Annual Report
MOU #AM10560 NYS DEC & SUNY Stony Brook
For the period January 1, 2020 – December 31, 2020

New York State Environmental Protection Fund Ocean and Great Lakes Program, NYS DEC

December 31, 2020

The MOU titled, "Development and implementation of an ocean ecosystem monitoring program for New York Bight", between NYS DEC and SUNY Stony Brook School of Marine and Atmospheric Sciences is to develop an interdisciplinary, multi-trophic level-ocean monitoring program in the New York Bight in order to provide information on the status of New York pelagic resources to managers; and to inform the development of a system of indicators of ecosystem health using existing data and observations collected in the offshore monitoring program in order to better inform decision making regionally and locally. This report follows the categories of activities found in the scope of work in that MOU.

Contact Lead Principal Investigator, Lesley Thorne (lesley.thorne@stonybrook.edu) with questions or comments.

Principal Investigators: Lesley Thorne, Assistant Professor; Janet Nye, Associate Professor; Joe Warren, Associate Professor; Charlie Flagg, Research Professor

Report Contributors: Eleanor Heywood, Cetacean and Seabird Technician; Tyler Menz, Carbonate Chemistry Technician; Hannah Blair, PhD Student; Rachel Carlowicz, MS student; Brandyn Lucca, PhD Student; Julia Stepanuk, PhD Student; Mark Wiggins, Operational Facilities Manager; Tom Wilson, Instrument Laboratory

Stony Brook University
School of Marine and Atmospheric Sciences

Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

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Tel: 631-632-3187; Fax: 631-632-8820

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Tel: 631-632-3187; Fax: 631-632-8820

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Tel: 631-632-3187; Fax: 631-632-8820

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Tel: 631-632-3187; Fax: 631-632-8820

Summary of accomplishments

This report covers the time period of January 1, 2020-December 31, 2020. We conducted three seasonal shipboard monitoring cruises in February 2020, June 2020, and October 2020 aboard the R/V Seawolf and the R/V Paumanok to monitor the pelagic ecosystem of the New York Bight (Table 1; Figure 1). During these cruises we completed 91 CTD stations (including 614 CTD water samples), 62 zooplankton tows, 3 fish trawls, 3341 km of fish acoustic survey, and 75 km of line transect survey effort. Our work during this period included implementing new and improved hydrographic data acquisition software on the R/V Seawolf, purchasing a new thermosalinograph, development of a collaboration with Rutgers University and the University of Maine to use ocean gliders to monitor ocean acidification in the Middle Atlantic Bight and the Gulf of Maine, and conducting 2974.5 km of UAV survey effort on the R/V Parker UAV to examine whale body condition. With the continuation of the seasonal cruises, we maintained a presence in the New York Bight and more broadly in the Northeast US, despite scheduling setbacks and a greatly reduced science crew during cruises due to the ongoing SARS-CoV-2 pandemic. The carbonate chemistry technician was trained on the analytical instruments used to analyze water samples collected on cruises, which are crucial to understanding carbonate chemistry at depth. A total of 348 water samples were analyzed for DIC and TA, but travel restrictions have delayed the arrival of the carbonate chemistry postdoc that is needed to complete the setup of the carbonate chemistry lab. Ongoing collaboration and coordination with other glider operators in the area has increased the data coverage of the Mid-Atlantic and broader Northeast US. Within these varied aspects of the program, we have developed and standardized protocols and have trained field staff to collect samples and perform surveys for multiple objectives. We created a Data Management plan to store and share data with the New York State Department of Environmental Conservation and to ensure the highest quality control standards for data as it is processed and analyzed. Finally, we submitted two manuscripts for publication: *Age-specific behavior and habitat use in humpback whales: Implications for vessel strike* is in final review for publication in Marine Ecology Progress Series, and M*arine ecosystem indicators are sensitive to ecosystem boundaries and spatial scale* is in final review in Ecological Indicators**.** Indicators of ocean health have been accumulated and examined. A brief summary of the review of existing data and indicators (Objective 1) is provided. An extensive report was provided in a separate document to NYSDEC in December 2020. The continuation of the offshore monitoring program represents the bulk of work covered in this report (Objectives 2-5).

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Tel: 631-632-3187; Fax: 631-632-8820

Table 1: Summary of sampling effort per cruise. For each cruise the number of trawls, ring net tows, CTD casts, CTD water samples, daily surface seawater samples, acoustic transect effort, and line-transect survey effort are detailed.

Cruise	Dates	Fish Trawls	Ring net Tows	CTD Casts	Water Samples	Surface Water OA Samples	Fish Acoustic Effort (km)	Line-Transect Effort (km)
FEB 2020	04Feb2020-10Feb2020	3	11	14	132	6	1030	75
JUN 2020	02Jun2020-09Jun2020	NA	12	36	62	0	311	NA
OCT 2020	19Oct2020-30Oct2020	NA	39	41	420	8	2000	NA

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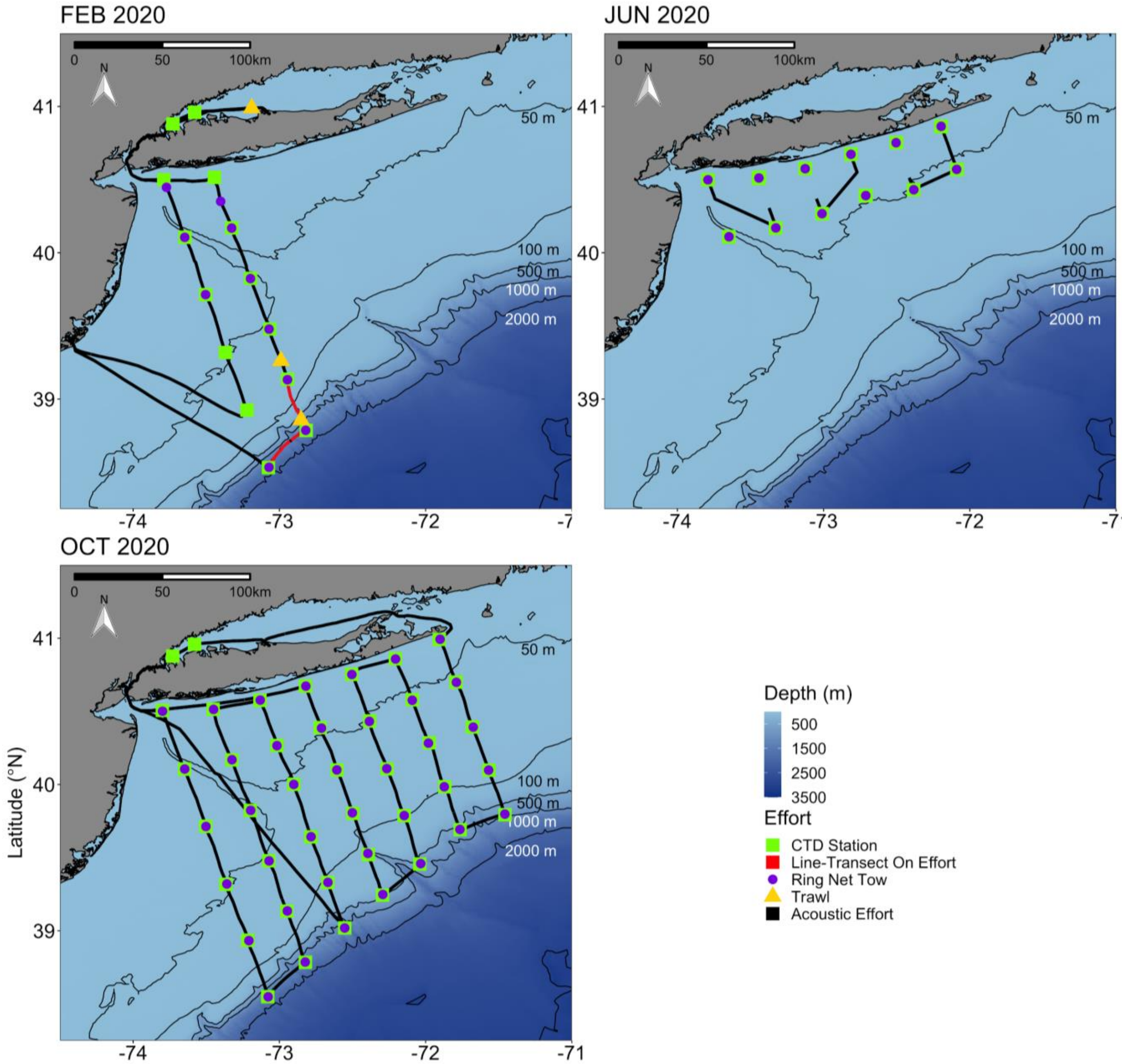

Figure 1: Acoustic effort (black) and locations of various sampling efforts (red: line-transect survey effort; green: CTD locations; purple: ring net tow locations; yellow: trawling locations) for all offshore monitoring cruises completed in 2020.

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Tel: 631-632-3187; Fax: 631-632-8820

Objective 1: Examination of available data and identifying data gaps

A complete indicator report was provided to NYS DEC in December 2020. This report details how we developed a set of criteria and four step process to choose a set of 40 indicators from over 200 potential indicators in the NYB. Of the 40 indicators prioritized, 24 have been completed and trends analyzed, 4 are under development and 12 have been proposed in the near term. An additional 12 indicators could be developed in the long-term with additional resources.

Objective 2: Monitor the physical environment including temperature, salinity, fluorescence, and carbonate chemistry

2.1: Shipboard Measurements of Physical Water Properties

Unfortunately, due to restrictions related to SARS-CoV-2, we were unable to perform a full survey in the spring and summer months. While we were able to compare July 2018 and July 2019 cruises in our past annual report, we could not complete the July 2020 cruise. However, with the completion of all seven transects on the October 2020 cruise, we are able to compare the physio-chemical environment with that seen in October 2019 (Figure 2). In October 2019, the water column was still stratified when we conducted our cruise and the cold pool is still evident. In October 2020, the water column is mixed and surface waters are not as warm. This is especially prevalent offshore where Figure 2 shows larger areas of warm colors that represent both warm and salty water. Dissolved oxygen in October 2020 sees a larger area of low oxygen at depth, depicted by blue and purple colors compared to October 2019. These interannual differences highlight the importance of monitoring.

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Tel: 631-632-3187; Fax: 631-632-8820

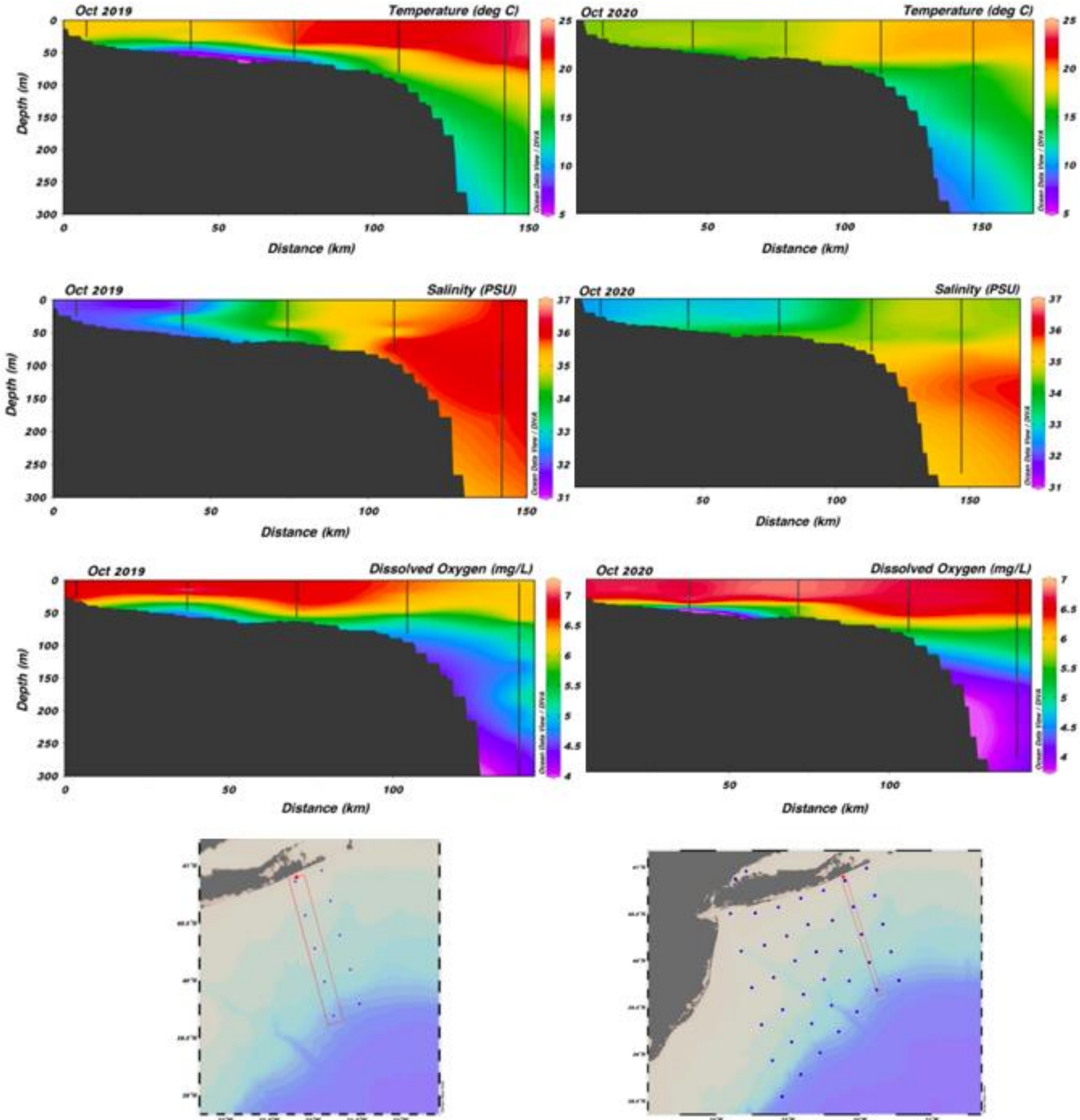

Figure 2: Temperature (°C), salinity (PSU), and dissolved oxygen (mg/L) on Transect 2 from October 2019 and October 2020. The bottom panels indicate the locations of CTD stations for each cruise.

