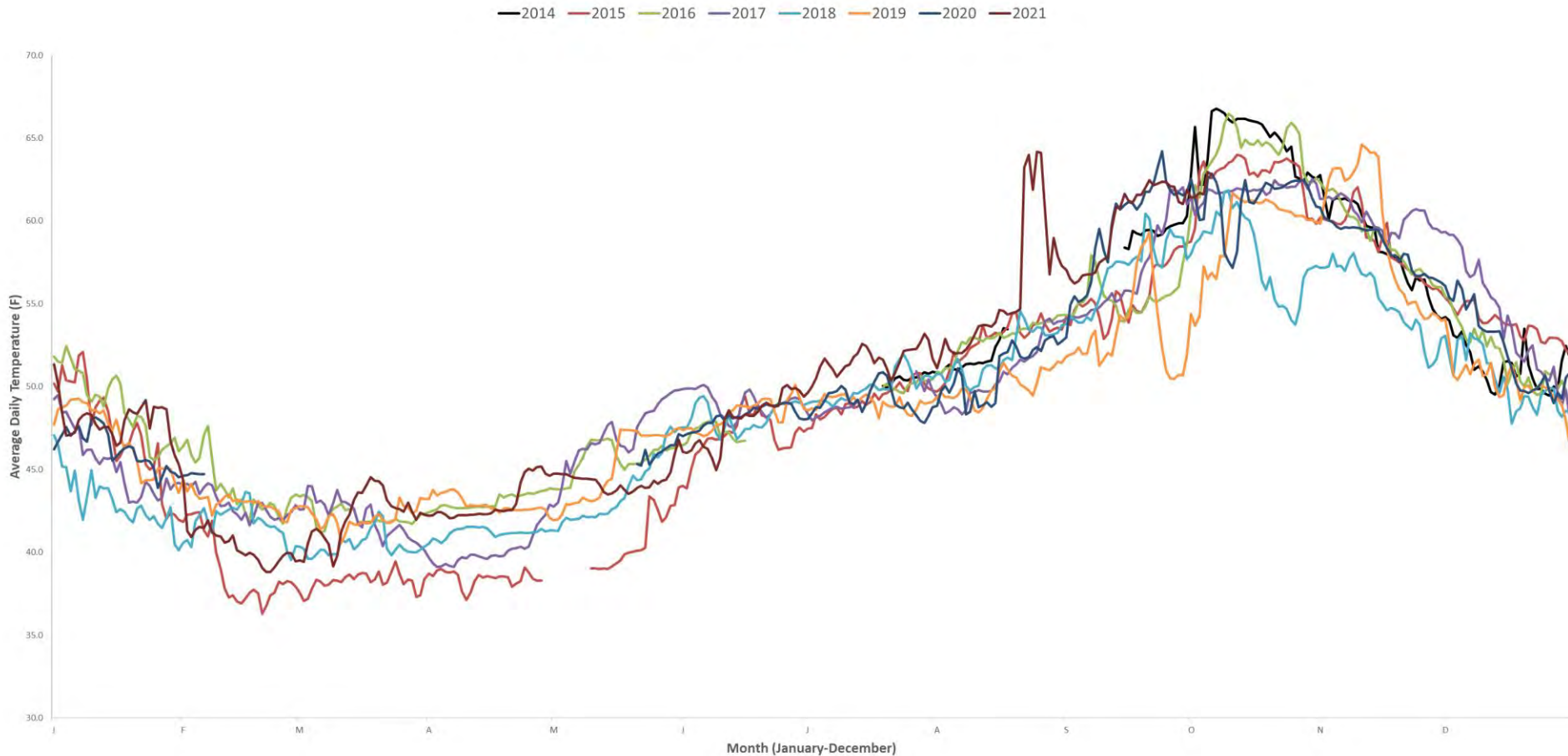
Discarded

Save Reset Finish Session

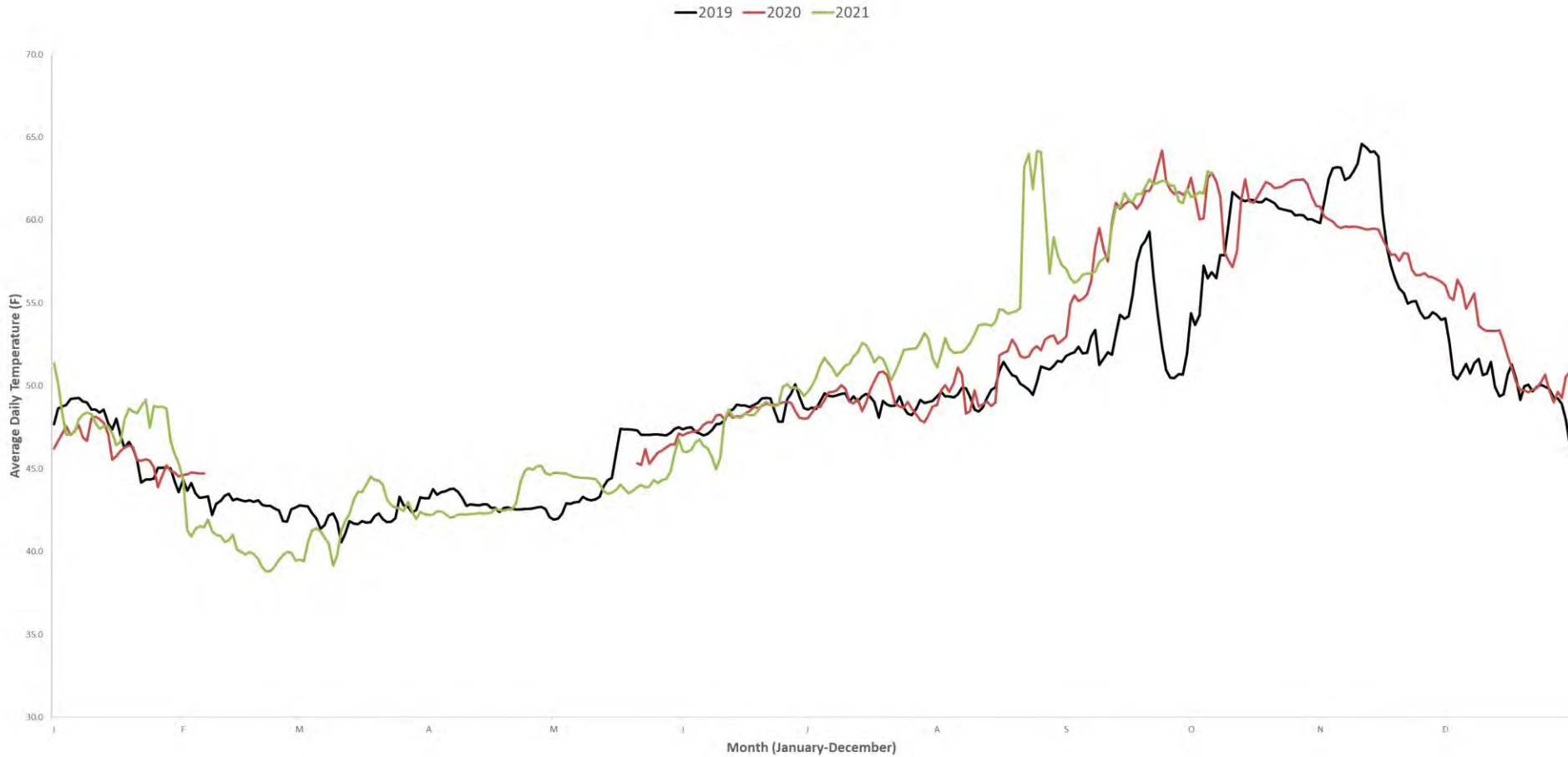
Research Fleets: Ocean Temps



Example of bottom water temp time series



Example of bottom water temp time series



Thank you!

CURRENT VESSELS:

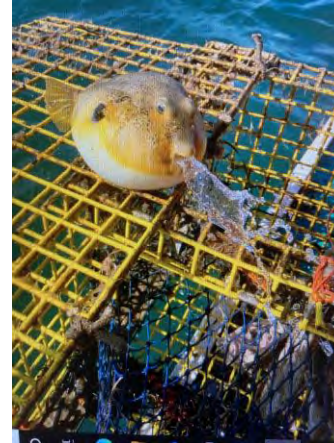
- F/V Anna Mary - Montauk, NY
- F/V Barbara Ann- Point Judith, RI
- F/V Catherine Ann - Newport, RI
- F/V Carol Coles- Newington, NH
- F/V Dilligaf, Scituate, MA
- F/V Direction - Fairhaven, MA
- F/V Erica Knight - Point Judith, RI
- F/V Endeavour - Newport, RI
- F/V Excalibur -Newport, RI
- F/V Gladys Elaine - Newington, NH
- F/V Karen Ann - Point Judith, RI
- F/V Kristin & Michael - Portland, ME
- F/V Linda and Laura - Block Island, RI
- F/V Miss Julie - Sandwich, MA
- F/V Nathaniel Lee - Newport, RI
- F/V Rachel Leah - Newington, NH
- F/V Revolution - New Bedford, MA
- F/V Select - Point Judith, RI
- F/V Terri-Ann - Sandwich, MA
- F/V Timothy Michael - Newport, RI
- F/V Virginia Marie - Sandwich, MA

PREVIOUS VESSELS INVOLVED WHO CONTRIBUTED TO DATA COLLECTION:

- F/V Ashley Ann - Point Judith, RI
- F/V Bug Catcha- Port Clyde, ME
- F/V Bluemoon - Newport, RI
- F/V Cailyn and Gregory - Sakonnet Point, RI
- F/V Dana Conant- Newington, NH
- F/V Debbie Ann - Point Judith, RI

- F/V Diversion - Point Judith, RI
- F/V Freedom - Newport, RI
- F/V Lady Clare - Point Judith, RI
- F/V Sakonnet Lobster II - Tiverton, RI
- FV Sherri & Deke - Fairhaven, MA
- F/V Two Dukes - Sea Isle City, NJ

2021 Photos Shared by YOU!



Progress and New Directions: CFRF's Lobster Crab Fleet



Aubrey Ellertson, Noelle Olsen, Dr. N. David Bethoney

Fleet Meeting

Tuesday, January 31st (4-5:30PM)



Agenda:

- 1) Introducing new Lobster/Crab Fleet lead: Noelle Olsen
- 2) Brief Overview of Fleet Activities
- 3) Updates to On Deck Data and Ocean Temps
- 4) Reminders when sampling
- 5) Stipend breakdown
- 6) Bottom Temp Monitoring
 - Extension work: cleaning up temp data
- 7) Exploring new temperature sensors
 - Fleet feedback and discussion
- 8) Closing remarks/conclusions

Introducing new CFRF Lobster Crab Lead:



Noelle Olsen

- Grew up in Southern CA
- Went to college in MA and MD
- Been with CFRF since May 2021
 - Jonah crab research, the Shelf Research Fleet, piloting automatic squid jigs, gillnet and fish pot SFWF windfarm surveys, and spider crabs (new)

310-594-0072

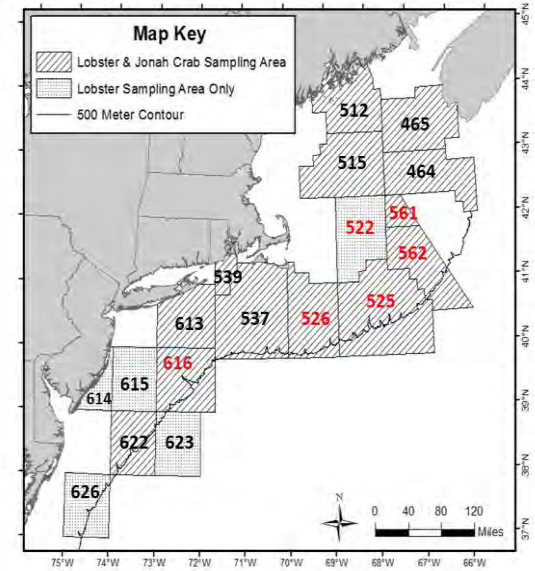
nolsen@cfrfoundation.org

Size at Sexual Maturity & Reproductive Biology of Jonah Crabs in the Mid-Atlantic Bight



Current Project Timeline

We are currently funded through NOAA S-K and the Campbell Foundation, and Appropriations Funding through May 2023



"Further, if the CFRF program did not exist, an additional 2.77 million pounds of lobster caught in GBK and SNE would not be sampled."

-2018 Addendum XXVI to Amendment 3 to the American Lobster Fishery Management Plan



Currently we are at:



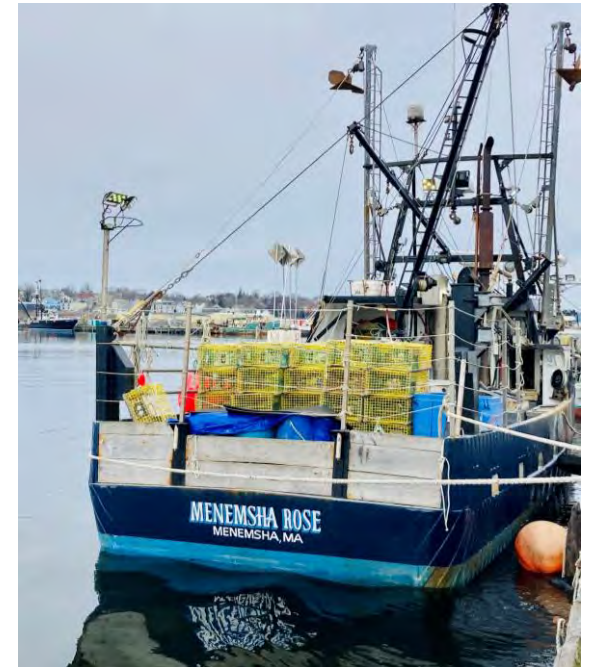
> 201,100 *lobsters*

> 118,700 *Jonah crabs*

The Research Fleet has been in effect since 2013 and has sampled lobsters and Jonah crabs from 24 statistical areas (464, 465, 511, 512, 513, 514, 515, 521, 522, 525, 526, 537, 538, 539, 561, 562, 611, 613, 615, 616, 621, 622, 626, and 627), including five identified as high priority areas for lobster sampling by the Atlantic States Marine Fisheries Commission's Addendum XXVI (522, 525, 526, 561, 562, and 616).