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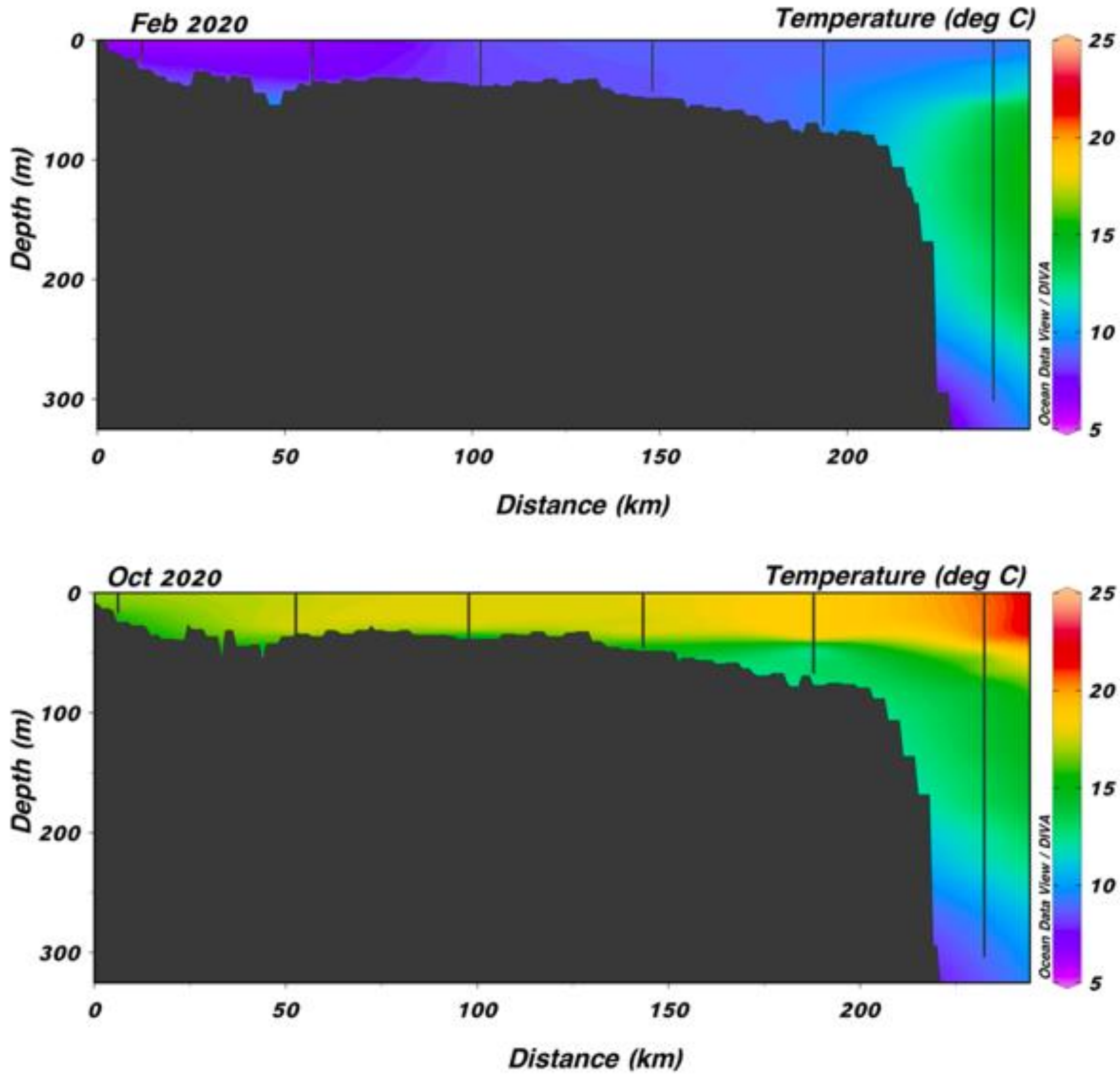

Figure 3: Seasonal profiles of temperature for transect 7 in February 2020 and October 2020.

2.2: Carbonate Chemistry

During this period, 324 water samples from the July 2018 cruise were analyzed at the NOAA NEFSC Lab in Milford, CT for dissolved inorganic carbon (DIC) and total alkalinity (TA). These data were then used to compute carbonate chemistry variables such as pH and aragonite saturation states. Aragonite saturation is important to assess water quality for shell-forming organisms like surf clams and scallops. Most calcifying organisms require well-saturated water in order to build and maintain their shells. The lower the saturation state, the less available calcium carbonate is for organisms to utilize. Saturation states above 1 indicate the water is well saturated with respect to aragonite. Aragonite saturation states approaching 1 can be stressful

Stony Brook University
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Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

to these organisms while saturation states less than 1 indicate the water is under saturated with respect to aragonite.

In July 2018, calculated surface pH was generally higher than the calculated bottom pH (Figure 4). Bottom pH is lowest inshore near Shinnecock Inlet and along the western edge of the sampling area within the Hudson River plume area. Surface pH does not have the same low area along the western edge but does have an area of low pH inshore, though in a different spot than the low pH region at depth. The spatial pattern in aragonite concentration for the surface and bottom waters are similar to the pattern in pH values with lower pH values corresponding with lower saturation values.

Saturation states in the NYB are generally super-saturated with respect to aragonite. Figure 5 shows the calculated aragonite saturation states in the NYB from July 2018 for surface and bottom water. The surface waters are supersaturated (greater than 1) with respect to aragonite while bottom waters consistently have lower saturation states, but only one station near Shinnecock inlet is undersaturated with respect to aragonite and has very low pH. These figures indicate that bottom water is potentially acidic and corrosive to organisms. Once water samples from additional cruises are completed, we can evaluate the seasonal dynamics in carbonate chemistry and aragonite saturation states.

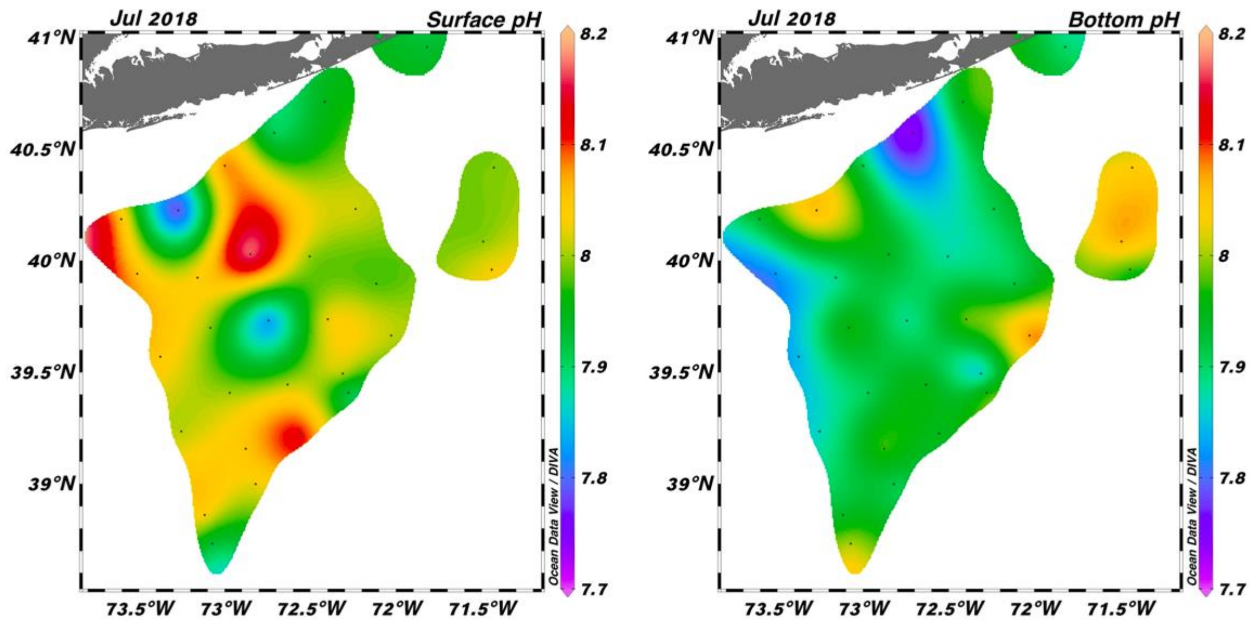

Figure 4: Calculated surface and bottom pH from July 2018.

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Tel: 631-632-3187; Fax: 631-632-8820

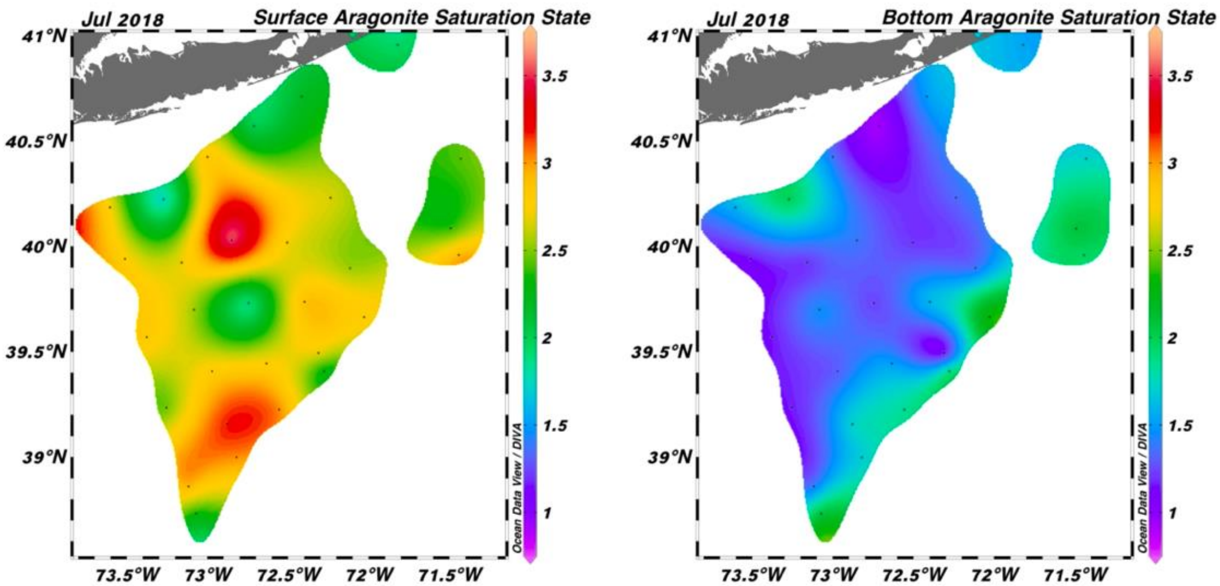

Figure 5: Calculated surface and bottom aragonite saturation states from July 2018.

Using pCO_2 and pH measurements collected simultaneously on RV Seawolf cruises, we have analyzed the seasonal dynamics of carbonate chemistry in NY coastal waters including the Long Island Sound (LIS). The surface pH values (on the total hydrogen scale) ranged from mean pH of 7.89 ± 0.15 in LIS and NYB inshore to mean pH of 8.03 ± 0.10 in NYB offshore in 2019. The vast areas of offshore waters of the NYB had pH values ranging from 7.99±0.02 during the warmer months to 8.12±0.02 during the colder months, a 25% change in the $[H^+]$ ion concentration from seasonal changes in productivity, temperature, and other factors (Figure 6, top panels). Surface waters of the NYB were consistently supersaturated with respect to aragonite (Figure 6, middle panels).

Using pCO_2 and pH parameters we calculated the Revelle Factor (γDIC), which is a measure of the ocean's buffer capacity and is defined as the ratio between the change in pCO_2 to the change in DIC at constant temperature, salinity, and TA. The buffering capacity of seawater is important to quantify because it is a measure of the ability of seawater to resist changes in pH from the addition of anthropogenic CO_2 from the atmosphere. Water bodies with a high buffering capacity are very efficient at mitigating changes in [H+] and will see a smaller change in pH compared to water bodies with low buffering capacity. The buffering capacity indicates how resistant different water bodies are to ocean acidification. The larger the Revelle factor (γDIC), the higher the buffering capacity of seawater.

In 2019, γDIC was highest in the offshore waters of the NYB in every season while the lowest γDIC were observed inshore and in the Long Island Sound (Figure 6, bottom panels), indicating that Long Island Sound waters are less resistant to increased atmospheric CO_2. Seasonally, the highest buffering capacity was seen in winter in the offshore NYB waters and the lowest buffering capacity was in inshore waters in the warmer months. These patterns are consistent with physicochemical principles and the measurements

Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

herein provide baseline quantitative values to the baseline carbonate chemistry dynamics in NYB that can inform water quality management in the future.

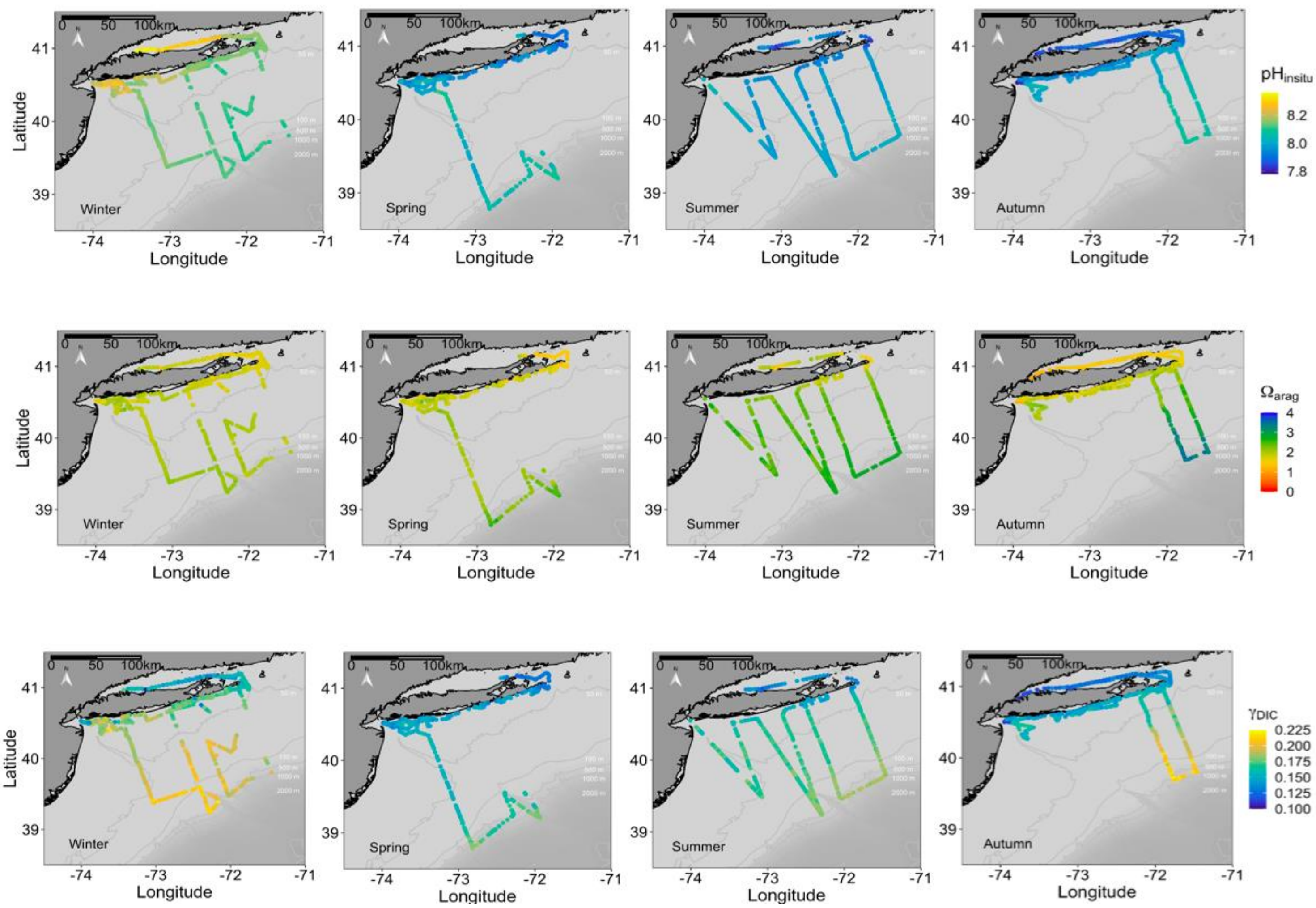

Figure 6: Seasonal maps of surface pH, aragonite saturation states, and surface γDIC, an indicator of the ability of the ocean to buffer changes in [CO2] as it rises in the atmosphere. Blue colors indicate low buffering capacity and are consistently inshore waters.

2.3: Glider Operations

Glider operations for the past year have been pretty much on hold primarily because the payload bay which was sent for repair in January only came back in late November due to a hold-up on paying the invoice from Webb Research. Even if the payload bay had been back, the general shutdown due to COVID-19 prevented access to vessels for deployment and retrieval until the fall.

One thing that did happen this past year was the development of a project in conjunction with Rutgers University and the University of Maine to use ocean gliders to monitor ocean acidification in the Middle

Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

Atlantic Bight and the Gulf of Maine. This project is funded by NOAA, through a subaward from Rutgers, which will equip three gliders with Sea-Bird Instruments CTD/pH sensors for deployment in the Bight. This ocean acidification monitoring effort will make use of the already planned seasonal Ocean Indicators deployments while expanding the list of variables that will be monitored. The CTD/pH sensor was purchased in the spring and installed while the payload bay was still at Webb Research. The original CTD sensor now acts as a spare.

With the return of the glider's payload bay, the glider was reassembled and has been undergoing the checkout procedure in preparation for a February deployment. The deployment will be coordinated with the next Ocean Indicators cruise and the deployments from Rutgers and University of Maine. Assuming that COVID-19 will be in some sort of retreat this coming year we expect to resume the seasonal deployments coordinated with the Ocean Indicator cruises.

Ocean Glider Data Processing and Analysis:

As discussed in previous progress reports, the near real time data that are telemetered ashore are processed and made available through the Rutgers supported ERDDAP glider DAC system (http://slocum-data.marine.rutgers.edu/erddap/info/index.html). The post deployment data processing and QA is done using a modified system built upon one developed by WHOI (Robert Todd) and BIOS (Ruth Curry). The results from that system save the processed data in large Matlab matfiles which are easy to use but not universally accessible. Work is underway to convert those matfiles into the netcdf format of the US glider DAC which makes the data available to the wider user community through the ERDDAP system. However, the routine to do the conversion while adhering to the Netcdf CF and ACDD Conventions and Metadata is a rather heavy lift and thus is still in progress

Early analysis of the glider data has focused on two areas. The first is to use the glider results to determine the tidal and residual velocities over the shelf. The second is to use the glider hydrographic data to study the collapse of the seasonal stratification and the erosion of the cold pool.

The glider's speed through the water is well modeled using compass heading, pitch and depth changes. We have used those data for the fall cruise, SBU01_02, to compute the glider's speed through the water which when combined with the glider's distance made good during each underwater segment, produces an estimate of the vertically averaged water velocity (Figure 7a). Those results can then be used to estimate the tidal velocities over the shelf which in turn can be used to determine the residual non-tidal velocitiesFigure 7b). The non-tidal velocities appear much smoother than the raw velocities but, since the glider takes many days to traverse the shelf, those velocities reflect the synoptic scale variations in the shelf currents which impact and reflect the variability in shelf water properties. Additional spatial or temporal averaging could be used to extract the longer-term mean currents across the shelf.

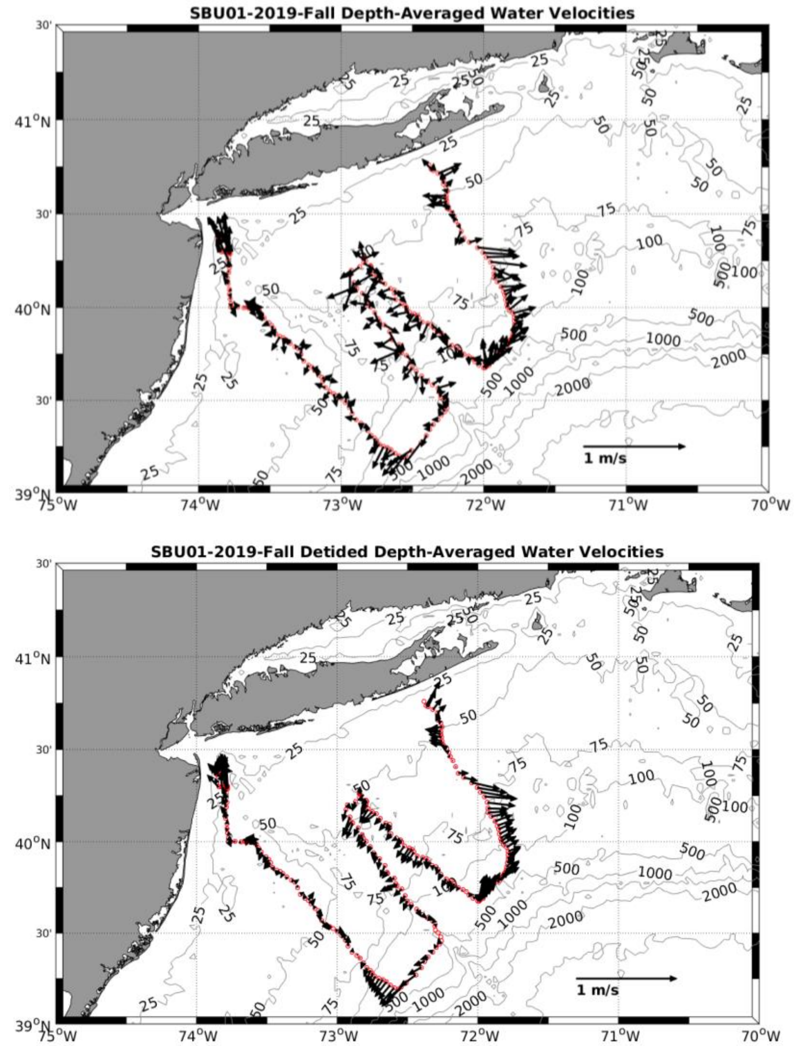

Figure 7: a) Vertical mean water velocities during the fall 2019 deployment, b) Mean water velocities with tidal effects removed.

A major and ecologically critical feature of the Middle Atlantic Bight is the cold pool, the band of remnant winter water trapped below the seasonal thermocline which supplies nutrients to the euphotic zone and a needed temperature refuge for demersal and pelagic fish. As a result, the cold pool's establishment in the spring, structure and distribution during the summer, and decay in the fall are all of special interest and a focus of the glider program. Here we describe an event during the fall 2019 glider deployment, SBU02_02, when a large wind event served to partially mix the water column during one of the glider's cross-shelf transits. For comparison, Figure 8 shows the vertical structure of the shelf hydrography during the summer of 2019 when the cold pool showed the coldest, most saline and densest waters at mid-shelf between the 40 and 60 m isobaths. The thermocline/pycnocline was the most intense at around 15m depth.

Stony Brook University
School *of* Marine and
Atmospheric Sciences

Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

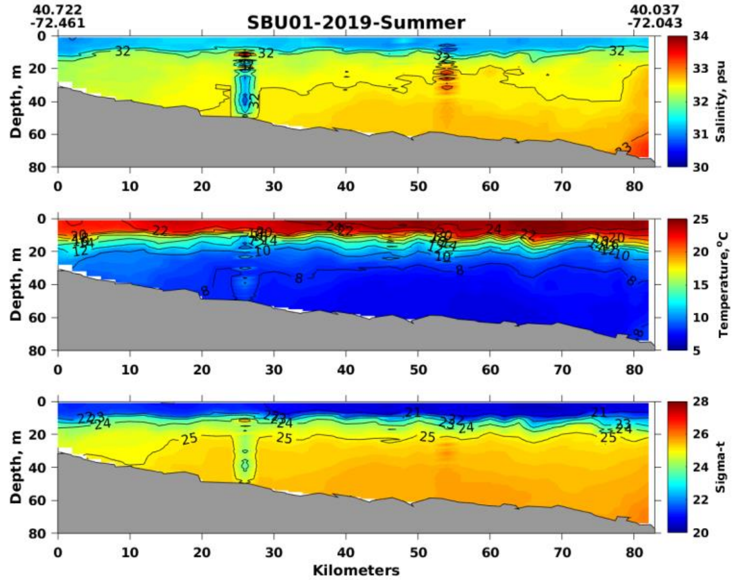

Figure 8: Salinity, temperature and density sections from the summer 2019 deployment.

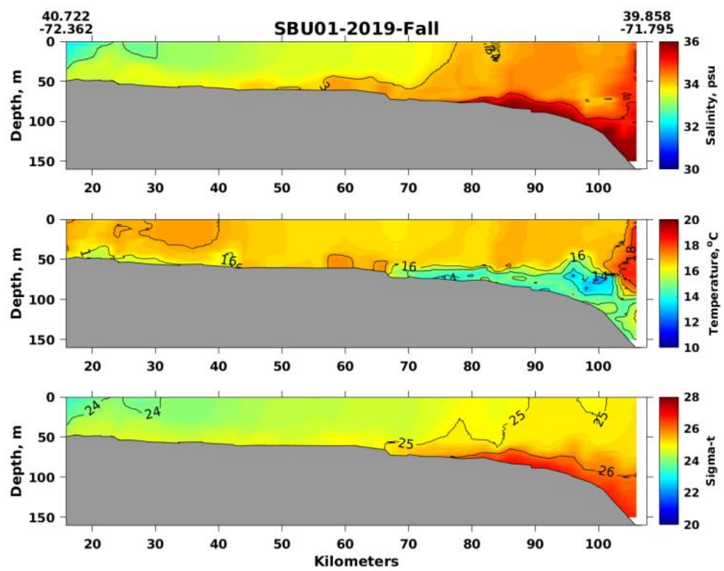

Figure 9: Salinity, temperature and density sections from the fall 2019 glider deployment.

The first transit of the fall deployment traversed nearly the same line as the summer section shown in Figure 8. The cold pool is formed in the spring when storm activity decreases and surface heating from solar insolation is sufficient to overcome the vertical mixing from winds, tides and internal motion. In the fall, as solar insolation decreases and wind mixing increases the cold pool begins the fall overturning by which surface temperatures decrease and bottom temperatures increase. By October 15th and the beginning of the

Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

fall glider deployment, the cold pool's fall transition was already well underway but there was still some residual stratification remaining. This stratification was undergoing increased erosion during the glider transit due to a wind event that lasted four days with peak winds at the nearby NDBO buoy 44025 of 20 m s^{-1} (~40 kts), initially from the northeast and then from the west as the front passed through.

The fall's erosion episode is examined here using the glider's hydrographic data collected during the transit that show the changes in stratification and water properties as the storm passed overhead. Figure 9 shows the same parameters as shown in Figure 8, but for the fall. It shows that the stratification over the inner shelf has decreased substantially from that of the July/August period such that surface temperatures have decreased from ~25ºC to ~17ºC while near bottom temperatures have increased from~8 ºC ~16 ºC. The storm started after the glider had traveled about 40 km into the section and its impact is reflected in the reduced stratification over the middle of the section. We can examine the destratification process more closely by looking at the timing of the storm, the mechanical energy imparted on the water and the changes in the potential energy anomaly (Burchard and Hofmeister, 2008) as shown in Figure 10. The horizontal axis is time covering the entire section shown in Figure 9. The top panel shows the work, proportional to the cube of the wind speed, being done by the storm on the water. It is the work of the wind on the water that both accelerates the water and produces the vertical shear. It is the shear stress that has to overcome the stability imparted by the stratification in order to destratify the water column. The lower panel shows the Brunt Vaisala frequency distribution that highlights the stratified portions of the water column. As the storm builds the well-mixed portion of the water column deepens from ~20 m to ~40 m over a period of about a day. The depth of the mixed layer remains at about 40 m as the glider heads offshore and even into the regime of the shelf-break front. The potential energy anomaly shown in red in the upper panel indicates an initial increase as the storm begins but then decreases as the glider moves offshore where there was near bottom stratification from the saline waters of the shelf-break.

This is just the first attempt at monitoring and understanding the details of the seasonal demise of the cold pool. As more glider deployments continue in the future we will get a better and clearer picture of the process as well as the development of the cold pool in the spring.

Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

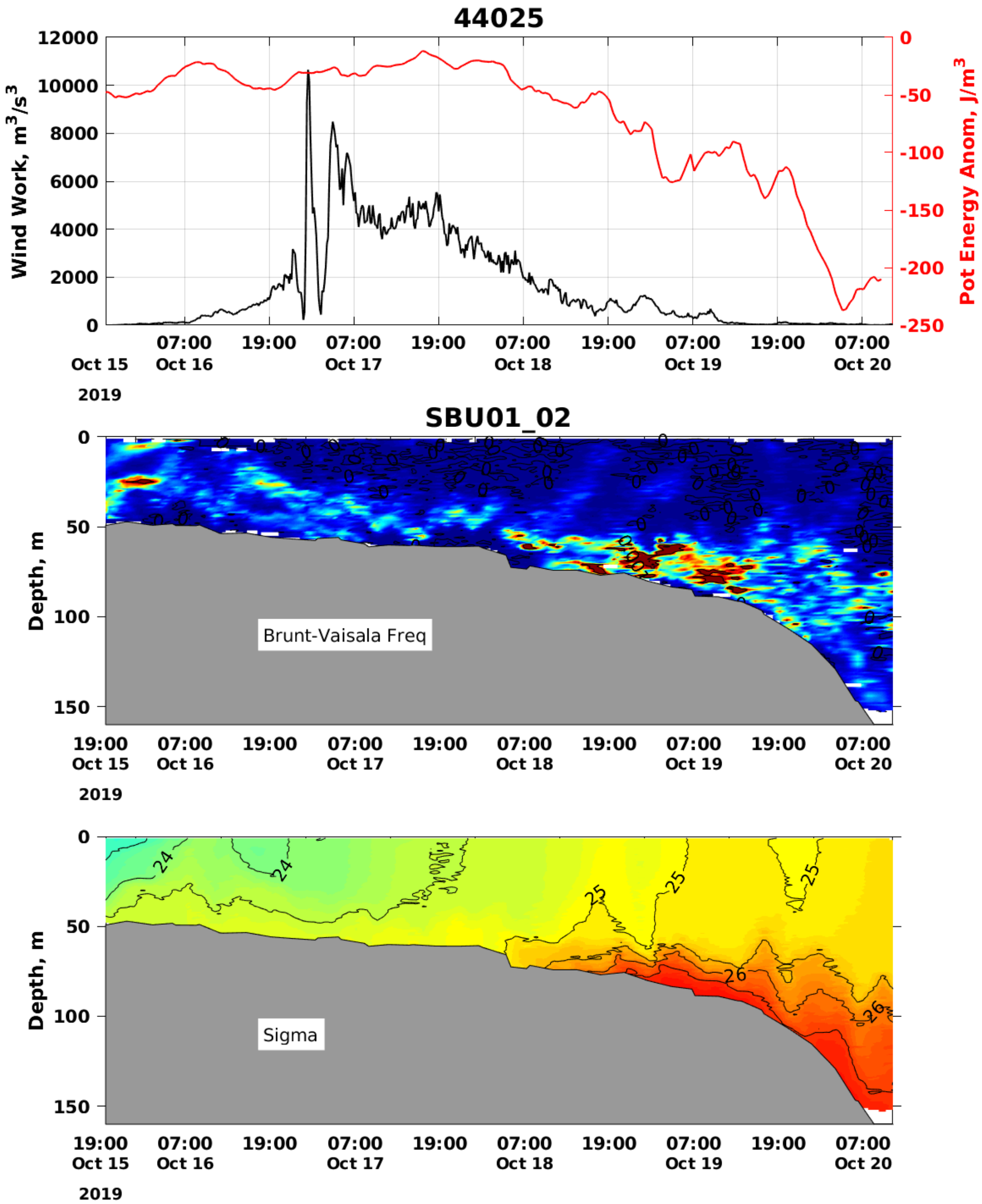

Figure 10: Temporal plots of wind work, potential energy anomaly and Brunt-Vaisala distribution along the fall 2019 glider transect.

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Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

Objective 3: Characterize lower trophic level productivity

Zooplankton ring net tows occurred at hydrographic stations during each research cruise. For all 2020 cruises, net tows were conducted at every hydrographic station, day or night, instead of a subset of stations. The net (60 cm diameter, net mesh 333 μm) is hauled vertically from a depth of 25 m to the surface. The biovolume of the catch is measured, then each sample is preserved in jars fixed with 10% formalin, 90% seawater.

Samples are taken back to the lab where a subsample of organisms are identified (to species level when possible), enumerated, and photographed (Figure 11). The lengths of a subset of the most common organisms are recorded. These data are then used to produce estimates of the numerical abundance of different species (# of animals / m3) at each sampling station (Figure 12). Sample analysis has been completed for the July 2018 (10 stations), February 2019 (9 stations), and May 2019 (10 stations) cruises and partially for the July 2019 (10 of 12 stations) and October 2019 (3 of 12 stations) cruises.

The most abundant organisms represented in samples processed thus far are copepods, amphipods, chaetognaths, and cladocerans. Other organisms found frequently include gelatinous zooplankton (ctenophores, siphonophores, medusa), pteropods, decapod larvae, and larval fish.

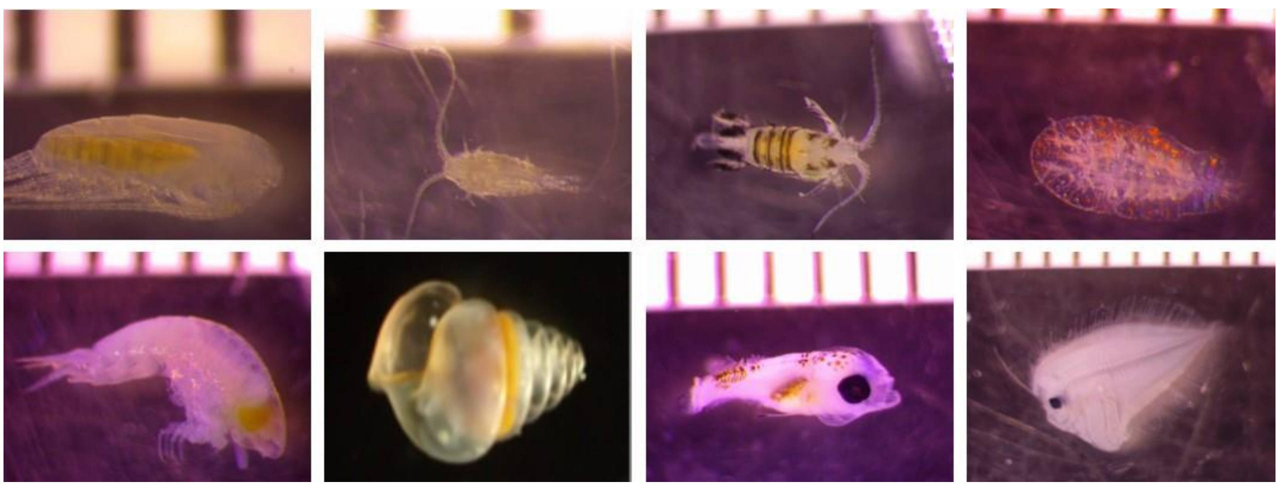

Figure 11: A wide variety of zooplankton and larval fish caught in the ring net tows. Some of these include copepods (top row, left to right: *Calanus finmarchicus*, *Centropages typicus*, *Candacia curta*, *Sapphirina* sp.), amphipods (bottom left), pteropods (bottom, second from left), and fish larvae (bottom right, families Phycidae, red hake, and Pleuronectidae, flatfish). Ruler gradations are 1 mm.

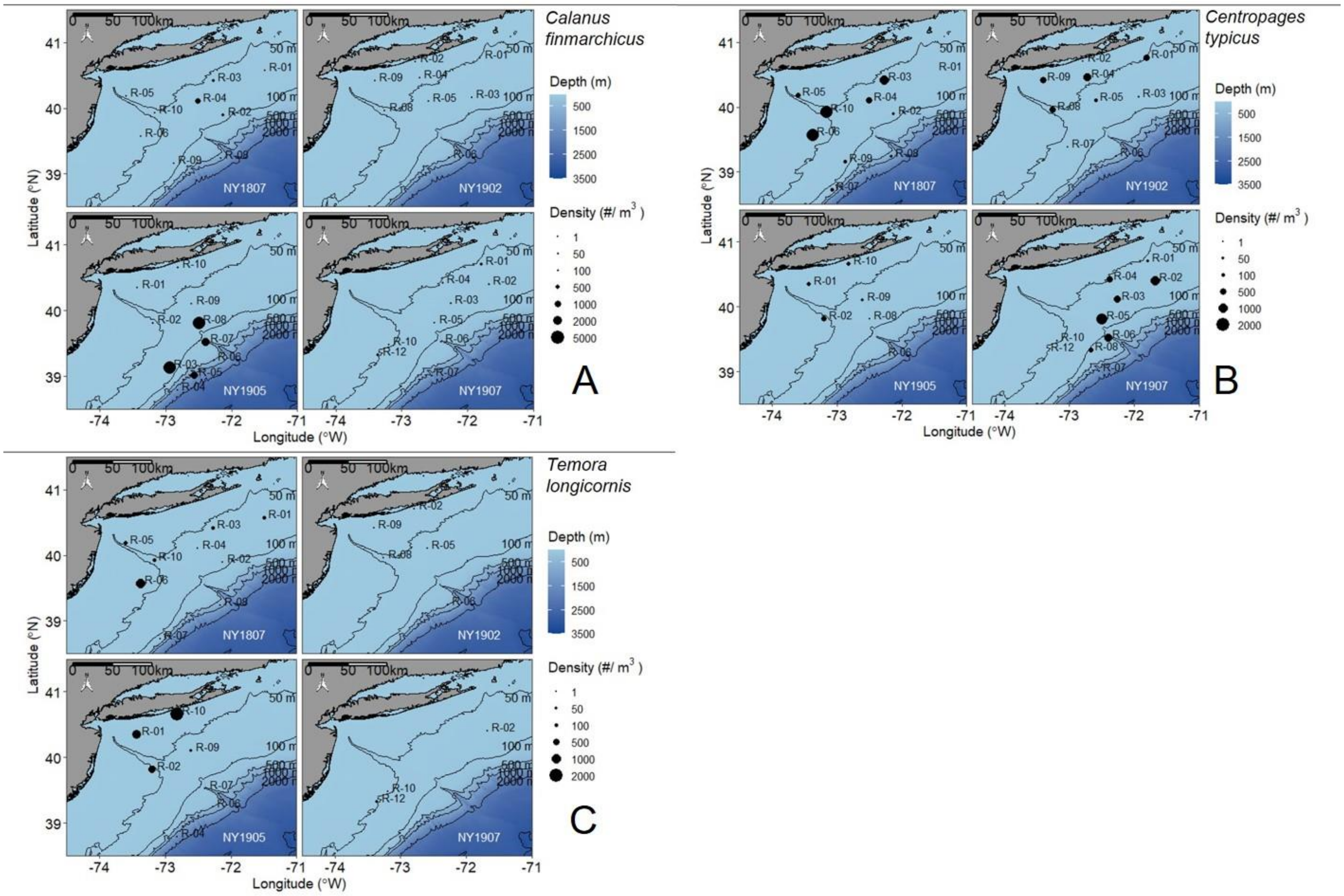

Figure 12:The three most abundant copepod species demonstrate different spatial patterns of abundance seasonally in the NY Bight. *Calanus finmarchicus* (A) and *Temora longicornis* (C) populations are both highest in May (May 2019 cruise), but *C. finmarchicus* is found more on the outer shelf while *T. longicornis* numbers are higher inshore. In contrast, *Centropages typicus* (B) numbers are lowest in May (NYOS1905), and highest in July (July 2018 and 2019 cruises - NYOS1807 and NYOS1907 respectively).

Objective 4: Quantify abundance and distribution of pelagic fishes and squid in the New York Bight.

Multiple-frequency (38, 70, 120, and 200 kHz) scientific echosounders are used to record the backscatter from pelagic fish and squid from a few meters below the surface to the seafloor continuously during each survey (Figure 13). Acoustic surveys are widely used throughout the world to assess fish stocks and in conjunction with net trawl ground-truthing this method can provide quantitative measures of distributions of pelagic fish and squid abundance. Acoustic backscatter measurements are processed to remove noise and scattering from non-biological sources (mostly bubbles near the surface produced by wind and waves). The backscatter at each individual frequency is then integrated both horizontally and vertically (Figure 14) producing a measure of the Nautical Area Scattering Coefficient (NASC) which is proportional in many cases to organism biomass. These processed data then allow for seasonal and geographic comparisons across the different cruises (Figure 15). Fish with swimbladders scatter sound differently than non-swimbladdered fish or crustacean zooplankton. These differences can be exploited by combining information from two or more frequencies to identify and discriminate backscatter caused by swimbladdered fish or other scatterers (Figures 13, 15).

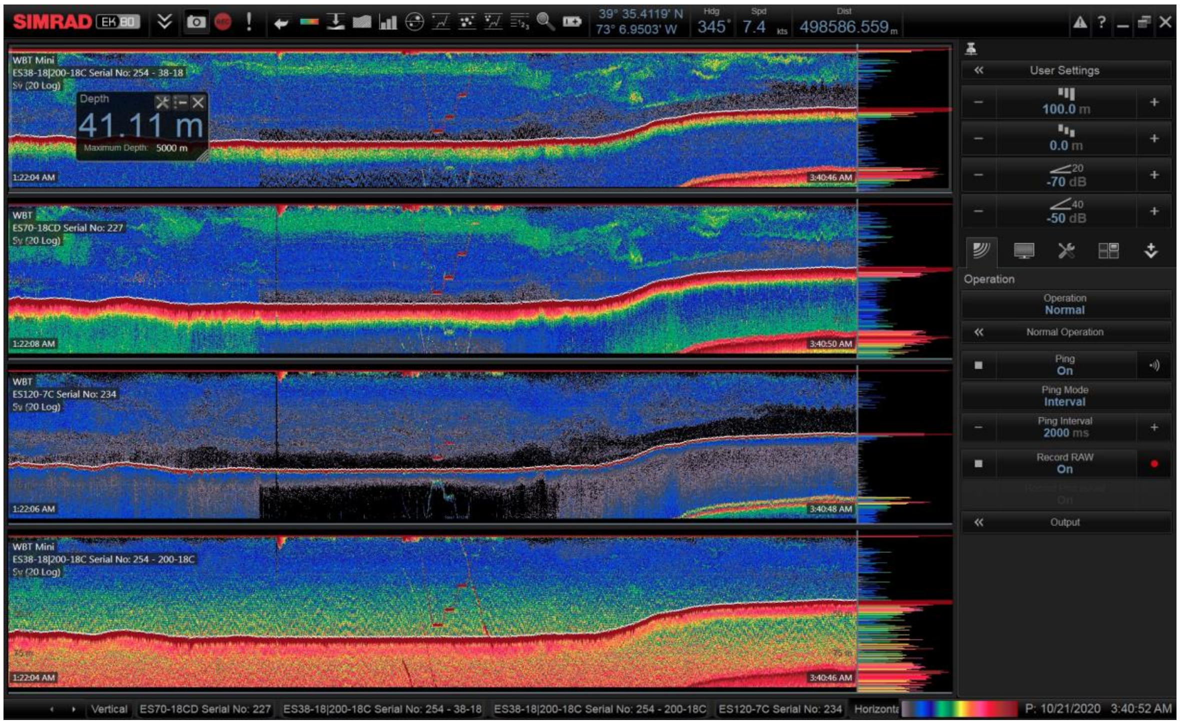

Figure 13: An echogram from the October 2020 RV Seawolf survey shows aggregations of small fish and other scatterers in the water column. These data were collected during a CTD deployment (i.e., the thick red lines that appear in the water column are reflections from the CTD itself). The vertical axis shows depth, horizontal axis shows time, and color corresponds to how much backscatter occurred. Using multiple frequencies (38, 70, 120, and 200 kHz from top to bottom, respectively), these data can provide detailed information on the location and, in some cases, identity (e.g., fish versus zooplankton) of scattering layers. One distinct advantage of the acoustic data is the high resolution in both the horizontal (meters) and vertical (10s cm) dimensions allowing for fine-scale structures to be observed.