Research Fleets: New Fleet Participants

- F/V Adventure (Provincetown, MA)
- F/V McKinley (Manomet, MA)
- F/V Menemsha Rose (New Bedford, MA)



Lobster and Jonah Crab Research Fleet (2013-present)

Session Data Parameters Collected:

- Date and time
- Location
- Depth
- Soak time
- Number of traps sampled

Individual Data Parameters Collected:

- Sex
- Carapace length/width
- Egg stage (lobster only)
- Shell hardness
- Retained or discarded
- V-notch status (lobster only)
- Shell disease severity (lobster only)

Data Collected to Date:

- 34 participant vessels
- 194,037 lobster samples
- 115,307 Jonah crab samples

A) Lobster Commercial Sample Sample 1

SAMPLE DATA NOTES AND PHOTO

Carapace Length (mm) 0

Sex: Male Female Unknown

No Disease No Eggs No V-Notch

Kept Shell Hard

Save Reset Finish Session

B) Jonah Crab Commercial Sample Sample 1

SAMPLE DATA NOTES AND PHOTO

Carapace Width (mm) 0

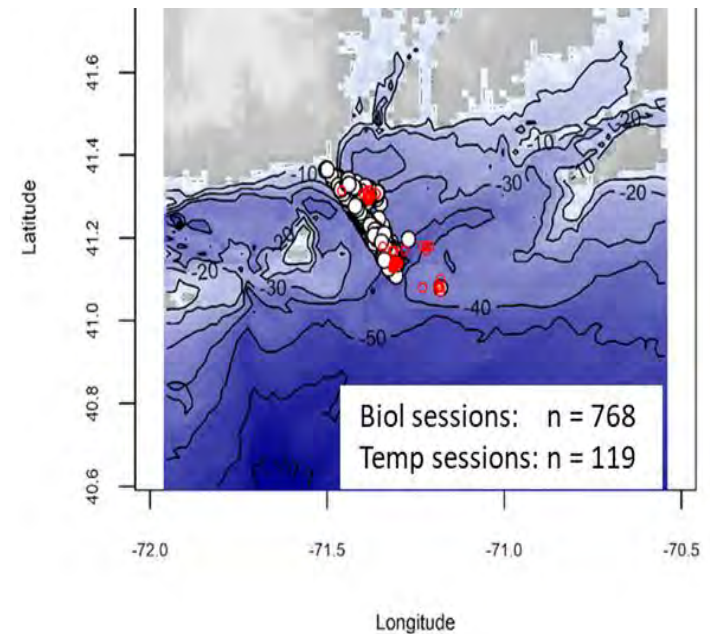
Sex: Male Female Unknown

No Eggs Kept Shell Hard

Save Reset Finish Session

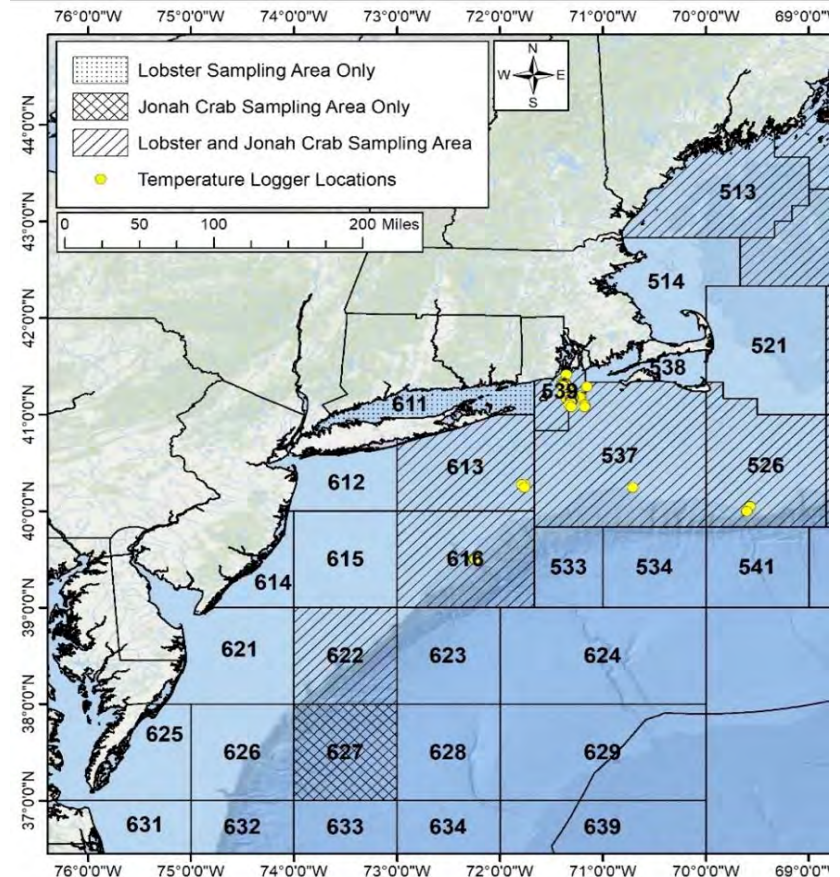
On Deck Data Application: Reminders

- Ventless trap sampling:
 - As of August 2022 we gave fleet members incentive to increase ventless trap sampling (\$100 per ventless trap, for up to an extra \$300 a month to stipend)
- When to start a sampling session:
 - Please start a sampling session in On Deck Data when you get to gear, before you start steaming home
 - Same goes for Ocean Temps



On Deck Data Application: Reminders

- Important to have accurate Lat/long because often we find vessels say stat area “X” but lat/long actually shows you in a different stat area
- When starting a sampling session – trap type * (lobster or crab)
- Changes to app coming down the pipeline:
 - A field check box when you start a sampling session to confirm if that string has a temperature logger in it or not (help us pair temp/biological sampling)



Stipend Breakdown

- The total stipend amount for the tasks performed will be \$850 per month.
- This stipend is broken down in the following manner:
 - \$425/month for 3 commercial lobster sessions (60 traps and/or 300 lobsters measured)
 - \$425/month for 3 commercial Jonah crab sessions (60 traps and/or 150 Jonah crabs measured)
- If a fishing vessel does not hit the sampling targets per month the stipend will be pro-rated :
 - \$150 – if at least 20 traps sampled and either 100 lobsters/50 crabs measured
 - \$300 – if at least 40 traps sampled and either 200 lobsters/100 crabs measured
- If a fishing vessel samples a ventless trap once a month (either all the lobsters or all the Jonah crabs per that ventless trap), an additional \$100/trap will be compensated. Up to \$300/month will be compensated for 3 ventless traps sampled

Quarterly Vessel Data Reports

	A	B	C
1	CFRF Lobster Research Fleet - Quarterly Data Report		
2	Date Range: July 1, 2022 to September 30, 2022		
3			
4	Vessel ID:		
5	Vessel Name:		
6	Owner/Operator:		
7			
8	Lobster Sampling Summary:		
9			
10	Number Commercial Sessions:	9	
11	Number of Ventless Sessions:	12	
12	Total # of Lobsters Sampled:	468	
13			
14	% Male	27.4%	
15	% Female	72.6%	
16	Male:Female Ratio	0.4:1	
17	% Shell Disease	9.6%	
18	% Soft Shell	1.9%	
19	Minimum Carapace Length	57	
20	Maximum Carapace Length	112	
21	Average Carapace Length	88.2	
22	% keepers (>= 86mm)	63.7%	
23	% Kept	57.3%	
24	Females: % Egg-Bearing	4.4%	
25	Females: % V-Notched	0.6%	
26			
27			
28	Jonah Crab Sampling Summary:		
29			
30	Number Commercial Sessions:	9	
31	Number of Ventless Sessions:	11	
32	Total # of Crabs Sampled:	608	
33			
34	% Male	73.8%	
35	% Female	26.2%	
36	Male:Female Ratio	2.8:1	
37	% Soft Shell	0.2%	
38	Minimum Carapace Width	11	
39	Maximum Carapace Width	152	
40	Average Carapace Length	121.9	
41	% Kept	50.5%	
42	Females: % Egg-Bearing	0.0%	
43			
44			
45			

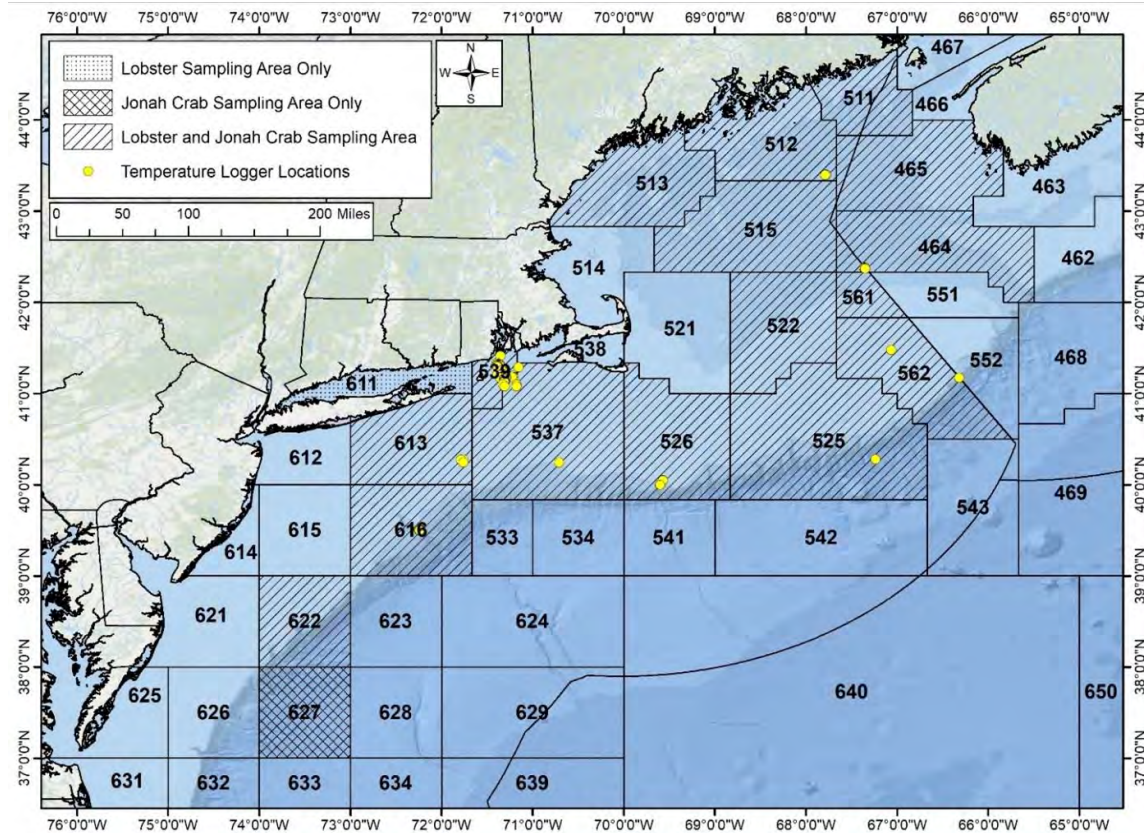
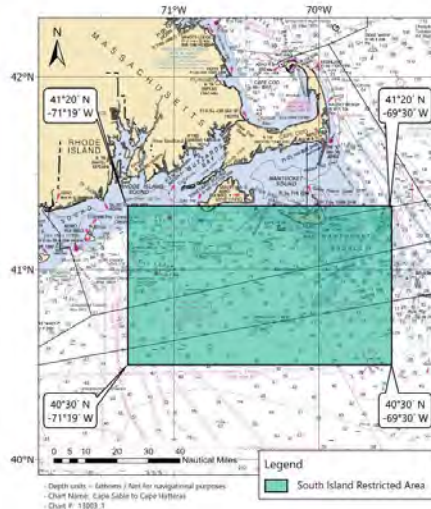
26		
27		
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43		
44		
45		

- User friendly?
- How do you want to see your data?
- Do you actually look at each tab on Excel spreadsheet?

Bottom Water Temperature Monitoring


- Logger records temperature every 10 min
- Geographic Range: Gulf of Maine to Hudson Canyon
- Temporal Range: Year Round
- Temperature Records: > 4.7 million

South Island Restricted Area





Extension Work:


- The Lobster and Jonah Crab Research Fleet has been in effect since 2013 (9 year time series), allowed for extension work











 **ERDDAP**
Easier access to scientific data


ERDDAP > tabledap > Data Access Form


Dataset Title: **CFRF moored bottom temperatures**  

Institution: Commercial Fisheries Research Foundation (Dataset ID: cfrf_temps)
Information: [Summary](#) | [License](#) | [FGDC](#) | [ISO 19115](#) | [Metadata](#) | [Background](#) | [Make a graph](#)

Variable  Check All Uncheck All

Variable	Optional Constraint #1	Optional Constraint #2
<input checked="" type="checkbox"/> LINE_NUM 	>=	<=
<input checked="" type="checkbox"/> time (UTC) 	>= 2023-01-07T00:00:00Z	<=
<input checked="" type="checkbox"/> VESSEL_ID 	>=	<=
<input checked="" type="checkbox"/> latitude (degrees_north) 	>=	<=
<input checked="" type="checkbox"/> longitude (degrees_east) 	>=	<=
<input checked="" type="checkbox"/> SESSION_ID 	>=	<=
<input checked="" type="checkbox"/> SERIAL_NUM 	>=	<=
<input checked="" type="checkbox"/> sea_water_temperature (degree_C) 	>=	<=
<input checked="" type="checkbox"/> YEARDAY 	>=	<=
<input checked="" type="checkbox"/> depth (m) 	>=	<=

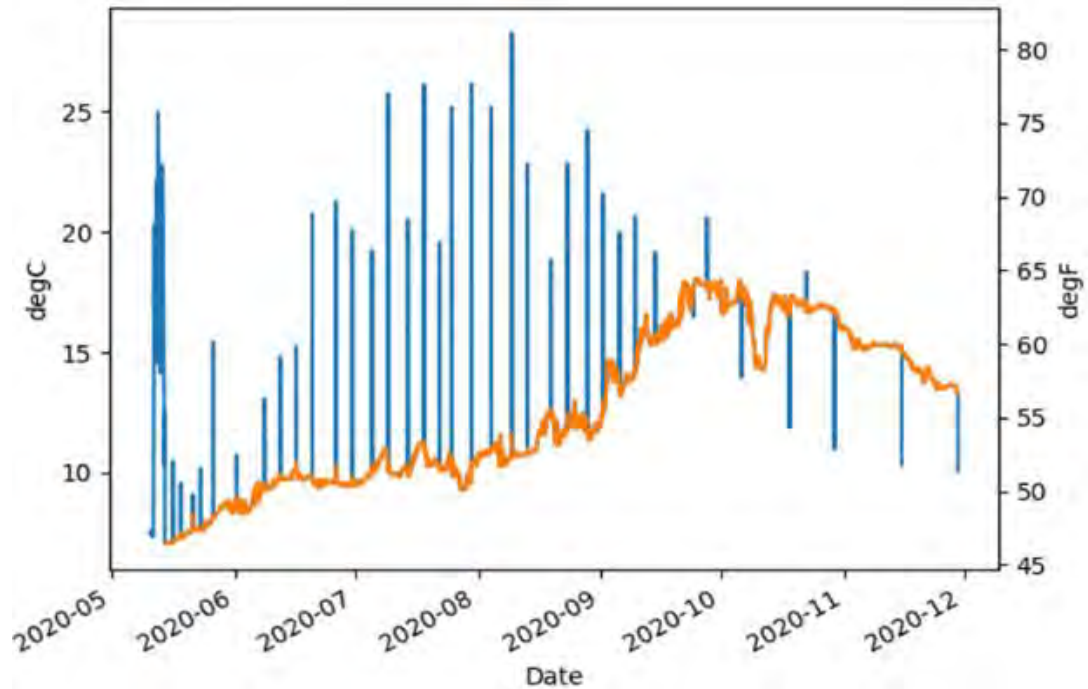
Server-side Functions 

distinct() 

File type: [\(more information\)](#)

[\(Documentation / Bypass this form\)](#)

Submit (Please be patient. It may take a while to get the data.)



Bottom Temperature Analyses

Started working on matching biological sampling sessions with temperature monitoring locations

Allows us to investigate if:

- There is a relationship between lobster or Jonah crab catch and bottom water temp
- The incidence, spatial variation and seasonal development of shell disease is related to bottom water temp
- The catch of egg bearing lobsters is related to bottom water temp
- Other ideas??

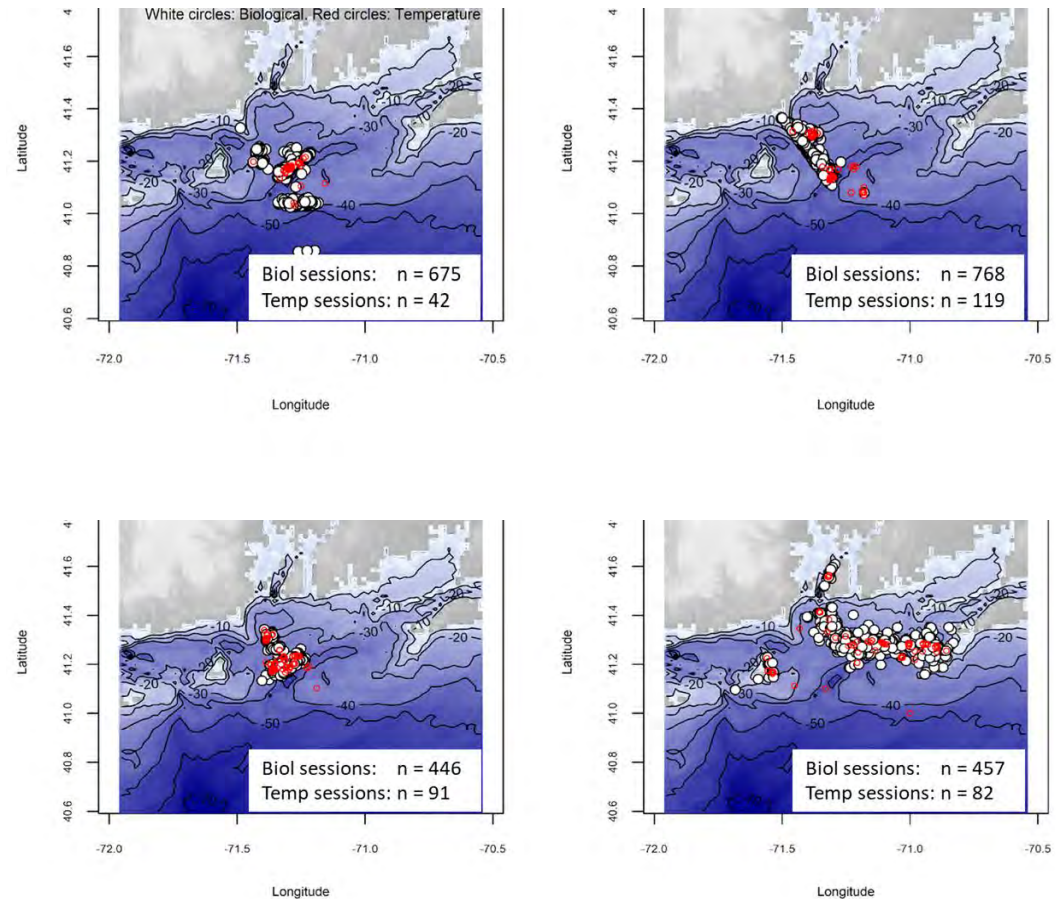
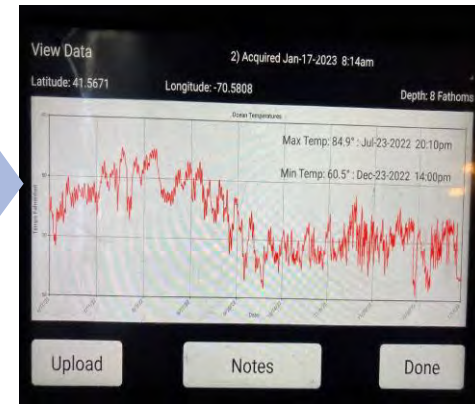
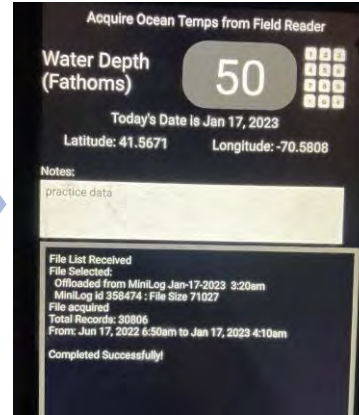


Figure: Dr. Stephen Arnott, CFRF

The current process:



Fishermen zip tie a VEMCO Minilog-II logger into their ventless trap

Once gear is onboard logger is removed and placed in field reader.
Field reader stores data

Field reader wirelessly talks to tablet via Bluetooth and Ocean Temps app to acquire the data

Ocean Temps gathers the data for fishermen to see in real-time

Piloting new loggers: Zebra Tech Moana Probe

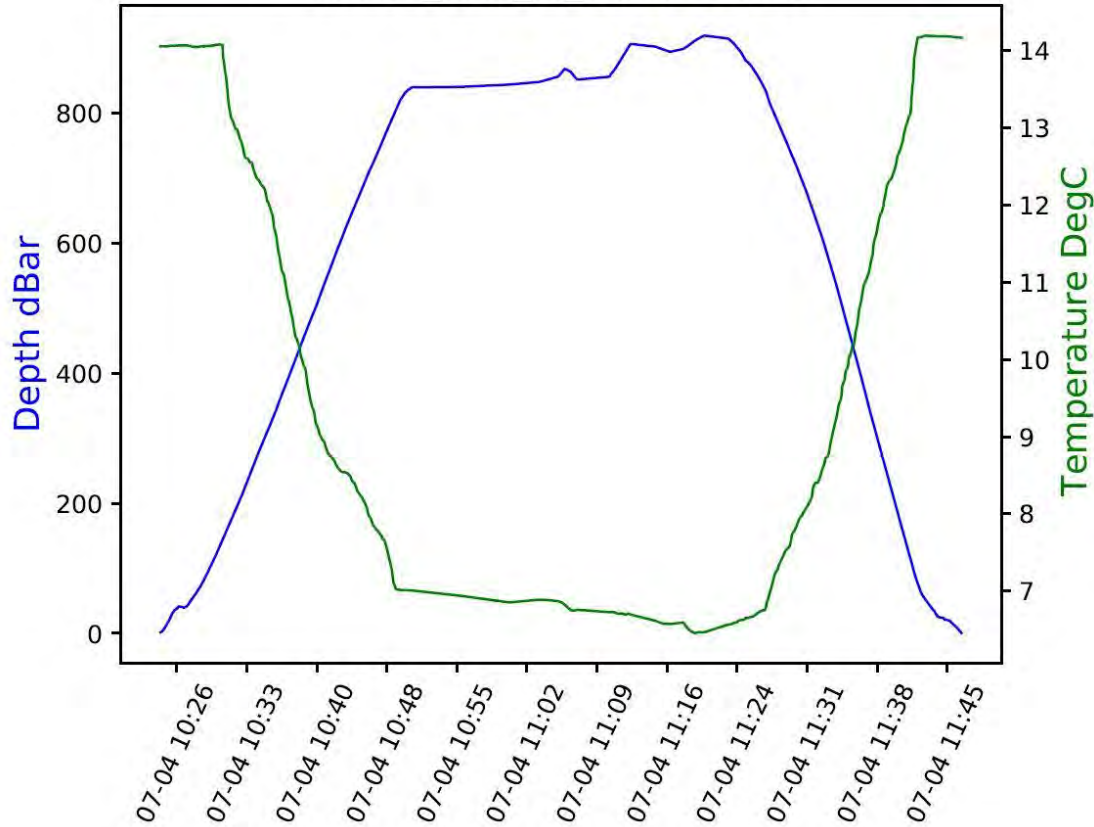


The Moana TD sensor (named Mangōpare within the Moana project) has been developed as a key part of the [Moana project](#)

The Moana project is a multi-organization New Zealand project that aims to vastly improve our understanding of coastal ocean circulation, connectivity and marine heatwaves, to provide information that supports sustainable growth of the seafood industry.

Piloting new loggers: Moana Probe

MOANA_0008_40_200704114822



- No human intervention required for daily operations
- Sensor starts and stops triggered by pressure change
- Automated data offload and transfer to the cloud
- Battery life – 2 years



Industry Feedback on Loggers:

- Is there any interest in multiple sensors per string?
- Is it important that you can visualize the data as soon as logger is onboard?
- What are the most effective ways to return data to you?
 - Seasonal overview?
 - Access to raw data?
 - Email updates?
 - Toggle between different tows/ strings?
 - Overlap of your temp data, with the thermal range for lobster/crab species?

Industry Feedback on Loggers:

- Most effective ways to provide the data (e.g., real time in the wheelhouse or at home on the web)
- Any concerns that would keep you from participating in a program (e.g., privacy issues)
- Would any fishers be interested in trying out online portals for viewing their own data?

Example of a Data Portal: ODN WHOI Portal

Dashboard

Select vessel Select units: Start Date: End Date:

Vessel ID

Troller 1

Number of tows

35

Selected tow

35

Selected profile mean depth

34.3 fath

Selected profile bottom mean temperature

43.8 °F

Select profile (UTC)

Mean bottom data values

35 Tow id: 21162

Ending time: July 4, 2021, 1:57 a.m.

Temp: 43.8°F, Depth: 34.3fath

Location: 58.789, -138.393

Gear sinking time: 2min 22sec

Fishing time: 0h 30min

34 Tow id: 21161

Ending time: July 4, 2021, 1:25 a.m.

Temp: 43.8°F, Depth: 35.3fath

Location: 58.79, -138.385

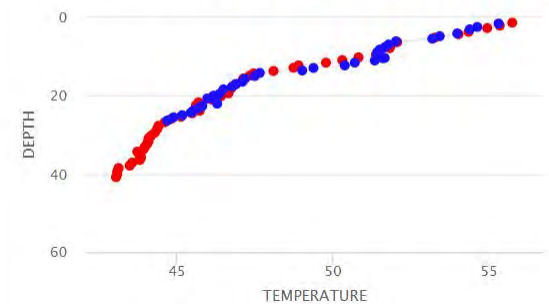
Map fishing events

Profiles distribution over a map



Selected profile

Depth over temperature



Example of a Data Portal: ODN WHOI Portal

Select profile (UTC)

Mean bottom data values

34 Tow id: 21161

Ending time: July 4, 2021, 1:25 a.m.

Temp: 43.8°F, Depth: 35.3fath

Location: 58.79, -138.385

Gear sinking time: 2min 8sec

Fishing time: 1h 47min

33 Tow id: 21138

Ending time: July 3, 2021, 11:35 p.m.

Temp: 43.6°F, Depth: 36.3fath

Location: 58.788, -138.394

Gear sinking time: 2min 58sec

Fishing time: 1h 52min

32 Tow id: 21137

Ending time: July 3, 2021, 9:41 p.m.

Temp: 43.6°F, Depth: 35.7fath

Location: 58.788, -138.384

Gear sinking time: 2min 14sec

Fishing time: 0h 27min

31 Tow id: 21136

Ending time: July 3, 2021, 9:12 p.m.