Stony Brook University
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Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

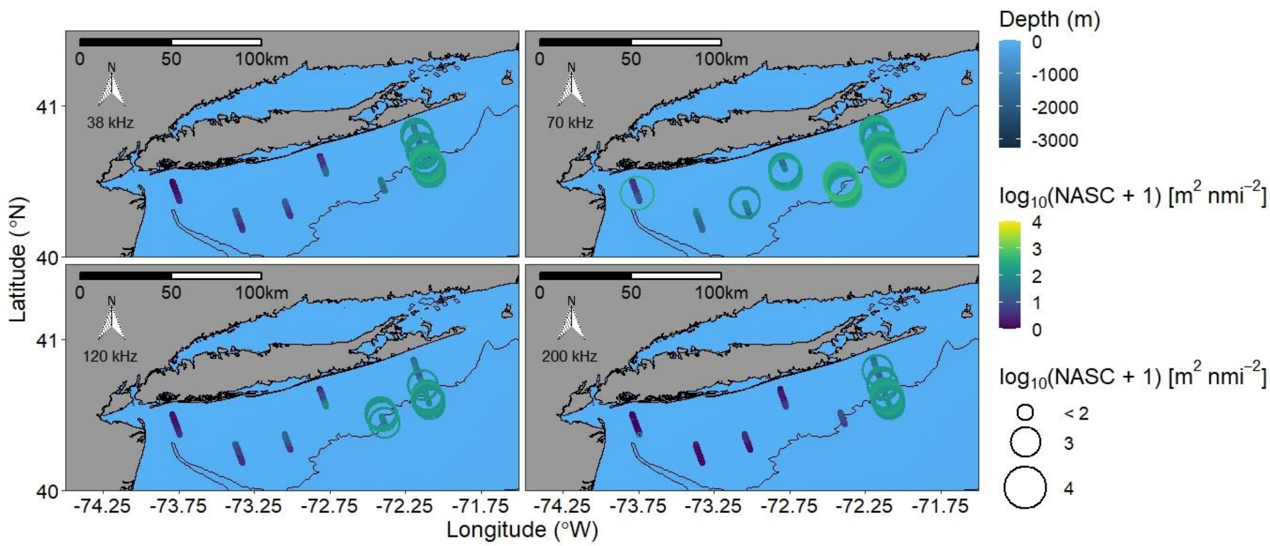

Figure 14: Fishery acoustic surveys produce spatial maps of NASC (Nautical Area Scattering Coefficient, m2 nmi-2). Here each panel represents NASC for a different frequency for the June 2020 survey. The color and size of each circle are scaled to how much backscatter occurred at that location. For many species of interest, NASC (at a specific frequency) will be proportional to animal biomass with lower frequencies (38 and 70 kHz, top panels) a better measure of swimbladdered fish and higher frequencies (120 and 200 kHz, bottom panels) a better measure of non-swimbladdered fish and/or zooplankton. These maps can be used to identify areas where pelagic fish and zooplankton regularly occur, which can be useful for marine planning purposes.

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Tel: 631-632-3187; Fax: 631-632-8820

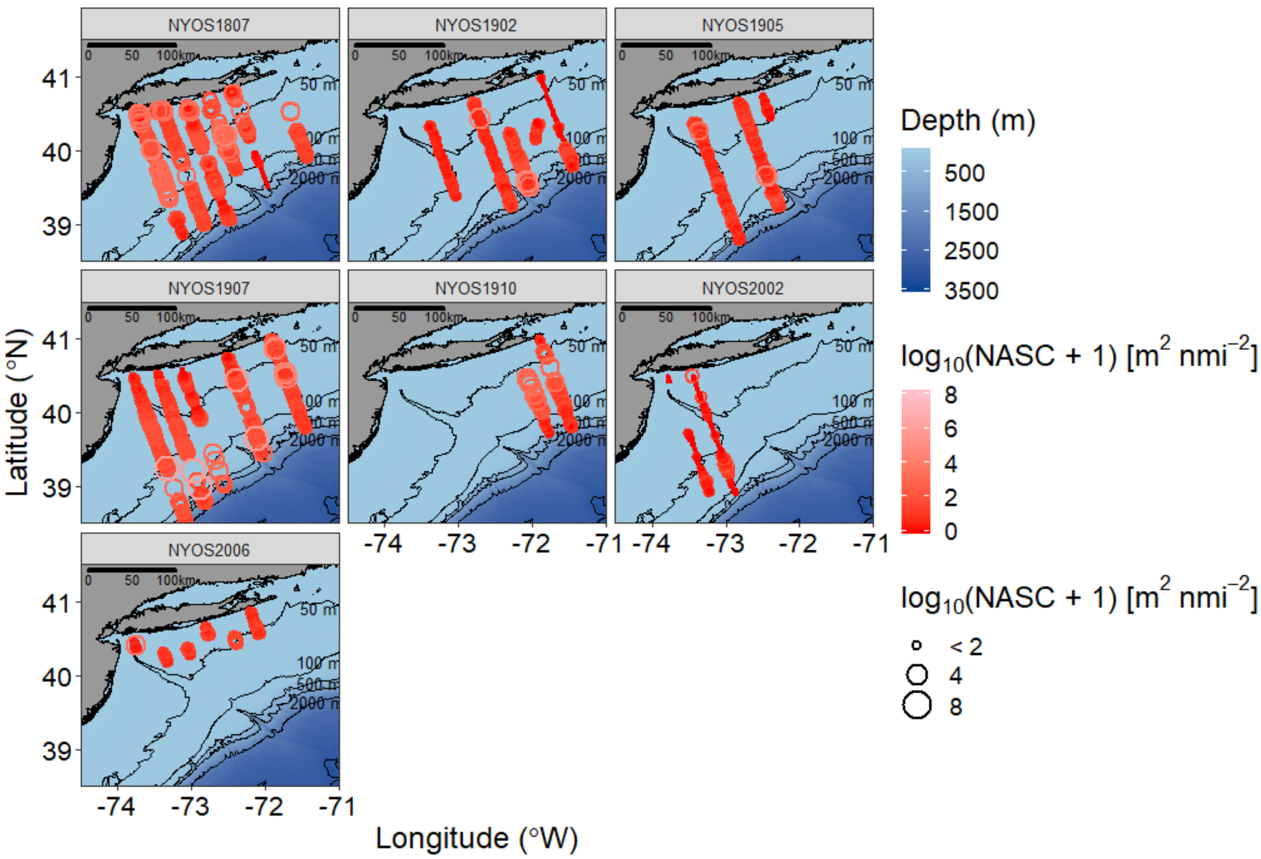

Figure 15: Multiple-frequency acoustics allows for the identification and discrimination of scattering from different trophic levels of the pelagic system. Preliminary analysis identifies backscatter that is likely from swimbladdered fish which can then be used as a proxy for fish biomass and compared across the different cruises to examine seasonal and spatial distributions. One complicating factor (seen above) is that survey coverage is not equal for all cruises (October 2020 cruise data is still being processed and is not shown). The goal of this analysis (which is still in progress and thus preliminary) has the goal of providing an index of biomass for multiple trophic levels (e.g. small zooplankton, large zooplankton, forage fish) in the New York Bight.

It can be challenging to quantify the acoustic scattering contributions from different types of fish, especially when they are co-located so regular fish trawls are conducted during the cruises when aggregations of fish or squid are encountered. These trawl contents can provide physical specimens of fish or squid for other analyses in addition to their use for verifying acoustic measurements (Table 2). Unlike traditional bottom-trawl surveys which sample specific locations selected before the cruise, the mid-water trawl used in this project is designed to ground-truth the acoustic data and the trawl data by themselves are not used to measure abundance of fish. The approach used in this study (acoustic measurements of fish abundance and distribution) is widely used by various NOAA NMFS groups as well as fishery researchers throughout the world to assess pelagic fish.

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Tel: 631-632-3187; Fax: 631-632-8820

The trawl net is a high-rise bottom trawl with front meshes that are 240 cm made from 7/16” Samson Polyron rope. The webbing is twisted nylon made ranging from 80 cm to 6 cm. We use Type 14 semi-pelagic Thyboron doors (1.5 m^2). This net is equipped with three SIMRAD sensors that display real-time net monitoring data (net spread, height, and depth) directly to the science crew. One sensor is attached to each of the net doors (to allow net spread determination), and one is attached to the middle of the headrope. Two temperature-depth (TD) sensors are also attached to the headrope and footrope of the net. These allow temperature and depth measurements at both locations (headrope and footrope), but cannot be monitored in real-time. The TD sensors are removed after each trawl and data are downloaded and checked before reattaching for the next trawl.

Determining when to conduct a trawl is at the discretion of the onboard acoustic technician. Usually, trawls are conducted when interesting acoustic data appear on the monitors (e.g., a large aggregation of fish), or in some cases, to validate the lack of acoustic signal. Trawls are conducted both day and night, and we have increased our trawl sampling frequency over the course of the project so far (aiming for at least three trawls every twenty-four hours when weather and sea state allow). The depth of each trawl is determined using the real-time depth data provided by the SIMRAD net sensors. Trawls cannot be conducted at depths deeper than 80 m due to equipment limitations and safety considerations. Trawl durations are determined by the onboard acoustic technician and are typically between 15 and 30 minutes long (depending on the size of the aggregation, tow speed, net depth, etc.).

Table 2: Species and total numbers of individuals caught during ground-truthing trawls for each cruise during the 2020 annual reporting period. The majority of species caught were pelagic organisms including butterfish, menhaden, hake, and both long- and short-fin squids. Occasionally groundfish or mesopelagic fish were also caught when the trawl was fished near the bottom or in deeper locations respectively.

Cruise	Species and No. Individuals Caught
FEB 2020	7 juvenile flatfish, 1 leptocephalus, 25 longfin squid, 10 northern searobin, 1 silver hake
JUN 2020	No trawling due to R/V Paumanok use
OCT 2020	No trawling due to COVID protocols

Objective 5: Collect opportunistic sighting and behavioral data of cetaceans in the New York Bight

5.1 Line-transect Marine Mammal and Opportunistic Seabird Surveys

We are conducting line-transect and photo-ID monitoring efforts in the NYB to assess the abundance, distribution, species composition and seasonal habitat use of cetaceans. Standardized shipboard line-transect surveys (Buckland et al. 2001) were used to monitor the abundance and distribution of cetaceans in the NYB during daylight hours for the February 2020 research cruise. Surveys on the remaining cruises conducted in 2020 were not possible due to the SARS-CoV-2 pandemic which resulted in a greatly reduced

Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

science crew. Sampling for objectives 2-4 was prioritized for June and October 2020 cruises following priorities discussed with the NYS DEC, and as a result line transect surveys were not conducted on these cruises. Though survey effort was minimal during the February cruise due to unsurveyable windy winter conditions (Beaufort scale > 4), we sighted a number of shelf-associated species along the ends of transect 6 and 7, with a total of 5 sightings of 3 confirmed species of cetaceans, short-beaked common dolphins (*Delphinus delphis*), bottlenose dolphins (*Tursiops truncatus*), and Risso's dolphins (*Grampus griseus*; Table 3; Figure 16 Panel A,B). We conducted opportunistic surveys for seabirds concurrent with the marine mammal line-transect surveys. During the February cruise alone, we sighted 5 species of seabirds, including 21 sightings and a total of 960 estimated individual seabirds, the majority of which were Dovekies (*Alle alle*) and great-black backed gulls (*Larus marinus*) (Figure 16 Panel C; Table 3). Very large groups of great black-backed gulls were primarily observed associated with offshore fishing vessels.

Photo-identification (photo-ID) surveys of humpback whales, bottlenose dolphins, pilot whales, and beaked whales were conducted whenever close approaches to these species were possible. Humpback whales were only sighted during the small-boat UAV surveys (described below) due to the limited line-transect effort from R/V Seawolf. Photo-ID images of humpback whales are being contributed to the following catalogues in order to facilitate matches of individuals between regions and through time: the New York Bight Photo-Identification Catalog (contributors include the Atlantic Marine Conservation Society, the Coastal Research and Education Society of Long Island, Gotham Whale, Inc., the Wildlife Conservation Society and this program) and the Gulf of Maine catalog maintained by Allied Whale for humpback whales. Bottlenose dolphin images are being contributed to the Mid-Atlantic Bottlenose Dolphin Photo-ID Catalogue for bottlenose dolphins, while pilot whales and beaked whales are being contributed to the Duke University photo-ID catalog.

Line-transect surveys are being conducted concurrent with oceanographic and fisheries acoustics surveys, and ongoing integrative analyses of these interdisciplinary datasets will allow us to better understand drivers of marine mammal abundance and distribution and trophic interactions between mid and upper trophic levels through the course of this monitoring program (Objective 6). In future work, we will be switching to dedicated distance sampling for seabird species and continuing our opportunistic work with marine mammals.

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Table 3: Summary of line-transect surveys of marine mammals and opportunistic sightings of seabirds conducted during the February, 2020 cruise.

Group	Scientific Name	Common Name	No. Sightings	No. Individuals
Marine Mammal	*Delphinus delphis*	Short-beaked common dolphin	1	30
Marine Mammal	*Grampus griseus*	Risso's dolphin	2	5
Marine Mammal	*Tursiops truncatus*	Common bottlenose dolphin	2	26
Seabird	*Alle alle*	Dovekie	12	224
Seabird	*Fulmarus glacialis*	Northern fulmar	1	1
Seabird	*Larus marinus*	Great black-backed gull	2	700
Seabird	*Morus bassanus*	Northern gannet	5	34
Seabird	*Stercorarius parasiticus*	Parasitic jaeger	1	1