Temp: 43.7°F, Depth: 35.6fath

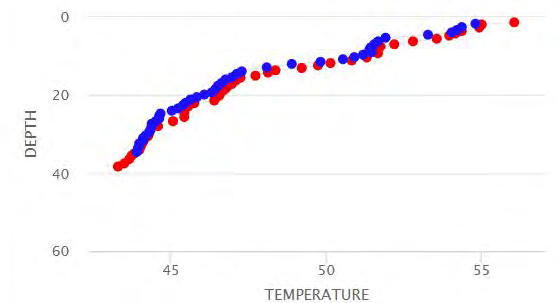
Map fishing events

Profiles distribution over a map

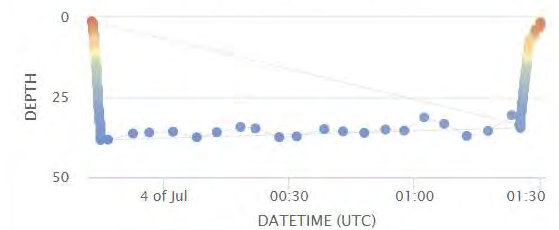


Selected profile

Depth over temperature



Depth over time



Final Thoughts and Thank you!

Data has been used in:

The 2018, 2020, and 2022 Lobster Benchmark Stock Assessments

2015 Interstate Fishery Management Plan for Jonah Crab

- Upcoming 2023 Jonah Crab Stock Assessment

Data also has been used by CFRF staff to:

- Investigate spatial patterns in lobster population
- Investigate lobster shell disease
- Update lobster maturity data in offshore SNE and GB
- Improve Jonah crab management
- Evaluate lobster and crab demographics in the Northeast Canyons and Seamounts Marine National Monument
- Link temperature with biological data, and improve oceanographic models
- And much more!!



The Commercial Fisheries Research Foundation: Lobster & Jonah Crab Research Fleet



Dr. N. David Bethoney & Mark Sweitzer

National Marine Fisheries Service Cooperative Research Program

Annual Meeting, September 15, 2022



The place



-
- A map of the New Bedford area, showing the coastline and surrounding land. Three green location pins are placed on the map, corresponding to the labels below. Lines connect these pins to the satellite and photograph images above.
- New Bedford
 - Commercial Fisheries Research Foundation
 - Superior Trawl

The Mission

A non-profit, private foundation established by commercial fishermen that is dedicated to conducting collaborative research and education projects that inform and promote sustainable fisheries.



Leadership: The Board

Fred Mattera



John Kennedy



Chis Lee



Donald Fox



Chris Roebuck



Jeff Grant



Jon Knight



Katie Almeida



Mark Sweitzer



Mike Marchetti

The Research Team



Steve Arnott

**Lobsters and Crabs
Statistical Analysis**



Aubrey Ellertson

**Lobsters and Crabs
Gillnet survey
Protected Species**



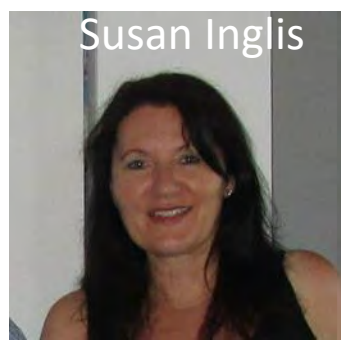
Thomas Heimann

**Squid
Whelks
Fish pot survey**



Carl Huntsberger

**Beam trawl survey
Sea scallops
Lobsters and Crabs**



Susan Inglis

**Ghost Gear
Human Dimensions
Lobster disease**



Mike Long

**Ventless trap survey
Sea scallops
Underutilized Species**



Noelle Olsen

**Crabs
Squid
Oceanography**



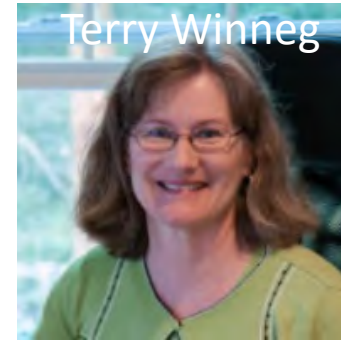
Hannah Verkamp

**Black sea bass
Electronic gear marking
Bay scallops**



Katie Viducic

**Sea Scallops
Gillnet survey
Electronic gear marking**



Terry Winneg

**Business Manager
Budgets!**

Vessels: Captains, Crews, Owners

Johan Crab and American Lobster

F/V Anna Mary – Montauk, NY
F/V Barbara Ann- Point Judith, RI
F/V Catherine Ann - Newport, RI
F/V Carol Coles- Newington, NH
F/V Dilligaf, Scituate, MA
F/V Direction - Fairhaven, MA
F/V Erica Knight - Point Judith, RI
F/V Endeavour - Newport, RI
F/V Excalibur -Newport, RI
F/V Gladys Elaine - Newington, NH
F/V Karen Ann - Point Judith, RI
F/V Kristin & Michael - Portland, ME
F/V Linda and Laura - Block Island, RI
F/V Miss Julie - Sandwich, MA
F/V Nathaniel Lee - Newport, RI
F/V Rachel Leah - Newington, NH
F/V Revolution - New Bedford, MA
F/V Select - Point Judith, RI
F/V Terri-Ann - Sandwich, MA
F/V Timothy Michael - Newport, RI
F/V Virginia Marie - Sandwich, MA

Whelk

F/V Elisabeth Mae – Vineyard Haven, MA
F/V Ragged Edge- Point Judith, RI
F/V Yes I am – West Greenwich, RI
F/V Bad Habit – Dartmouth, MA
F/V Johnny B - Point Judith, RI
F/V Rock & Roll – Edgartown, MA
F/V Peggy-B II – West Dennis, MA
F/V Haul-In, Bristol, RI

Shelf

F/V Brooke C - Point Judith, RI
F/V Erica Knight - Point Judith, RI
F/V Finast Kind II - Tiverton, RI
F/V Excalibur - Newport, RI
F/V Harvest Moon- Point Judith, RI
F/V Mister G - Point Judith, RI
F/V Catherine Ann - Newport, RI
F/V Christopher Andrew -Newport, RI

Ghost gear

Black sea bass

F/V Sweet Misery - Newport, RI
F/V More Misery - Newport, RI
F/V Johnny B - Portsmouth, RI
F/V Laura Lynn - Point Judith, RI
F/V Matrix - Wickford, RI
F/V Lucy Rose - Wickford, RI
F/V New Hope - Point Judith, RI
F/V Nancy Beth - Point Judith, RI
F/V Virginia BAE – Newport, RI
F/V Rayna and Kerstin – Newport, RI
F/V Johnny B - Point Judith, RI
F/V Priority Too - Point Judith, RI
F/V Ragged Edge- Point Judith, RI
F/V Debbie Sue - Point Judith, RI
F/V Harvest Moon - Point Judith, RI
F/V X-Terminator - Little Compton, RI
F/V Catherine Ann - Newport, RI
F/V Blue Label – Newport, RI
F/V Savanna Paige – Cape May, NJ
F/V Ruthless – Cape May, NJ
F/V Brooke C – Point Judith, RI

Sea Scallops

F/V Brooke C - Point Judith, RI
F/V Harvest Moon- Point Judith, RI
F/V Mister G - Point Judith, RI
F/V Karen Elizabeth - Point Judith, RI
F/V Yankee Pride - Point Judith, RI
F/V Georges Banks- New Bedford, MA
F/V Clean Sweep - Provincetown, MA
F/V Midnight Our - Harwich, MA
F/V Northern Light - Portland, ME
F/V Glutton- Provincetown, MA

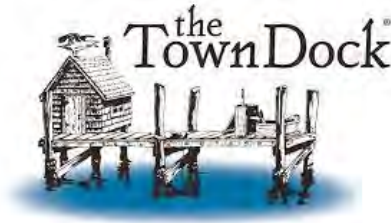
Squid

F/V Miss Edi- Point Judith, RI
F/V Hadley Ruth - Point Judith, RI

Wind Surveys

F/V Amelia Anne - Point Judith, RI
F/V Ashley Anne II - Point Judith, RI
F/V Erica Knight- Point Judith, RI
F/V Harvest Moon- Point Judith, RI
F/V Mister G - Point Judith, RI
F/V Cailyn & Maren - Little Compton, RI
F/V More Misery- Newport, RI

Other Collaborators

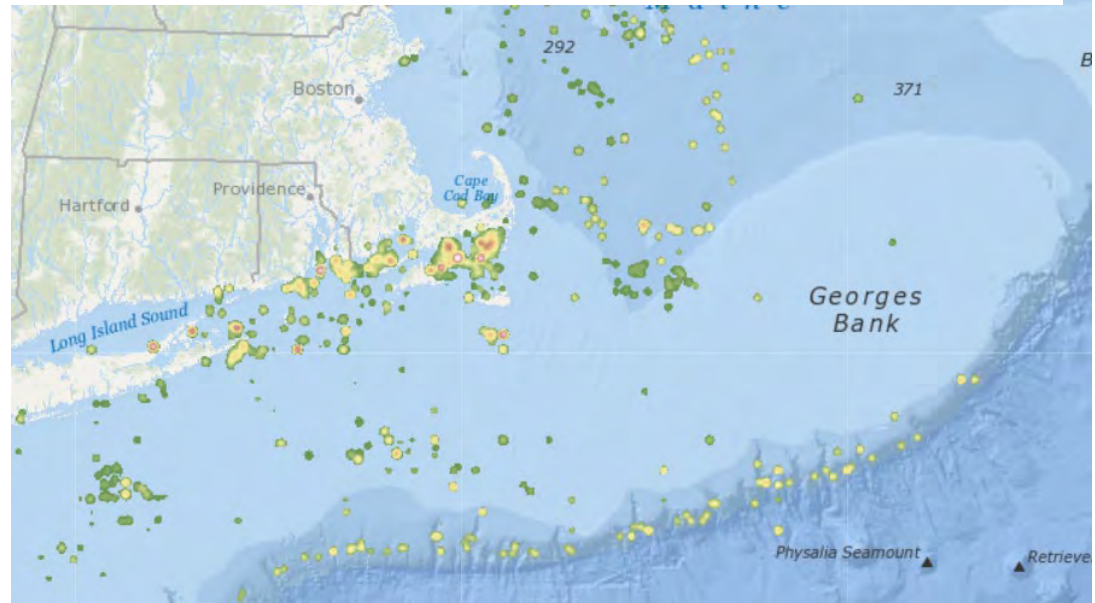


Lobster-Crab Research Fleet: The Gap

“The third priority task is to increase the sea sampling for biological samples to complement the landings in offshore waters.”

2015 Lobster Stock Assessment

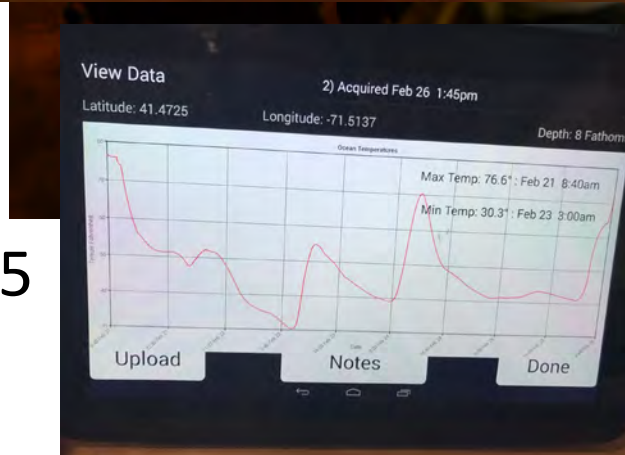
- Offshore
 - Significant landings
 - Little Data
 - Trawl survey
 - Limited fishery dependent



Northeast Ocean Data portal
Federal pot and trap effort 2011-2015

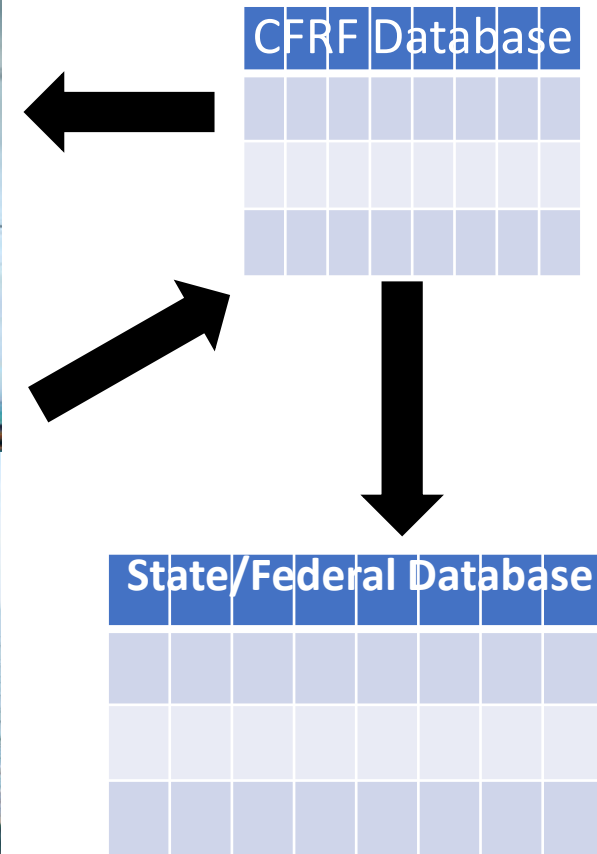
Lobster-Crab Research Fleet: The Solution

- Empower fishery
- The tools
 - On Deck Data
 - Calipers
 - Compensation
- The data
 - Effort
 - Biological data
 - American Lobster
 - Jonah crab
 - Temperature
- The start – 2013-2015
 - 12 vessels
 - 75,000 samples

A screenshot of a 'Lobster Commercial Sample' data entry form. The form is titled 'Lobster Commercial Sample' and 'Sample 1'. It has two tabs: 'Sample Data' and 'Notes and Photo'. The 'Sample Data' tab is active. It features a 'Carapace Length (mm)' field with a value of 0 and a numeric keypad. Below that is a 'Sex:' field with three options: 'Male', 'Female', and 'Unknown'. There are three checkboxes: 'No Disease', 'No Eggs', and 'No V-Notch'. Below these are two more checkboxes: 'Kept' and 'Shell Hard'. At the bottom, there are three buttons: 'Save', 'Reset', and 'Finish Session'.

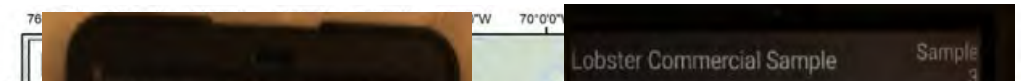
Lobster-Crab Research Fleet: The Solution

- Empower fishery
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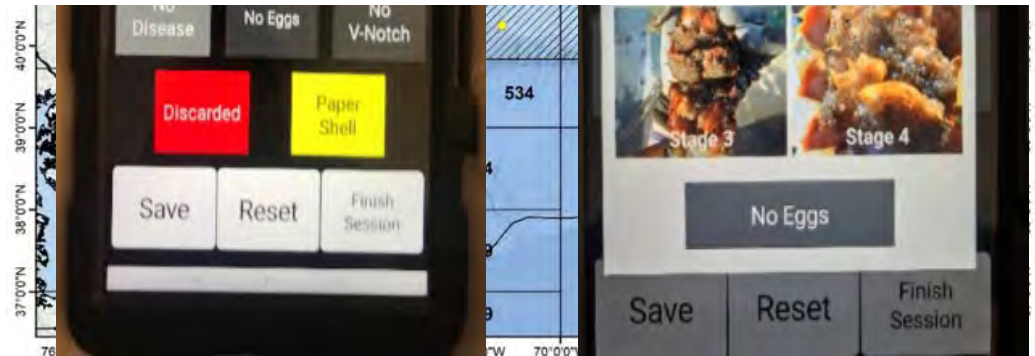
Lobster-Crab Research Fleet: The Results

- 33 vessels since start
- Time series
 - Lobster: 2013
 - Crab: 2014
 - 100,000s biological samples
- Data expansion
 - Egg and molt staging
 - Crab disease
- Millions of temperature readings
- Key part of lobster stock assessment



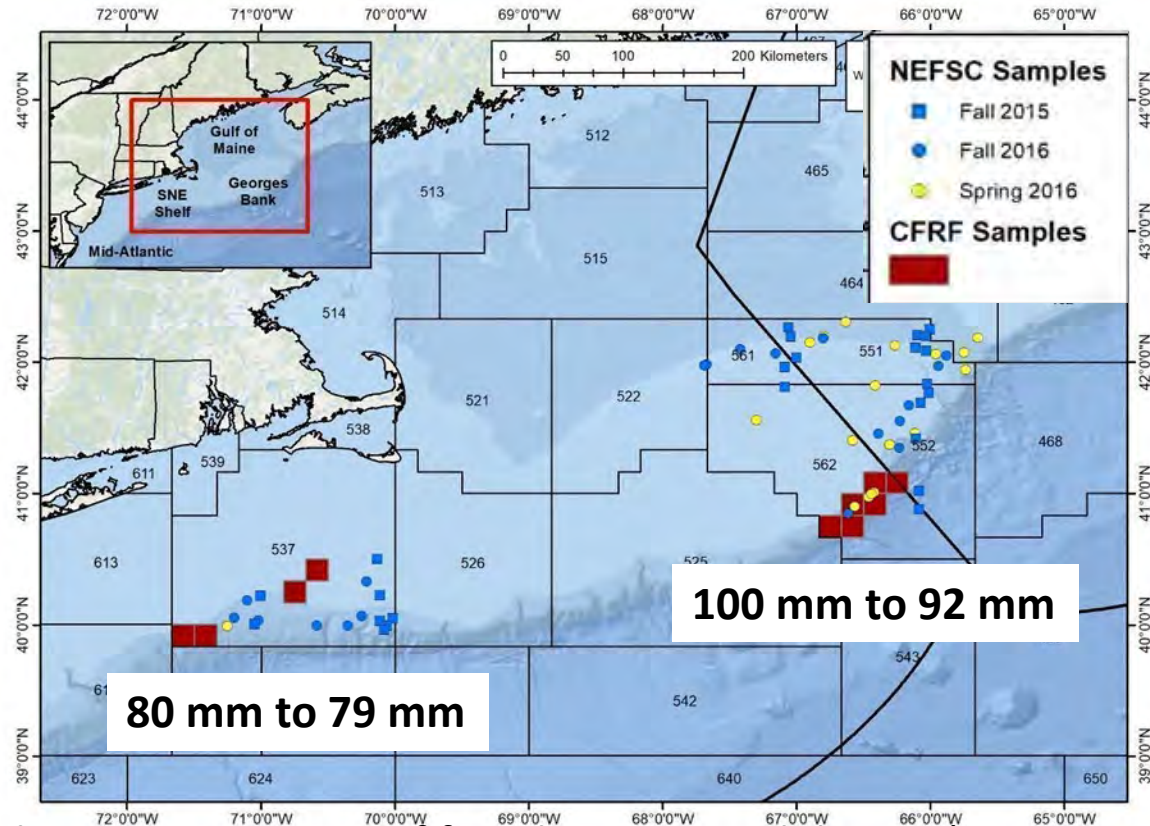
“Further, if the CFRF program did not exist, an additional 2.77 million pounds of lobster caught in GBK and SNE would not be sampled.”

2018 ADDENDUM XXVI TO AMENDMENT 3 TO THE AMERICAN LOBSTER FISHERY MANAGEMENT PLAN



Lobster-Crab Research Fleet: Extended Impact

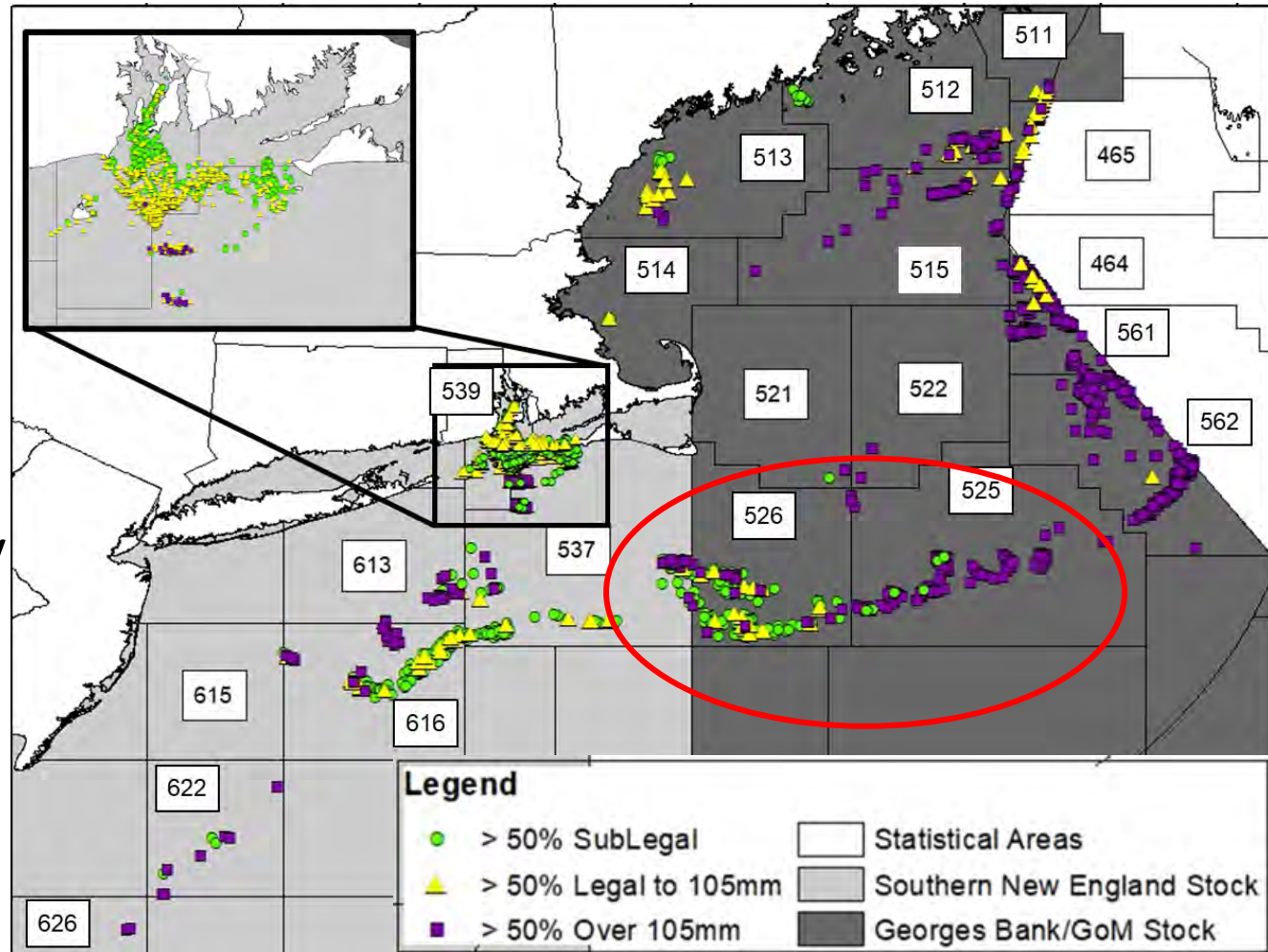
- Lobster Maturity
 - From 20 years ago
 - Decreases and similarities



Ellertson et al 2022, Differences in the size at maturity of female American lobsters (*Homarus americanus*) from offshore Southern New England and eastern Georges Bank, USA

Lobster-Crab Research Fleet: Extended Impact

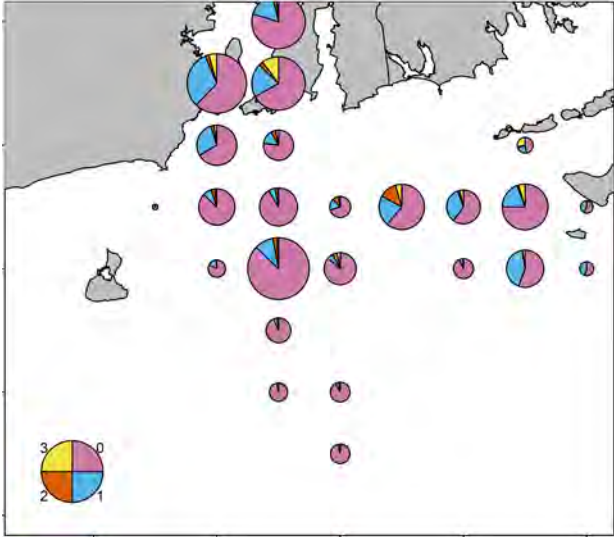
- Spatial Patterns
 - No vessel effect
 - Biological, stock area discrepancy



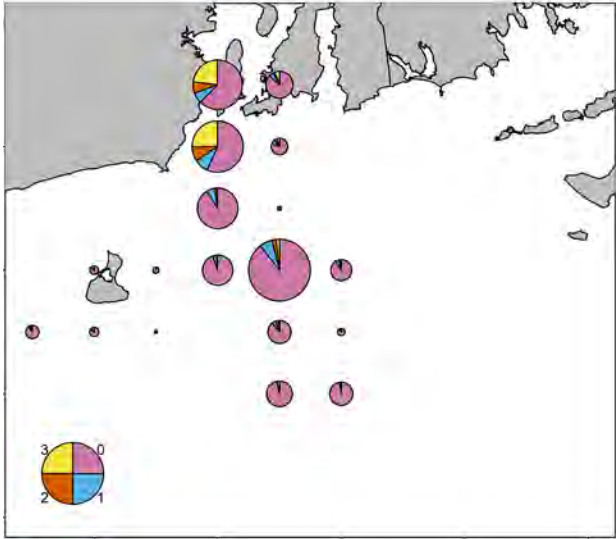
Lobster-Crab Research Fleet: Extended Impact

- Lobster disease
 - Juvenile increase?
 - Within Bay trend

2014



2020



Lobster-Crab Research Fleet: Extended Impact

- Jonah Crab
 - Growth
 - Stock assessment



Growth and molting characteristics of Jonah crab (*Cancer borealis*) in Rhode Island Sound

Corinne L. Truesdale^{a,*}, M. Conor McManus^b, Jeremy S. Collie^a

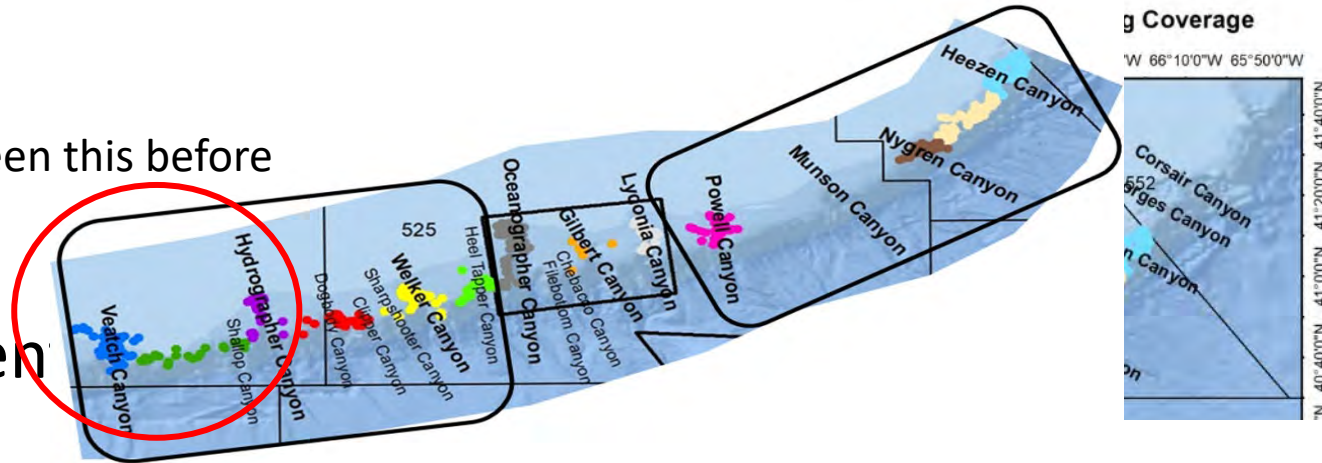
^a Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, 02882, United States

^b Rhode Island Department of Environmental Management, Division of Marine Fisheries, Jamestown, RI, 02835, United States