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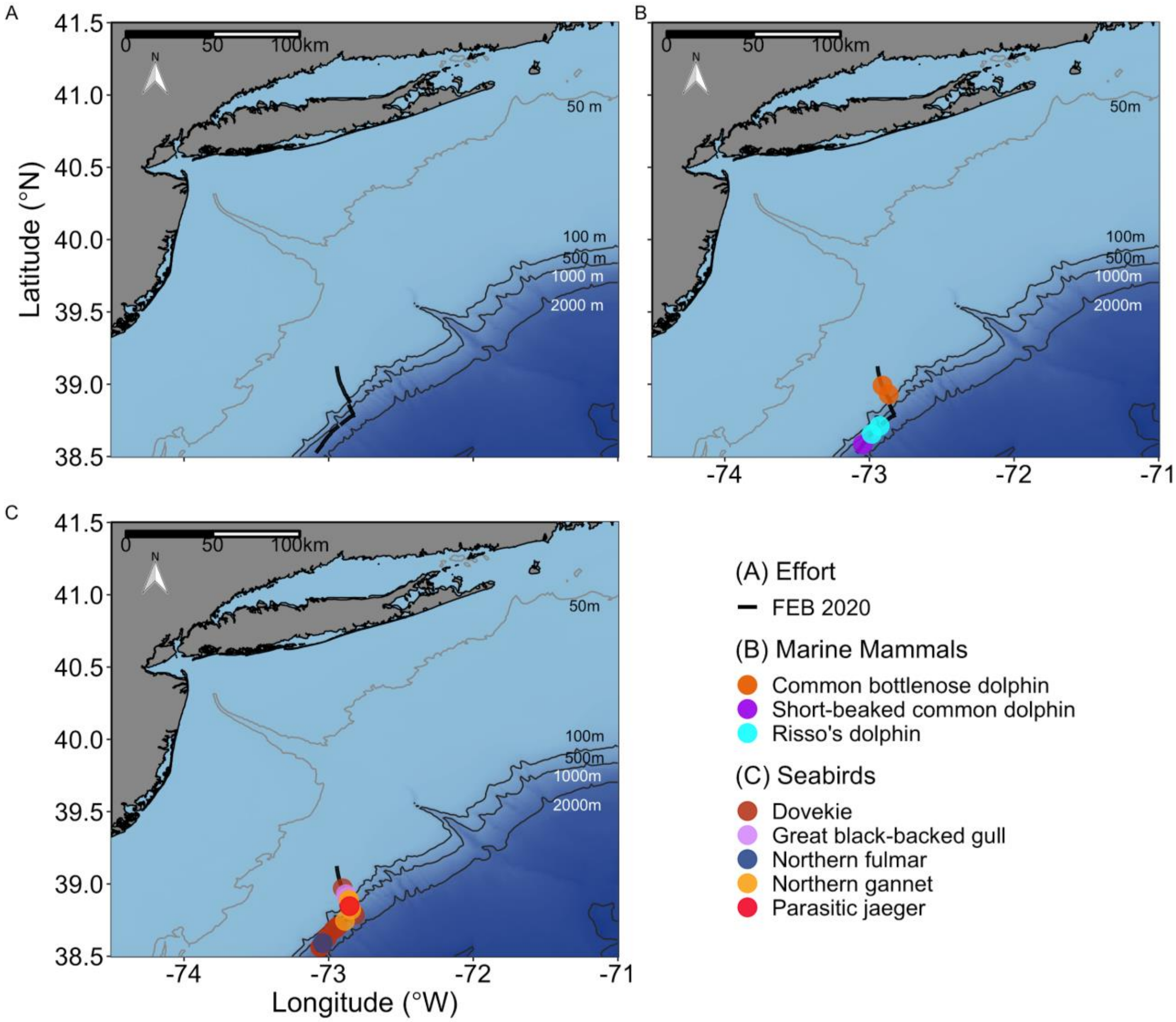

Figure 16: Cumulative sightings of marine mammals and seabirds for 2020. A) Survey effort for February 2020 cruise, B) marine mammal sightings of common bottlenose, short-beaked common, and Risso's dolphins, and C) opportunistic sightings of seabirds in the NYB. Due to the SARS-CoV-2 global pandemic and reduction in science crew on the summer and fall cruises, we were only able to conduct line transect surveys during the February 2020 cruise.

5.2 UAV surveys of humpback whales and results of body size and body condition analyses

We conducted photogrammetry studies of humpback whales in the NYB using drones or Unmanned Aerial Vehicles (UAVs). The NYB provides important foraging habitat for humpback whales during summer months, when humpback whales build up energy stores to use when fasting during the breeding season (Lockyer, 1987; Christiansen et al. 2016, Brown et al. 2018). Sightings of humpback whales are thought to have increased in the NYB in recent years, possibly due to increases in Atlantic menhaden (Brown et al. 2018), and local reports

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suggest that most humpback whales foraging in the NYB are juveniles. However, adult whales have been observed in offshore waters, and it is unclear whether juveniles are observed more frequently due to higher observer effort in inshore regions of the NYB. Further, little is known about foraging behavior and health of humpback whales in the NYB. To address these gaps in knowledge and to provide an indicator of resource availability in the NYB through time, we are quantifying the body size and body condition of humpback whales using UAV measurements (Groskreutz et al. 2019).

Between May 14 and November 11 2020, 17 days of opportunistic UAV surveys for humpback whales were conducted aboard the R/V Parker operating out of Stony Brook University's Southampton Marine Station to assess humpback whale body condition in the New York Bight. During this period, a total of 34 humpback whales were sighted (three individuals were sighted on multiple dates) and 2974.5 km were surveyed (average of 175 km of effort per survey day). Humpback whales were sighted on 10 of 17 days (Table 5.2.1). Of the 34 whales flown with a UAV in 2020, imagery suitable for length measurements to determine age class was obtained for 25 individuals, and imagery suitable for measurements of body condition was obtained for 17 individuals. Cooperative foraging behavior was observed on June 25 2020, July 9 2020, July 25 2020, and August 9 2020. No surface lunge feeding was observed in 2020, likely due to our focus in offshore waters to prioritize body condition data for adults given limited measurements of adult humpback whales from prior survey years. However, surface lunge feeding behavior was documented in nearshore waters by other research groups in 2020 and by our research team in previous years. The cooperative foraging behavior was observed primarily in waters between 48-62 km from shore, and were often multi-species foraging events (including sightings of fin whales, minke whales, shearwaters, storm petrels, and skuas).

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Table 4: Summary of UAV survey effort (time and distance) and the number of humpback whales sighted and measured during the 2020 field season.

Day	Effort Hours	Effort Distance (km)	No. humpback whales sighted	No. humpback whales measured with UAV for length	No. humpback whales measured with UAV for body volume
2020-05-14	8.2	203.1	0	0	0
2020-05-26	6.2	128	0	0	0
2020-06-02	6.4	68.8	5	4	2
2020-06-08	8.7	193.9	4	2	2
2020-06-13	5.8	150.3	2	0	0
2020-06-22	6.6	173.9	0	0	0
2020-06-25	8.5	158.7	8	3	2
2020-06-29	7.4	207.5	0	0	0
2020-06-30	7.6	220.4	1	1	0
2020-07-02	8.5	247	0	0	0
2020-07-09	8.6	156.2	2	2	2
2020-07-22	6.8	215.6	1	0	0
2020-07-25	6.9	142.3	8	7	5
2020-08-09	8.6	215.1	3	1	1
2020-08-31	5.4	149.5	3	3	1
2020-09-24	5.7	141.8	2	0	0
2020-11-09	8.5	202.4	2	2	2

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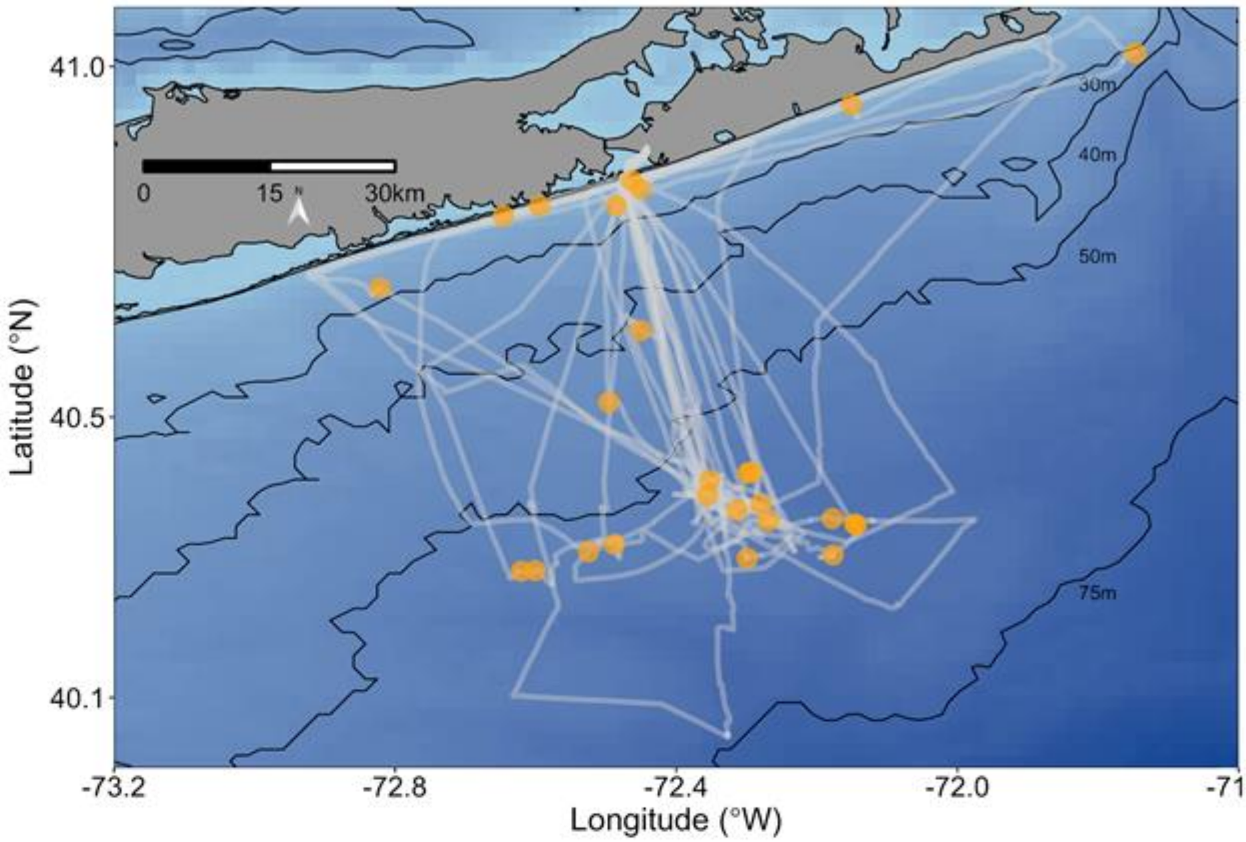

Figure 17: Small-boat UAV survey effort (light grey) and humpback whale sightings (orange) during the 2020 field season. All surveys were conducted from R/V Parker.

We analyzed still images from UAV video for all surveys conducted from 2018 through 2020 in order to conduct morphometric analyses (both length and body volume analyses) for humpback whales (Figure 18). Images were scored by two independent researchers for focus, animal position, and overall ability to measure length and width. Discrepancies in scoring were analyzed and discussed on a case-by-case basis. Across the three field seasons from 2018-2020, imagery sufficient for length measurements was obtained for 52 individuals (38 juvenile whales and 14 adult whales). Whales were measured using the MorphometriX GUI to obtain width and length measurements (Torres & Bierlich 2020), and individuals were determined to be juveniles or adults based on a threshold length of 12m (Clapham 1992, Wiley et al. 1995, Barco et al. 2002). In addition, foraging behavior for each sighting was classified into two categories: multi-animal cooperative feeding or surface lunge feeding. Our analysis showed that juvenile whales were found throughout the sampling region, while adult whales were only observed in offshore waters (greater than 10 km from shore) (Figure 19 panel A). In addition, surface lunge feeding was only observed in inshore waters (within 10km of shore) while cooperative foraging behavior was only observed beyond

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Tel: 631-632-3187; Fax: 631-632-8820

40km from shore (Figure 19, panel B). Our results suggest that juvenile whales are exclusively exhibiting surface foraging behavior in inshore waters, while both adults and juveniles are exhibiting cooperative foraging behavior in offshore waters (Stepanuk et al. in press).

Figure 18: Example of still image obtained from drone imagery of humpback whales in the New York Bight. Image taken under NMFS GA No. 21889 to L. Thorne.

Vessel strikes are a major source of mortality for humpback whales, and the National Marine Fisheries Service has declared an Unusual Mortality Event (UME) in the Northeast U.S. due to elevated levels of humpback whale strandings since 2016 (NOAA Fisheries 2020). More than 25% of confirmed vessel strikes of humpback whales occurring in the NEUS from 2016 and 2017 occurred in New York waters (Hayes et al. 2020). We examined AIS data from 2017 (the most recent year of data available at the time of analysis) relative to our humpback whale observations and found that surface foraging behavior was observed in regions where passenger vessels were operating at very high speeds (over 20 knots). Together our findings suggest that that habitat use of juvenile humpback whales may make them more vulnerable to vessel strike in nearshore waters, and that increases in vessel traffic in inshore waters in the New York Bight could put juvenile whales at a disproportionate risk of vessel strike (Stepanuk et al. in press).

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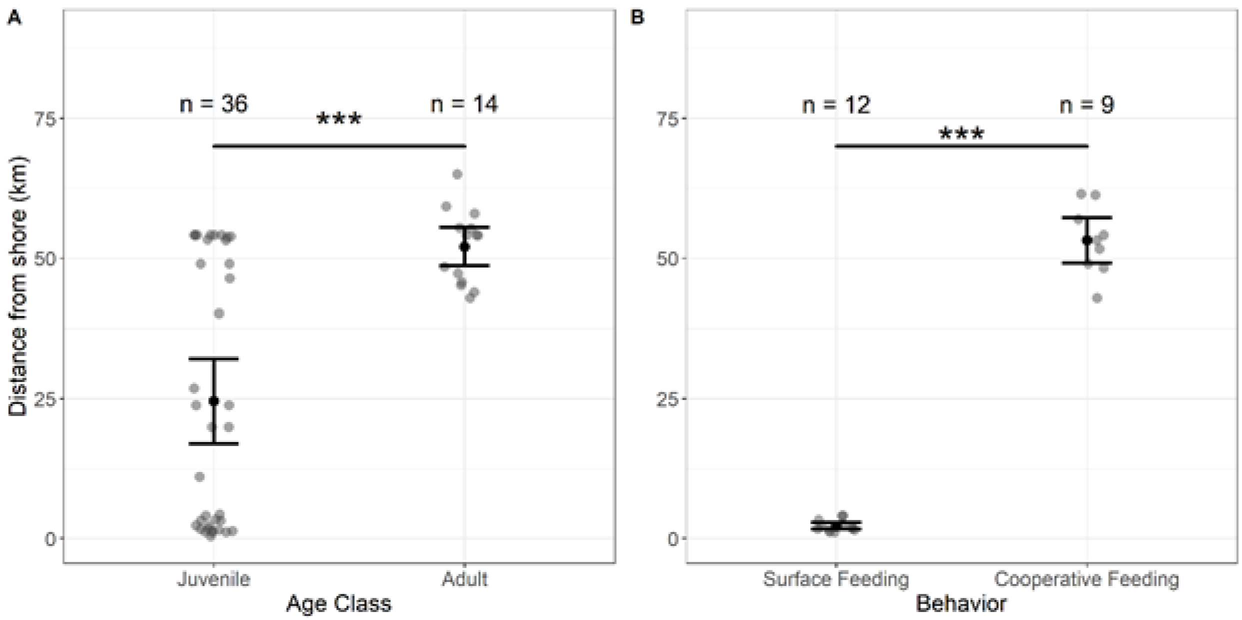

Figure 19: Distribution of (A) adult and juvenile whales observed in the New York Bight (NYB); (B) foraging behavior relative to distance from shore in km. Significance is delineated by asterisks (* = $p < 0.001$).**

In order to characterize body condition in humpback whales, we developed a body volume index by creating a scalable 3D model of humpback whales. The 3D model was created using the software Blender (www.blender.org) by creating a 3D mesh draped over dorsal and lateral images of representative humpback whale images (as in Adamczak et al. 2019). The length and width measurements of individual whales obtained from UAV images were then used to scale the 3D model in order to obtain a measure of body volume that conserves the external morphology of humpback whales (Hirtle et al. in prep). Separate 3D models were created for adult and juvenile whales due to morphometric differences between age classes. Imagery sufficient for body volume analyses was available for 42 individuals between 2018 and 2020. Body volume indices were compared within seasons, and between age classes and years. Preliminary models of juvenile and adult body condition suggest that body condition increases throughout the season and body condition is higher farther from shore (Generalized Additive Models; Deviance explained=43.8%, $p=0.042$ for day of year, $p=0.016$ for distance from shore).