Lobster-Crab Research Fleet: Extended Impact

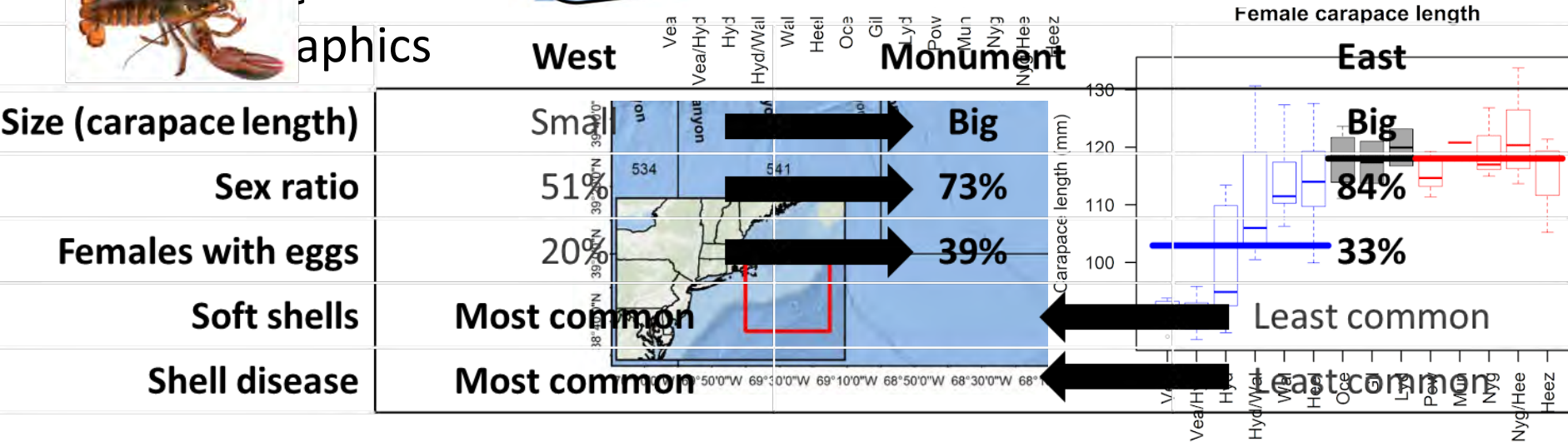
Different....we've seen this before



- Marine Monumen

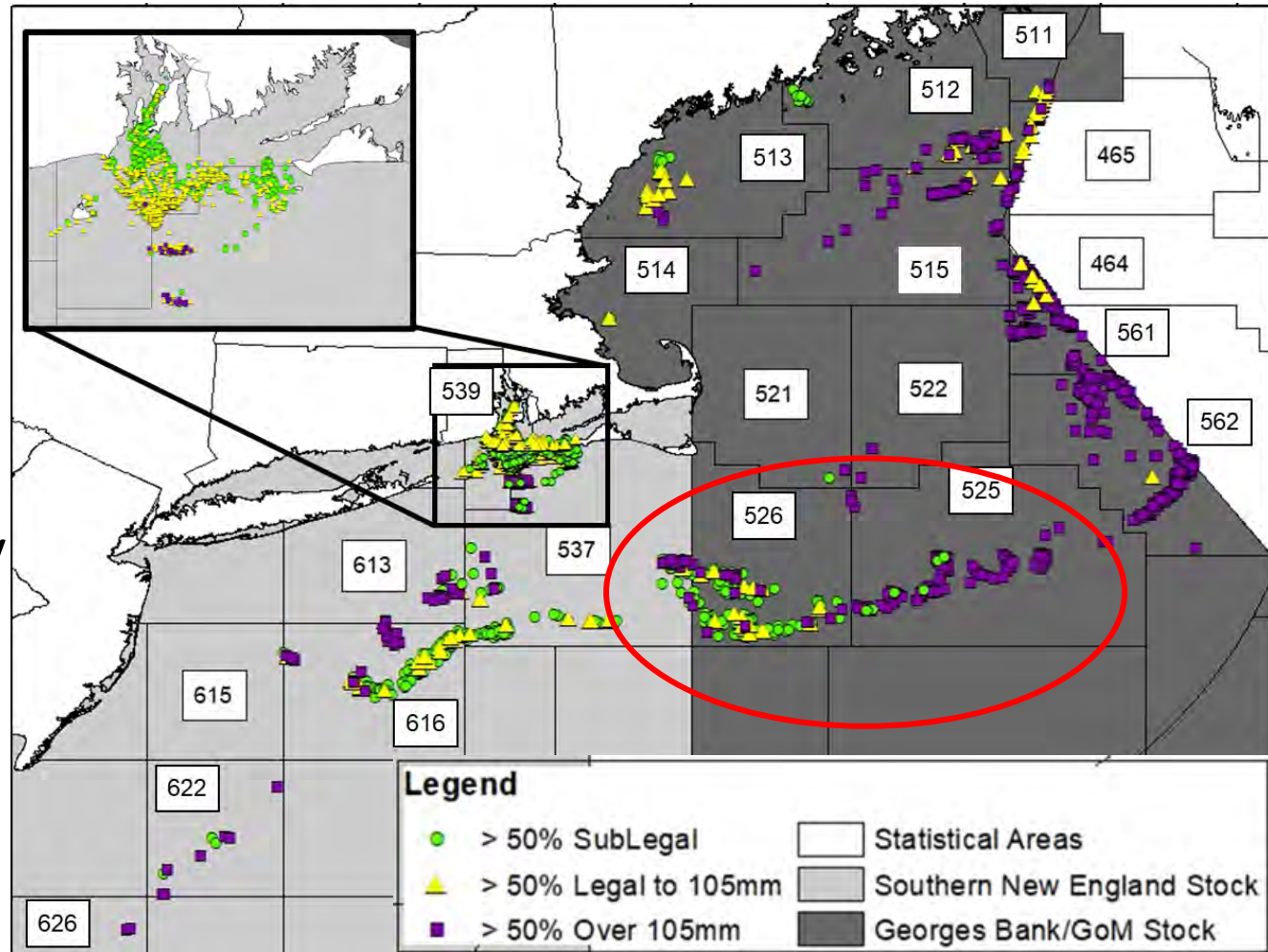


aphics



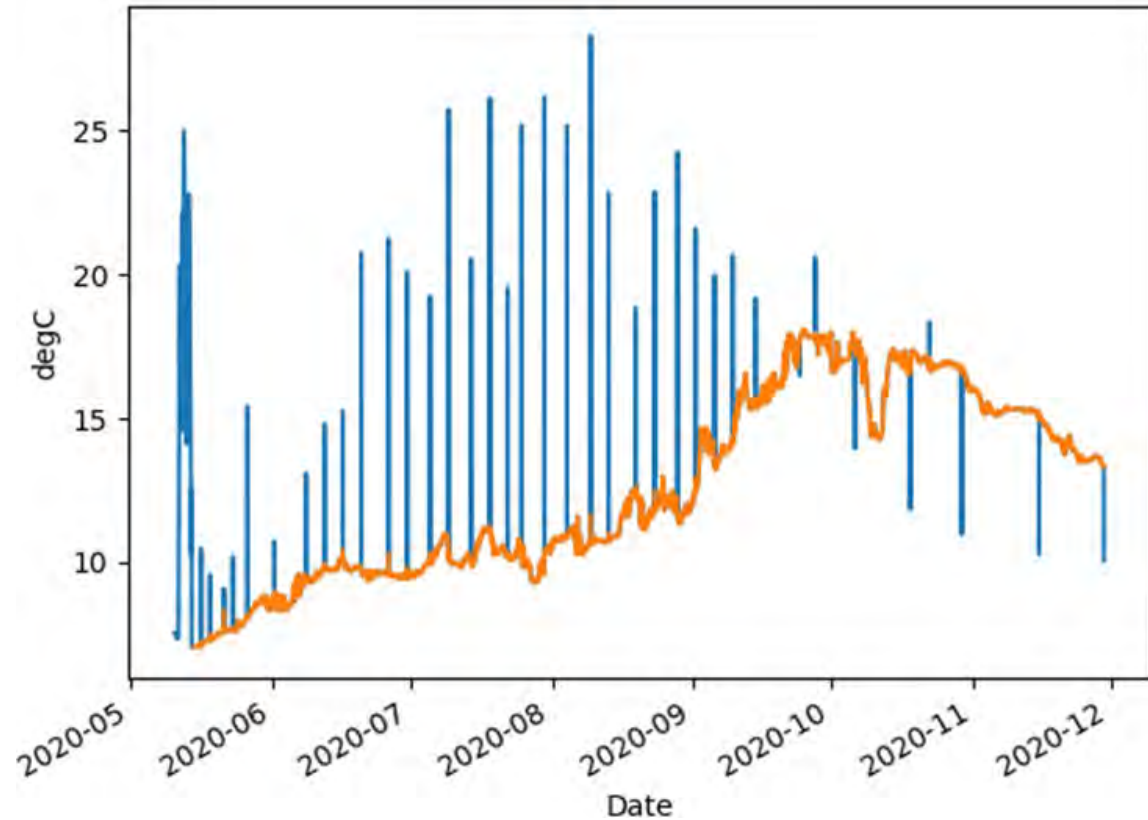
Lobster-Crab Research Fleet: Extended Impact

- Spatial Patterns
 - No vessel effect
 - Biological, stock area discrepancy



Lobster-Crab Research Fleet: Extended Impact

- Temperature
 - Link to biological data
 - eMolt integration
 - Model use



The Research Fleet Model

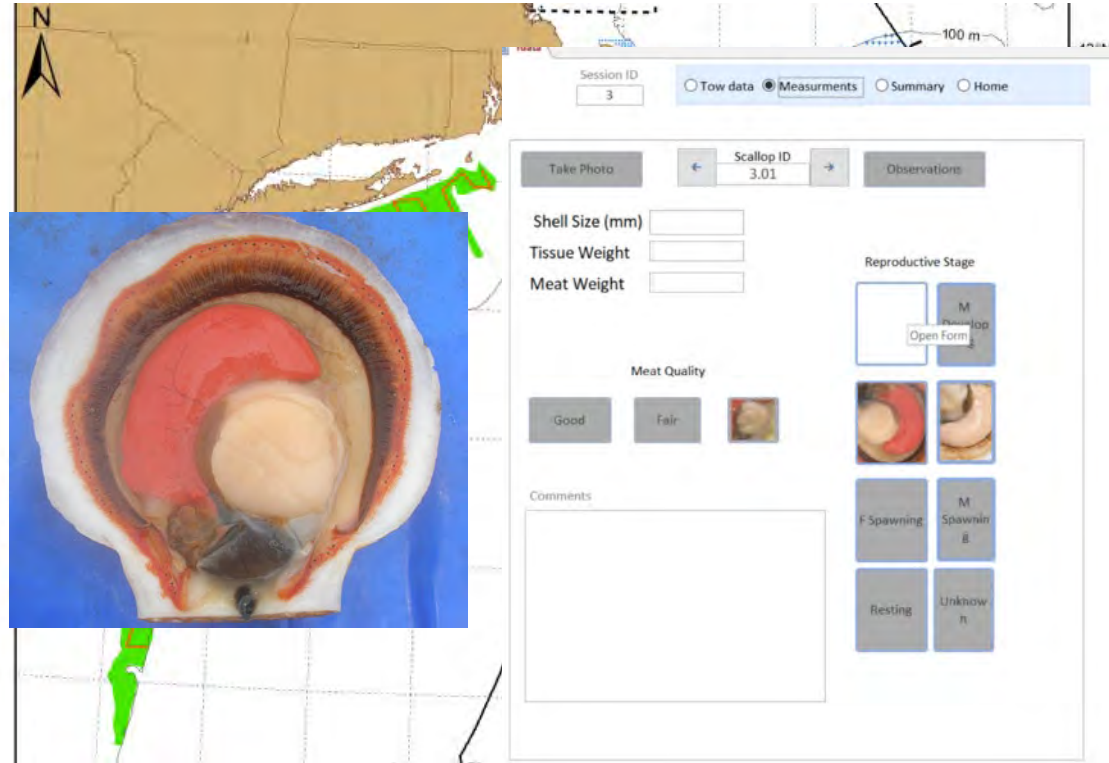
A partnership between scientists and fishermen to collect and utilize data

- Foundation Scientists
 - Training – App and protocols
 - Technical Support
 - Get the data used
- Fishermen
 - Sampling
 - Other contributions
- Scientists, Fishermen, Managers...
 - Need Identification
 - Method Development
 - Implementation
 - Funding
 - Recruitment



Sea Scallop Research Fleet

- The gaps
 - Seasonal changes
 - Northern Gulf of Maine
- The data
 - Effort
 - Individual
 - Shell height
 - Meat, gonad weight
 - Meat quality
 - Gonad stage
 - Photographs
- The results
 - 6 vessels pilot fleet
 - Data collection started
 - A simpler approach?



Mark's thoughts

Acknowledgments

- Staff, Board of Directors, Fishing Community & Collaborators

Funders



Questions?



Participant thoughts



“The CFRF gives us the ability to get this information to management. Through the Foundation we have a voice. Our data is backed up by scientists and managers. It gives us credibility. We have a mechanism and the tools to collect real time data and create change. That is the key to fisheries management.”

-Norbert Stamps, F/V Debbie Ann, Point Judith, RI

“We are out there all the time and you know a lot of us have been fishing for years. We see a lot of different things, a lot of changes. We have the opportunity to collect this data, so I think it is a great opportunity for us to give back to the industry and supply the data that is needed for the biologists to do the stock assessments and management. I think we are supplying the data that needs to be supplied, so we know exactly what is taking place. I am glad to be involved and I am proud too.”

- Al Eagles, F/V Catherine Ann, Newport, RI



The CFRF Lobster-Jonah crab Research Fleet

Lobstermen: Responsible Stewards of Marine Resources

Noelle A. Olsen & N. David Bethoney

Lobster-Jonah crab Fleet Basics

- Founded in 2013 to address biological data gaps in offshore lobster populations in Southern New England, Georges Bank, and the Gulf of Maine year-round
- A steering committee comprised of scientists, managers, and fishermen met to discuss the goals, logistics, and sampling methodology
- Jonah crab sampling started in 2014
- 34 participating vessels since 2013 with ~22 currently active vessels
- Data collected by the Fleet is incorporated into state and federal databases



Lobster-Jonah crab Fleet steering committee at the CFRF office.