Objective 6: Characterize trophic interactions and oceanographic drivers of living marine resources

In Years 1-2, our focus was on collecting data synoptically that can then be used to understand how oceanographic features affect the abundance and distribution of pelagic organisms. The above maps and figures represent the first stages of this analysis. To satisfy Objective 6, we will begin to combine these data to determine to what degree higher trophic level organisms like fishes and whales covary with their prey and the degree to which physical features like the Mid-Atlantic Cold Pool and Shelf Break Front structure the environment (Figure 20) to enhance trophic interactions. Fine scale physical data combined with acoustic data, trawls and marine mammal sightings will allow us to develop predictive habitat models that could ultimately be used to project the effects of climate change in the New York Bight. In addition to BAI UAV research discussed in Objective 5, UAV studies will be investigating fine-scale interactions between humpback whales and their prey in future years of this program. Together, these UAV studies represent an important step in understanding predator-prey dynamics within hotspots for foraging upper trophic level predators and will lead to critical insight into how fish distributions affect marine mammal distribution and potentially mortality events.

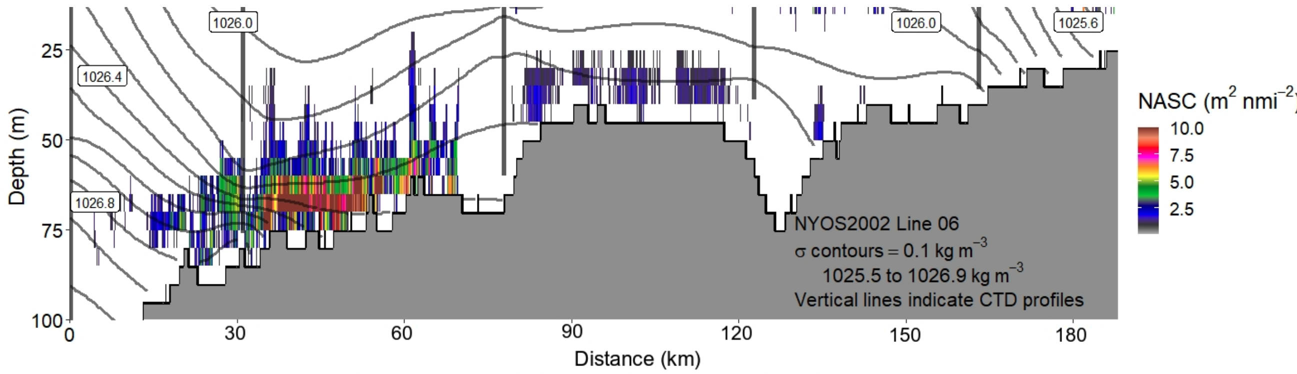

Figure 20: Combining acoustic and hydrographic data provides insight into environmental factors related to fish and zooplankton aggregations. The 38 kHz echogram from the westernmost transect from the February 2020 survey was overlaid with interpolated density (ρ, kg m^{-3}) isopycnal contours (0.1 kg m^{-3} resolution) to examine relationships between hydrographic features and scattering aggregations. In this transect, a near-bottom aggregation was associated with the location of the shelf-break front (indicated by the decreased isopycnal spacing occurring roughly 30 km from the offshore end of transect 6 and 70 m depth).

Objective 7: Provide supplemental R/V Seawolf vessel staffing support

The offshore monitoring and survey projects covered within this agreement requires extensive use of the SoMAS R/V Seawolf. The increase in vessel operations is so significant that previous operating crew size was insufficient to meet the safety and programmatic needs of these field-intensive offshore projects. Shoaling in Shinnecock Inlet has made the only one port on the south shore of Long Island that the Seawolf can enter almost impossible to use. Due to the lack of harbors, the Seawolf must operate round the clock for these projects in order to eliminate the transit times which were making the projects sampling schemes not viable. The goals for this objective are to hire additional crew to support the increased use and 24-hour operations necessary for the projects. The additional crew specified are one captain capable of running trawling operations and two deckhand technicians. The programs within this MOU require extensive use of commercial fishing gear. This is a very specific skill set which most mariners capable of operating the Seawolf do not possess. In September 2019, we successfully recruited Michael Mason as captain with this skillset. Michael has extensive experience working on vessels the size of the Seawolf engaged in commercial bottom trawling, midwater trawling, surf clam dredging, and scalloping, as well as experience working on vessels engaged in scientific research. With the addition of Michael Mason, we have three captains able to run trawling operations. Captain Mason has been working on the Ecosystem Monitoring Program and the Inshore Trawl Survey projects. With respect to the deckhand hiring, we had a failed search

Stony Brook University, Stony Brook, NY 11794-5000
Tel: 631-632-3187; Fax: 631-632-8820

in 2019 which we restarted in March 2020. Unfortunately, the University instituted a hiring freeze in June of 2020 just as we were about to complete the selection process. We have not yet been able to move ahead with hiring but are hopeful we will get permission to restart the search in the new year.

8. Issues encountered during this period:

The major issues encountered for this reporting period are primarily related to complications due to the SARS-CoV-2 pandemic. All in-person, on-campus Stony Brook University research operations were halted in March due to SARS-CoV-2. We requested and were granted permission to resume in-person laboratory and field sampling in May, although with safety precautions and restrictions on the number of personnel on-campus and in the lab. We attempted to ameliorate these complications by a) conducting partial sampling during day trips from the R/V Paumanok, b) conducting our fall cruise with a skeleton crew and partial sampling plan (e.g. we did not conduct trawls or line transect surveys of marine mammals). We are actively seeking to hire NYOS DEC MOU staff to replace Kurt Heim and Devan Nichols as the indicator postdoc and acoustic technician respectively.

- Loss of seasonal full sampling coverage for the July / summer cruise due to SARS-CoV-2 pandemic
- Transition of critical staff (acoustic technician, indicators postdoc, carbonate chemistry postdoc, glider technician)
- Zooplankton sample analysis was suspended from March to July 2020 due to University restrictions on laboratory work on campus due to the SARS-CoV-2 pandemic. However, during this time period, a streamlined fish larvae identification protocol was developed and an updated in-lab guide to common NY Bight zooplankton was produced. A new graduate student joined the project and began working in the lab in July and was trained in zooplankton sample processing techniques (lab procedure, zooplankton identification, etc.) allowing sample processing to resume in late August.
- University safety regulations (due to SARS-CoV-2) resulted in the use of a different vessel (RV Paumanok) for the July 2020 cruise which does not have trawl capability. Similarly, the October 2020 cruise sailed with a reduced science crew (due to COVID safety restrictions) and trawls were not possible on this trip.
- The arrival of the new carbonate chemistry postdoc has been delayed due to international travel restrictions and delays in visa approval associated with the SARS-CoV-2 pandemic.

Stony Brook University, Stony Brook, NY 11794-5000
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9. Work planned for upcoming quarters:

Table 5: Summary of work planned for upcoming quarters in 2021.

Objective #	Activity/Deliverable	Timeframe
5	Continue UAV studies of Humpback whales	May-Nov. 2021
5	Process UAV imagery and generate body condition indices	Ongoing
2	Analyze Carbonate Chemistry Samples for TA/DIC	Ongoing
1-6	Complete Four Seasonal Cruises including physical and biological sampling as outlined in the scope of work	Jan. - Dec. 2021
2	Complete Four Seasonal Glider Missions	Jan. - Dec. 2021
1-6	Continue to provide data to the DEC	Quarterly, post-cruise
3	Process zooplankton samples	Ongoing
7	Complete hiring for two deckhands	Dependent on SBU COVID restrictions
1-6	Database development	Ongoing
3-4	Complete hiring of new acoustic technician	Feb - Mar 2021
1	Complete hiring of new indicators postdoc	Jan. 2021
1	Continued development of ecosystem indicators	Jan. - Dec. 2021

10. Quarter Four NYOS Cruise Summary - October 2020

The R/V Seawolf left Port Jefferson at 07:30 EST on October 19, 2020. We sampled two stations in the Long Island Sound before transiting through the city to transect 7. We completed sampling on transect 7, 6, and 5 before heading into port in Caven Point, NJ to hide from weather. We arrived at Caven Point at 19:29 EST on October 22, 2020. We departed from Caven Point at 13:33 on October 26, 2020 after the bad weather passed. We transited to transect 4 and were able to complete transects 4, 3, 2, and 1. The R/V Seawolf returned to Port Jefferson at 01:05 EST on October 30, 2020 completing the October offshore cruise.

All stations were sampled on this cruise for a total of 41 CTD casts, 39 zooplankton tows, and complete coverage of acoustic and surface underway data. A total of 210 samples were each collected for TA/DIC and pH analysis. 8 samples were collected from the surface underway system throughout the course of the cruise. Due to restrictions related to SARS- COV-2, this cruise was completed with a reduced science crew.

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In order to ensure the health and safety of all crew members, fish trawls and marine mammal observations were not conducted on this cruise due to limited personnel.

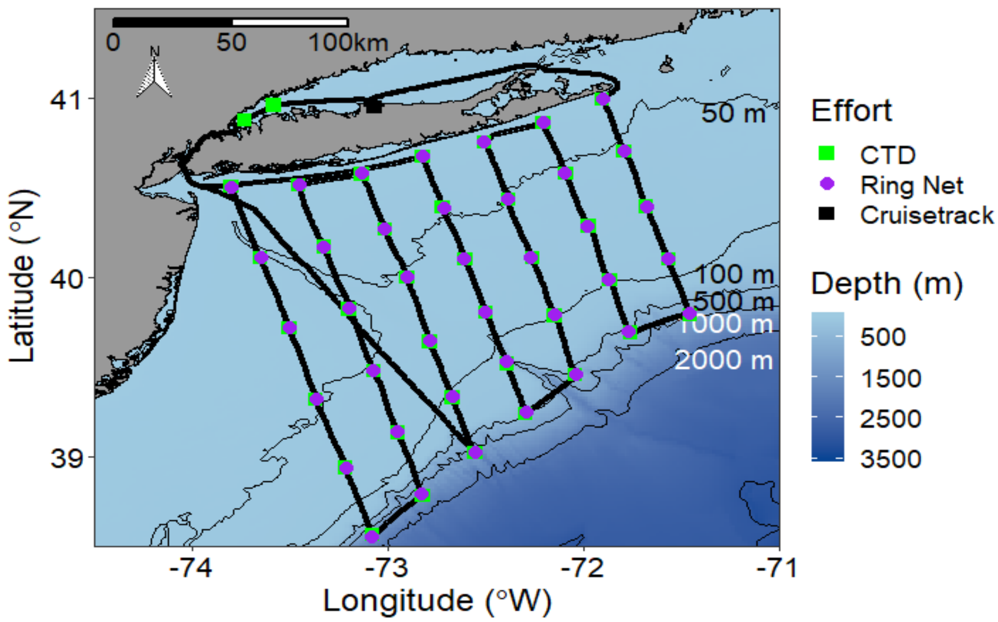

Figure 21: NYOS2010 cruise track from October 19-October 30 2020. Ring net tows (purple circles) and CTD casts (green squares) and the full suite of water sampling were completed for all stations across all lines. Acoustic transects were also completed on all lines. No marine mammal observations or fish trawls were conducted.

10.1 Physical and chemical observations

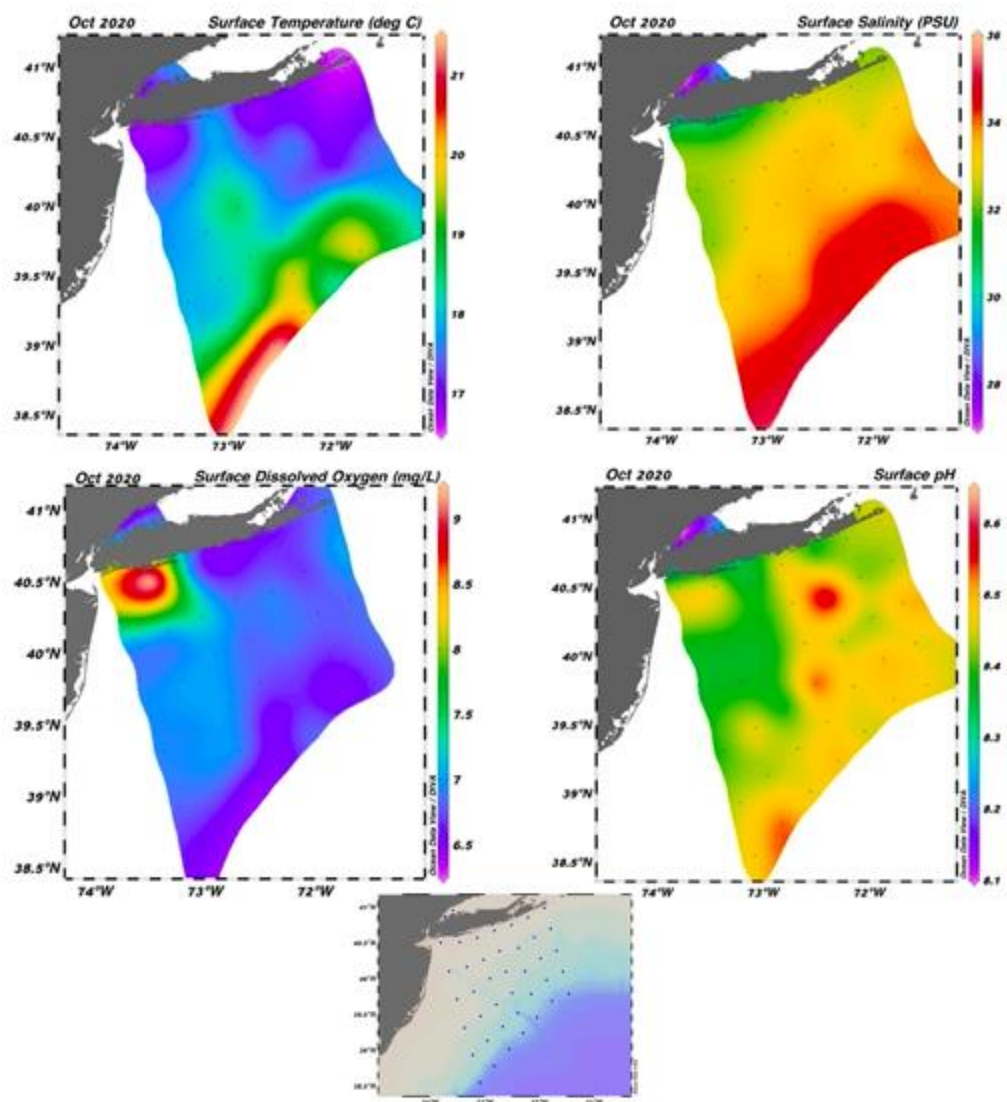

Figure 22: Spatial distribution of temperature (deg C), salinity (PSU), dissolved oxygen (mg/L), and pH in surface waters during the fall monitoring cruise (NYOS2010).