Acknowledgements

Thank you to all of our Fleet participants over the years! We'd like to thank Aubrey Ellertson for her contributions to growing and expanding the Fleet to help manage these resources!



Biological sampling methods, tools, & technologies

- Vessels are trained to measure lobsters and Jonah crabs using calipers and record their data with the On Deck Data application on a tablet
- Data are wirelessly uploaded to server via WiFi
- Vessels are asked to complete three lobster and three Jonah crab sessions per month using commercial traps
 - Lobster session = 100 lobsters or 20 traps
 - Jonah crab session = 50 crabs or 20 traps
- Fishermen receive a **stipend** for sampling which is prorated if sampling goals aren't met
- Vessels are provided three ventless traps and receive an additional **stipend** when either all lobsters and/or all Jonah crabs are sampled from each ventless trap



Session Data Parameters Collected:

- Date and time
- Location and Depth
- Soak time
- Number of traps sampled



Individual Data Parameters Collected:

- Sex
- Carapace length (lobsters)/width (crabs)
- Egg stage (lobster only)
- Shell hardness
- Retained or discarded
- V-notch status (lobster only)
- Shell disease severity (lobster only)



A screen shot of the On Deck Data app for a commercial lobster sampling session.

Temperature sampling tools & technologies

- Fleet participants are provided a VEMCO Minilog-II temperature logger and field reader
- The logger is zip-tied to a ventless trap
- Loggers must be removed from the trap and placed in field reader to offload data
- Field readers connect to the Ocean Temps app on tablet via Bluetooth
- Fishermen can view temperature plots at-sea
- Temperature data are wirelessly uploaded to CFRF server via WiFi
- Some Fleet members have opted to use the temperature loggers through eMOLT instead



VEMCO logger being attached.



VEMCO logger and field reader.

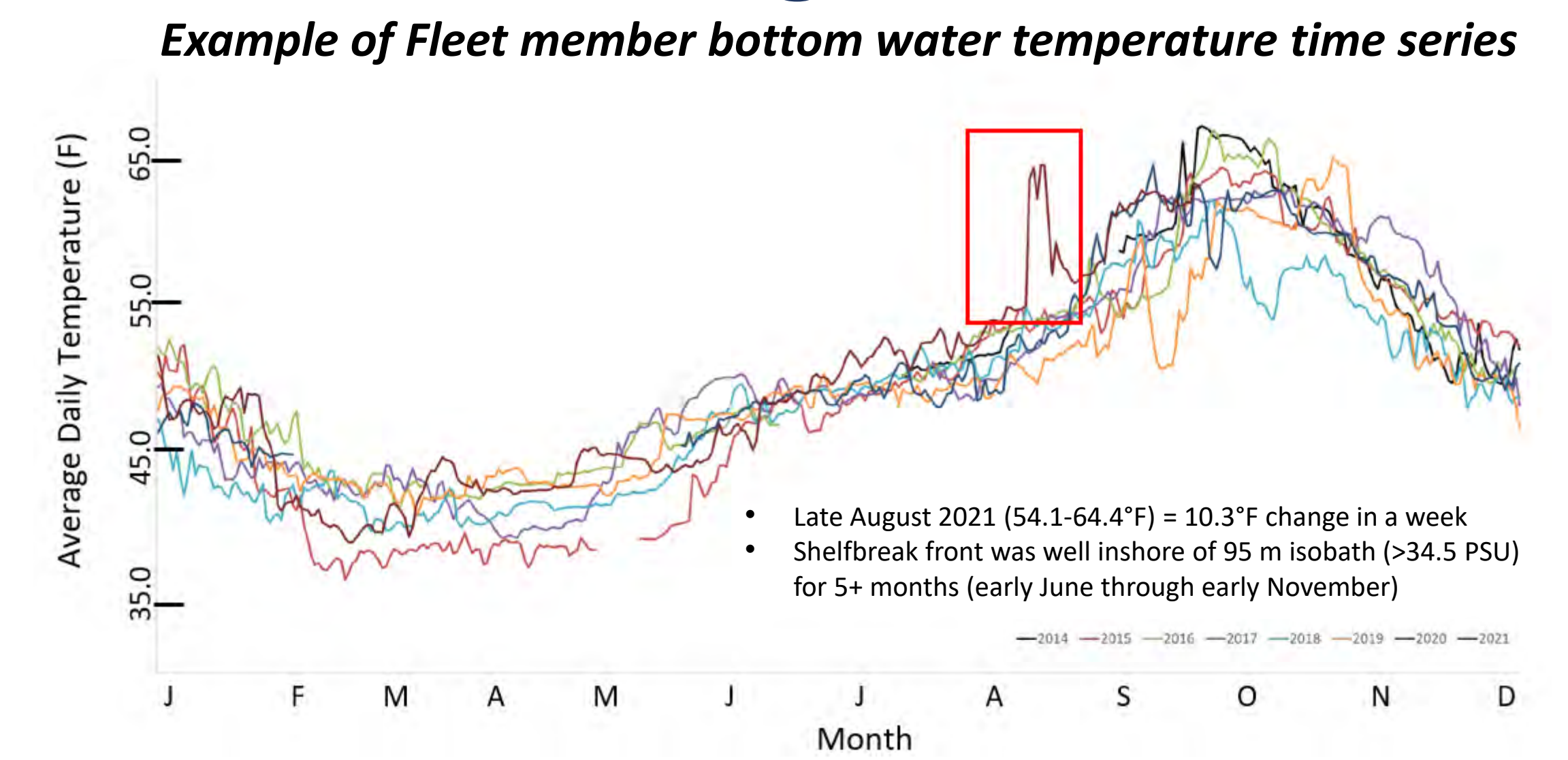


Figure by Aubrey Ellertson.

Successes & Challenges

Successes:

- Lobster data have been incorporated into the stock assessment, and the Jonah crab data will be incorporated in the upcoming assessment in 2023
- Fishermen directly contribute to the management of these highly valuable resources
- These extensive datasets have been utilized in numerous extension projects shown below

Challenges:

- Keeping up with everchanging advances in technology (e.g. loggers) and updates to tablet Operating Systems and connectivity
- In-person vessel support can be time consuming and labor intensive
- Developing quality control procedures on large datasets

Extension Research Projects

Female lobster maturity

- Updated female size at maturity for offshore Southern New England (SNE) and eastern Georges Bank (GB) lobsters
- When compared to historical estimates,
 - SNE did not change
 - GB decreased from 100mm to 92mm

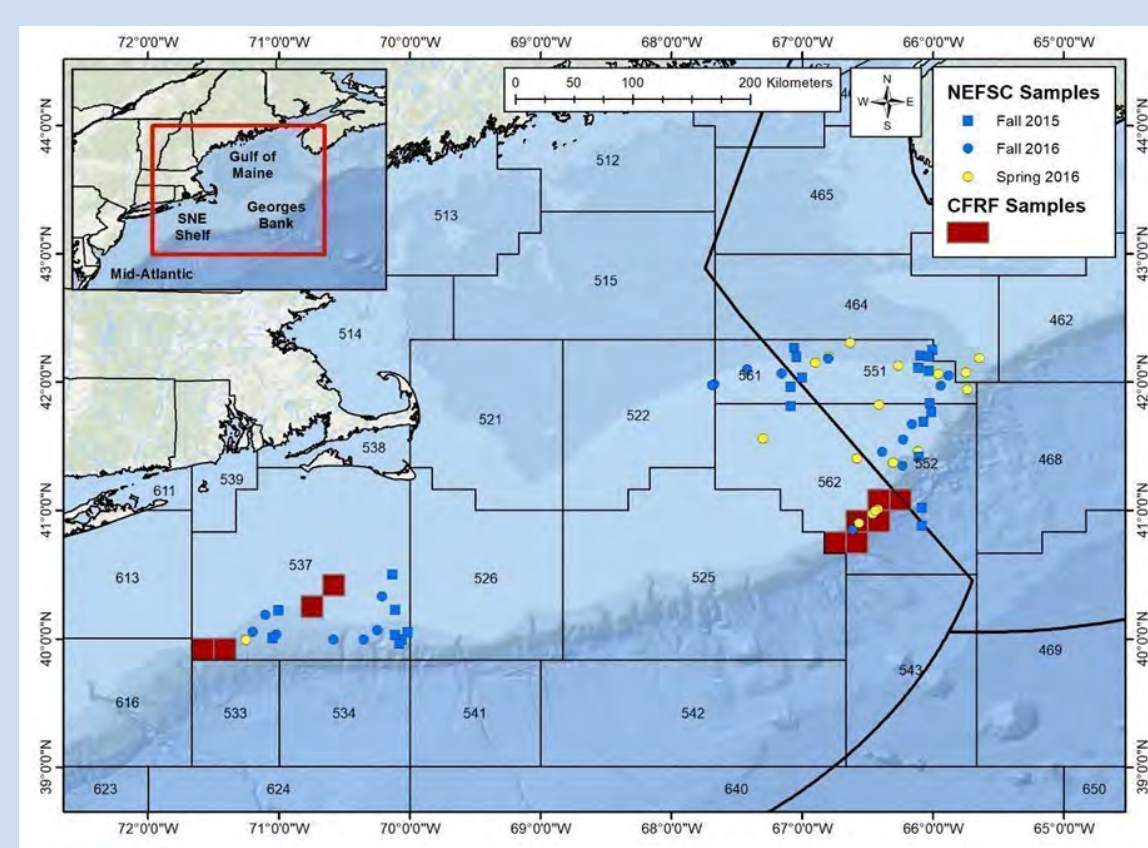
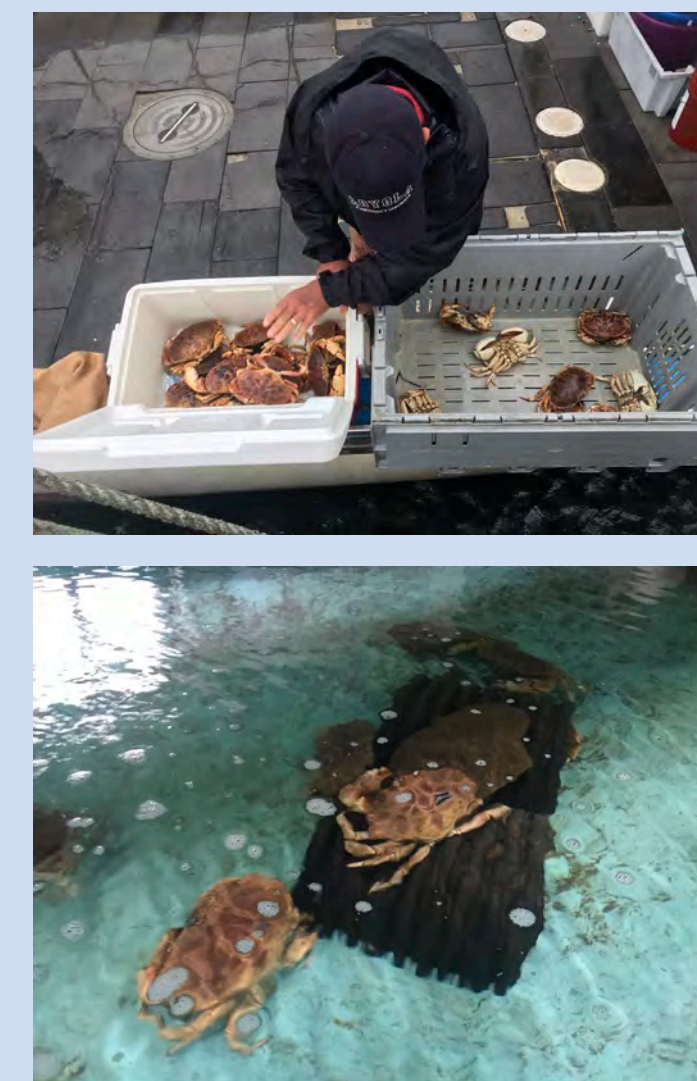


Figure by Aubrey Ellertson.

A.A. Ellertson et al. 2022. Differences in the size at maturity of female American lobsters (*Homarus americanus*) from offshore Southern New England and eastern Georges Bank, USA. Fisheries Research. <https://doi.org/10.1016/j.fishres.2022.106276>.

Jonah crab growth & MSE

- Fleet members provided Jonah crabs to monitor molting events in a laboratory setting with Corinne Truesdale (RI Dept. Env. Management (DEM))
 - Due to weather events, the lab study was disrupted in late 2021
 - A scaled-down version of the study is continuing at the University of RI
- CFRF staff helped support a workshop to engage Jonah crab stakeholders in discussion related to the status of the fishery and potential harvest control rules
 - Management strategy evaluation simulation tools are currently being developed and tested



Captain Jay Swoboda providing crabs for the growth study (top). Jonah crabs at the RI DEM lab (below).

NE Canyons Marine Monument

- The Northeast Canyons and Seamounts Marine National Monument was established in 2016 and restricted commercial fishing
- CFRF analyzed lobster and Jonah crab data collected by the Fleet in the Canyons
 - Area and year had largest effect on lobsters
 - Sex and year had largest effect on Jonah crabs

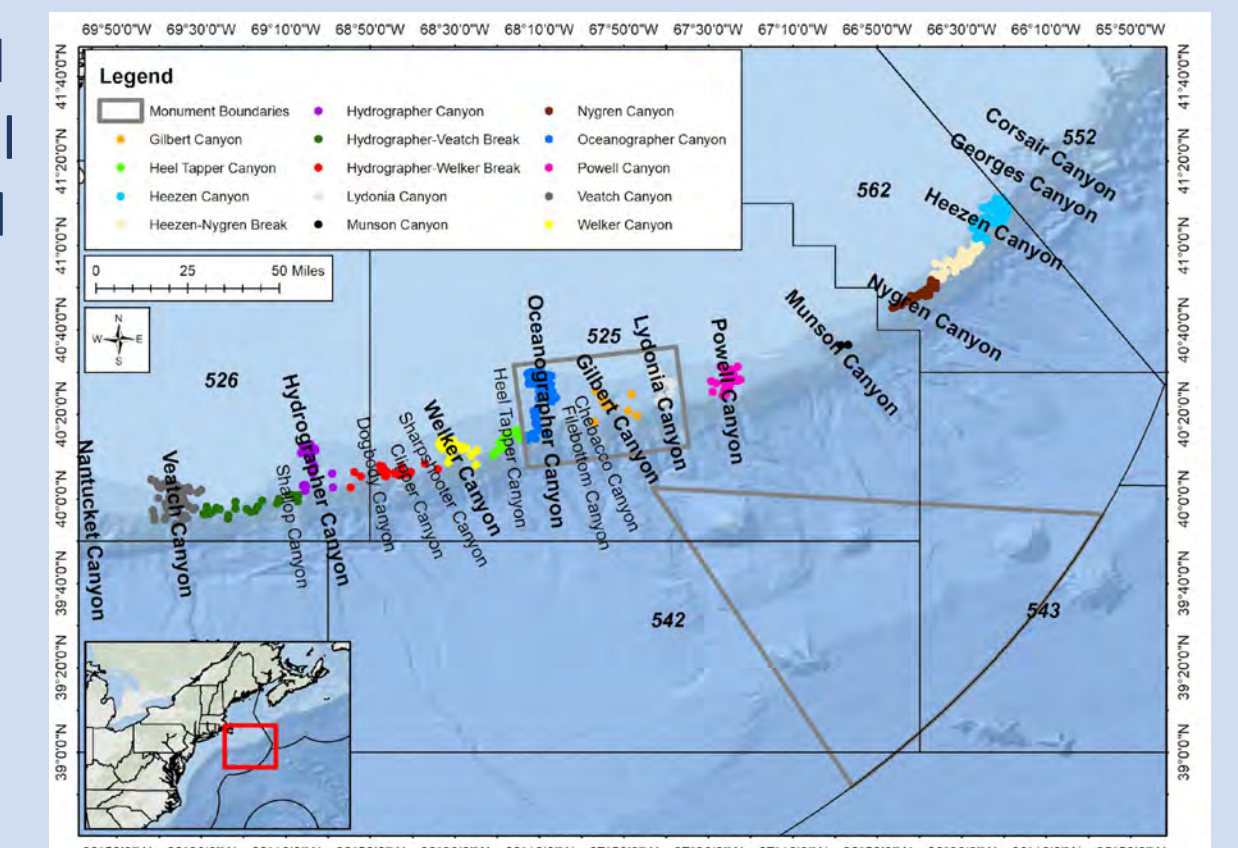
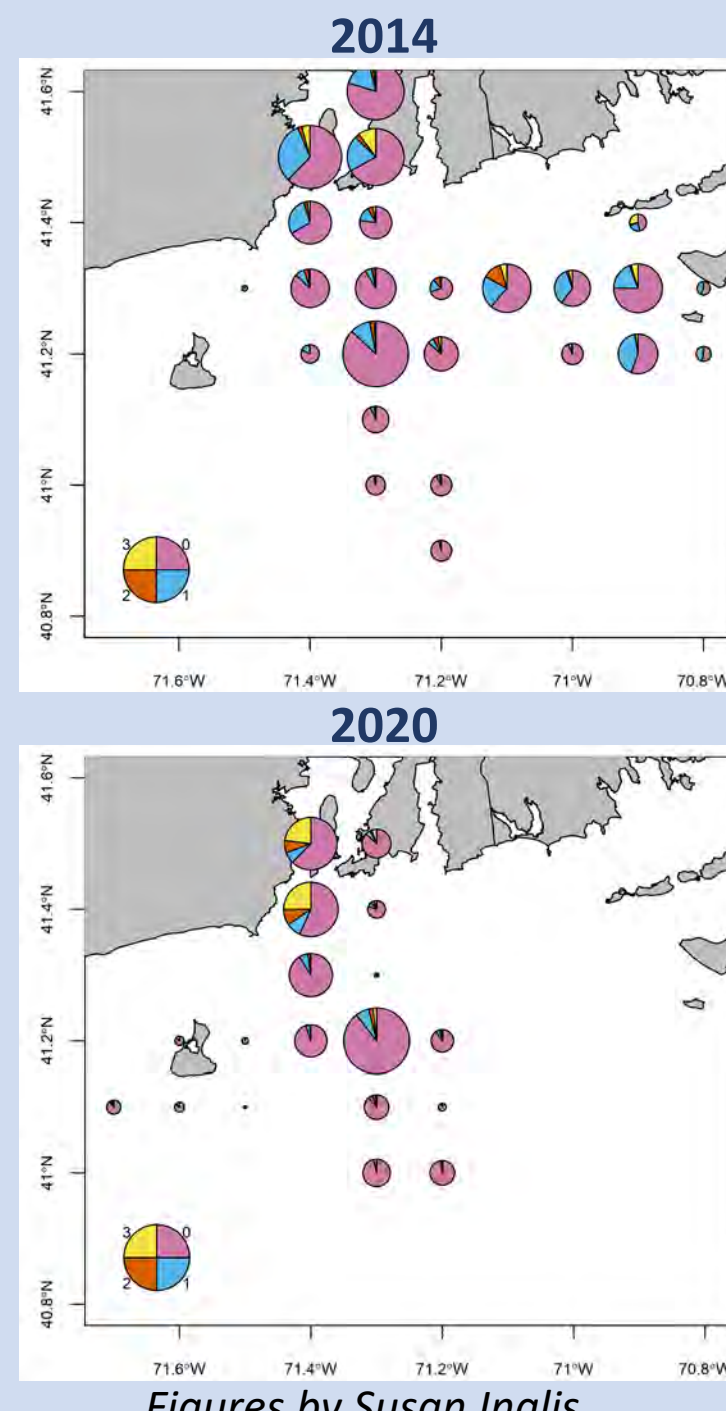


Figure by Mike Long.

S.A. Arnott et al. 2022. Demographics of American Lobster and Jonah Crab populations inside and outside the Northeast Canyons and Seamounts Marine National Monument, USA. Marine and Coastal Fisheries (in review).

Lobster shell disease trends

- CFRF was approached by Fleet members to investigate the apparent increase in shell disease in the juvenile lobsters and in the Narraganset Bay
- On the right, preliminary results comparing lobster shell disease incidence in 2014 and 2020
- Shell disease level is recorded by the Fleet members while at-sea
 - Shell disease scores range from none (0), mild (1), moderate (2), and severe (3).



Figures by Susan Inglis

Lobster spatiotemporal patterns

- Fleet data were analyzed using k-means cluster analyses to investigate potential spatiotemporal patterns and vessel effects
 - Year and statistical areas were significant predictors
 - No vessel effects
- Potential management implications for lobster stock boundaries

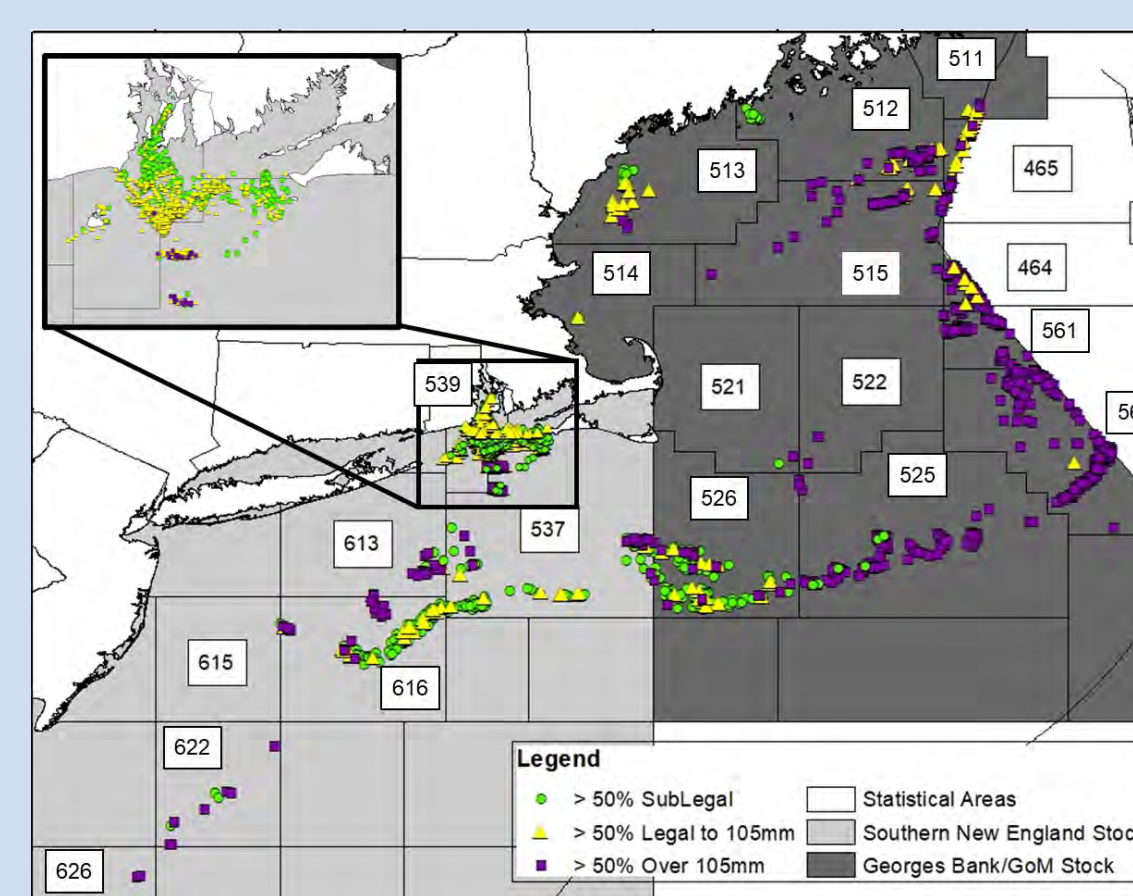
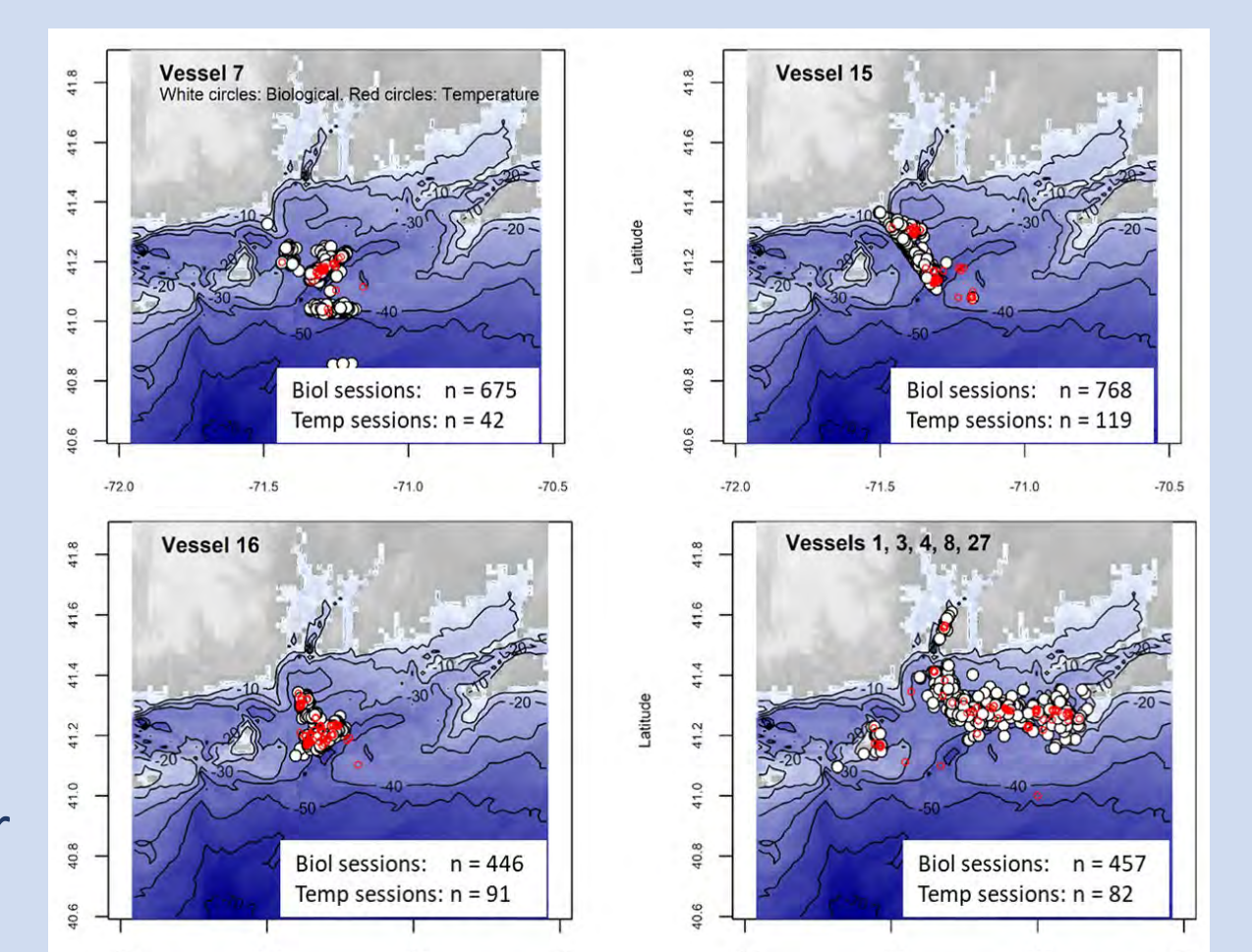


Figure by Carl Huntsberger.

C.J. Huntsberger et al. 2022. Industry reported biological data informs population demographics and commercial fleet heterogeneity for American lobster (*Homarus americanus*). Fisheries Research (in review).

Bottom water temperature

- CFRF collaborates with NOAA and the eMOLT program to create more open access resources
- Fleet temperature data is made available on the NOAA ERDDAP server
- CFRF staff are working to link Fleet biological and temperature data to better understand lobster and Jonah crab dynamics
 - On the right, examples of session type overlap by vessel



Figures by Steve Arnott.