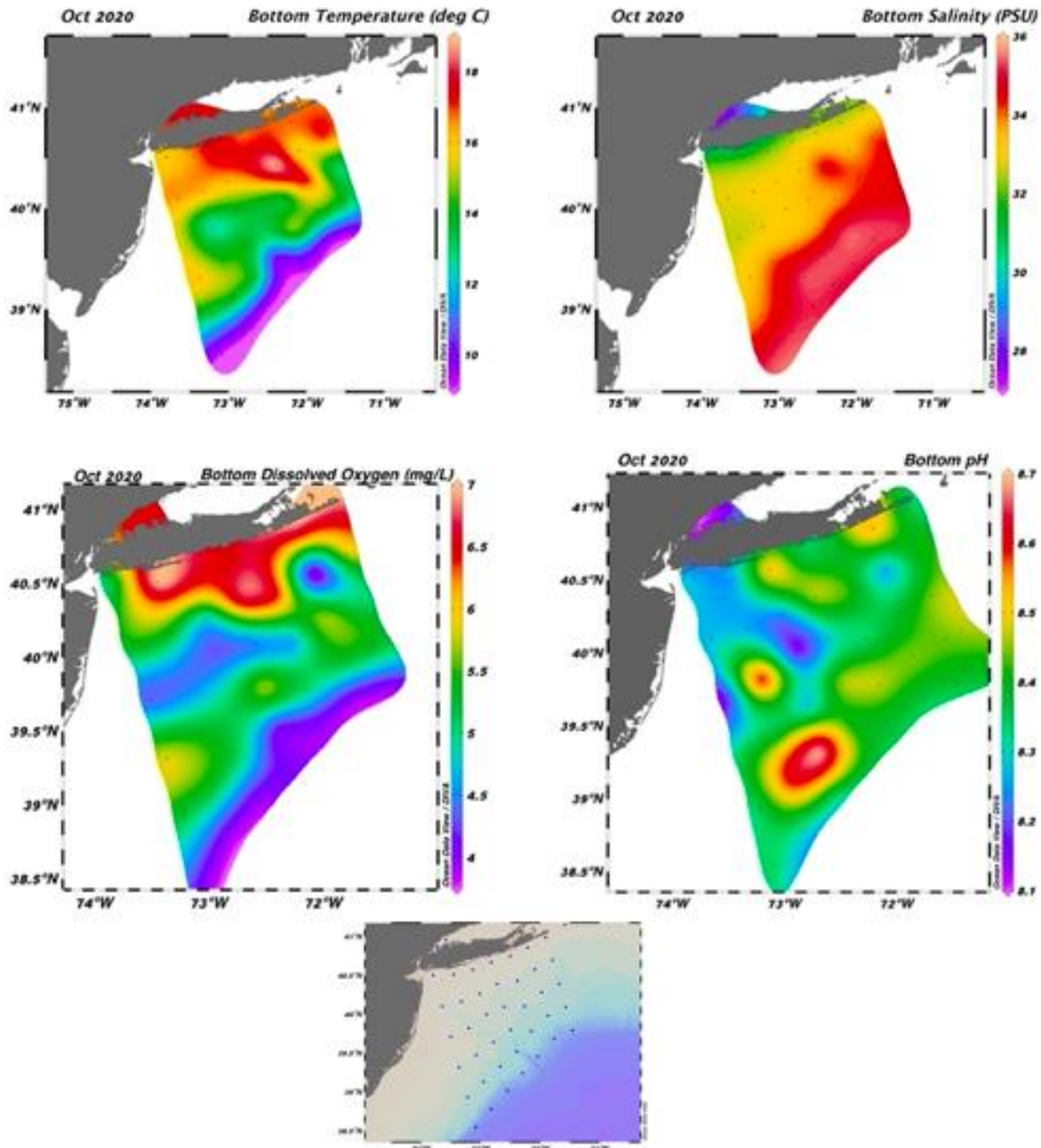

Figure 23: Spatial distribution of temperature (deg C), salinity (PSU), dissolved oxygen (mg/L), and pH in bottom waters during the fall monitoring cruise (NYOS2010).

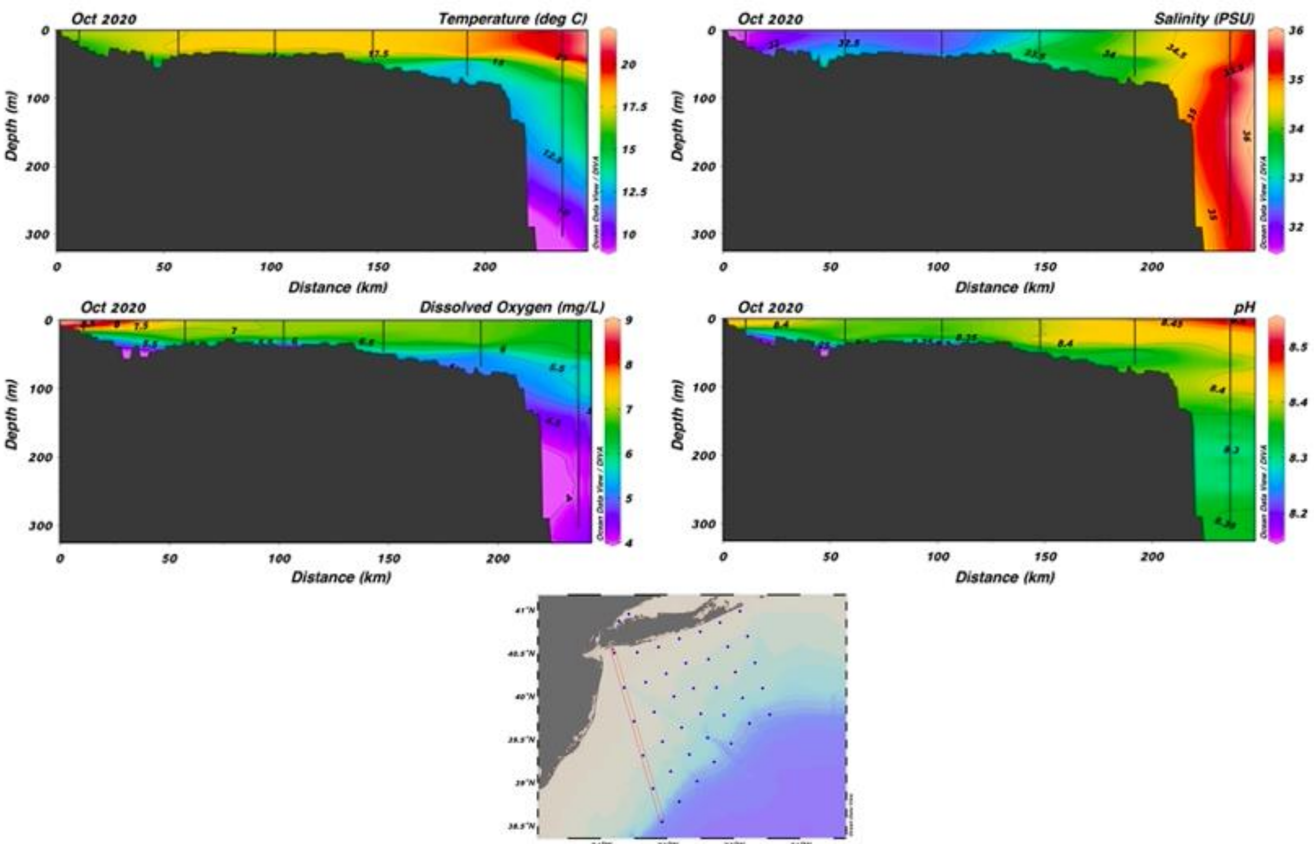

Figure 24: Vertical structure of temperature (deg C), salinity (PSU), dissolved oxygen (mg/L), and pH for NYOS2010 transect 7.

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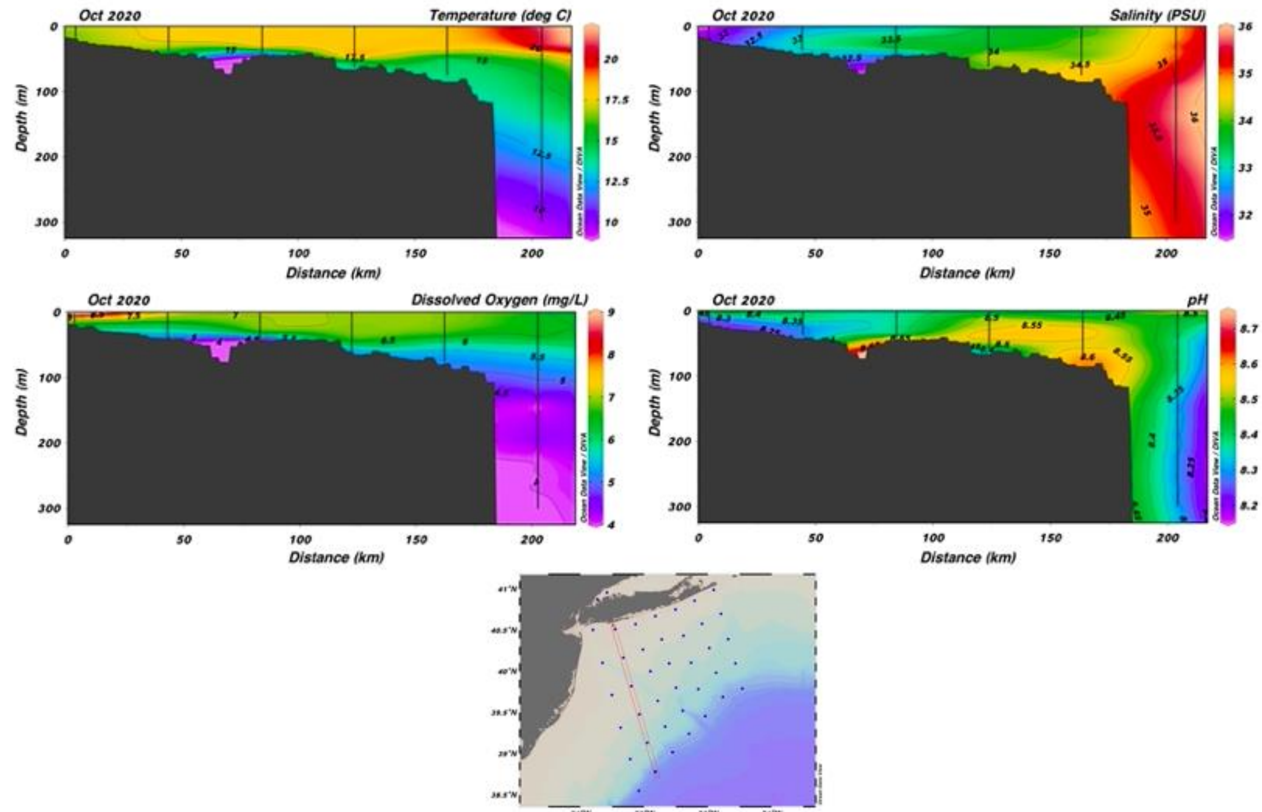

Figure 25: Vertical structure of temperature (deg C), salinity (PSU), dissolved oxygen (mg/L), and pH for NYOS2010 transect 6.

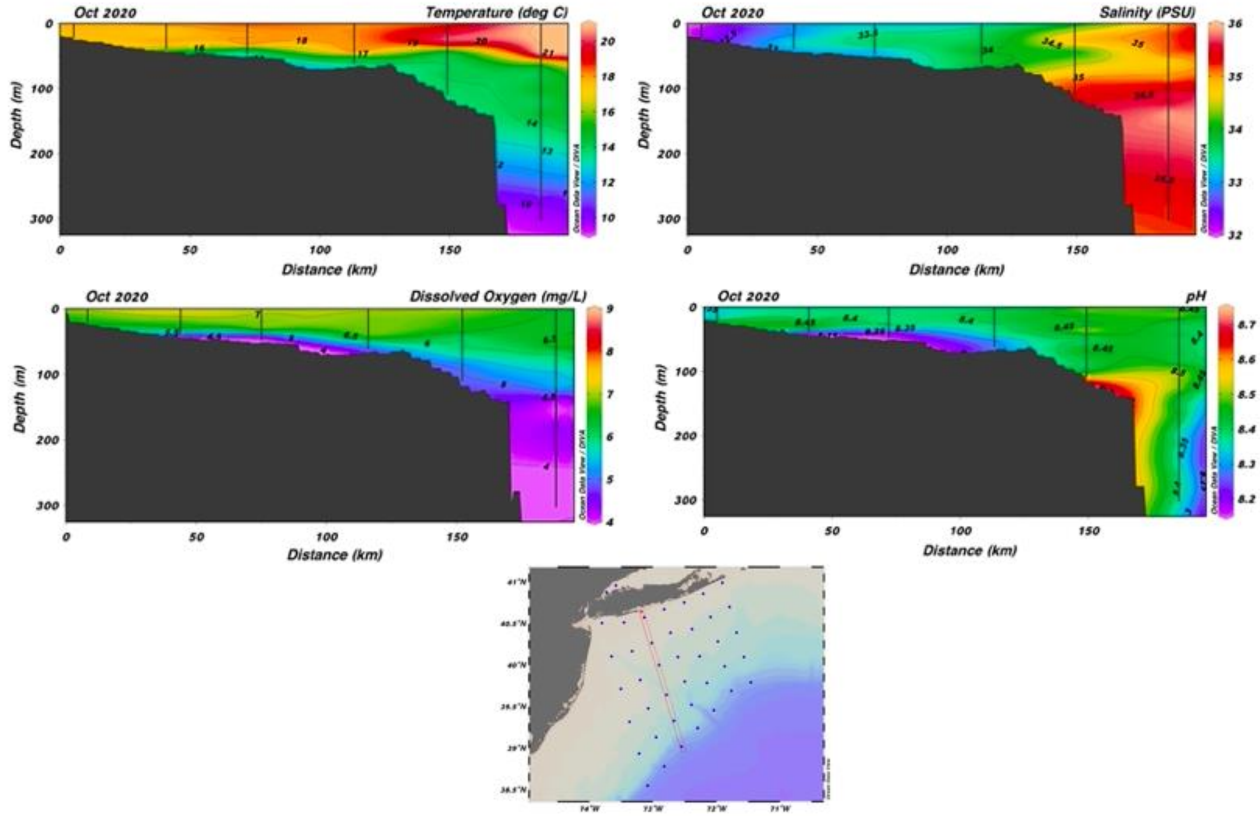

Figure 26: Vertical structure of temperature (deg C), salinity (PSU), dissolved oxygen (mg/L), and pH for NYOS2010 transect 5.

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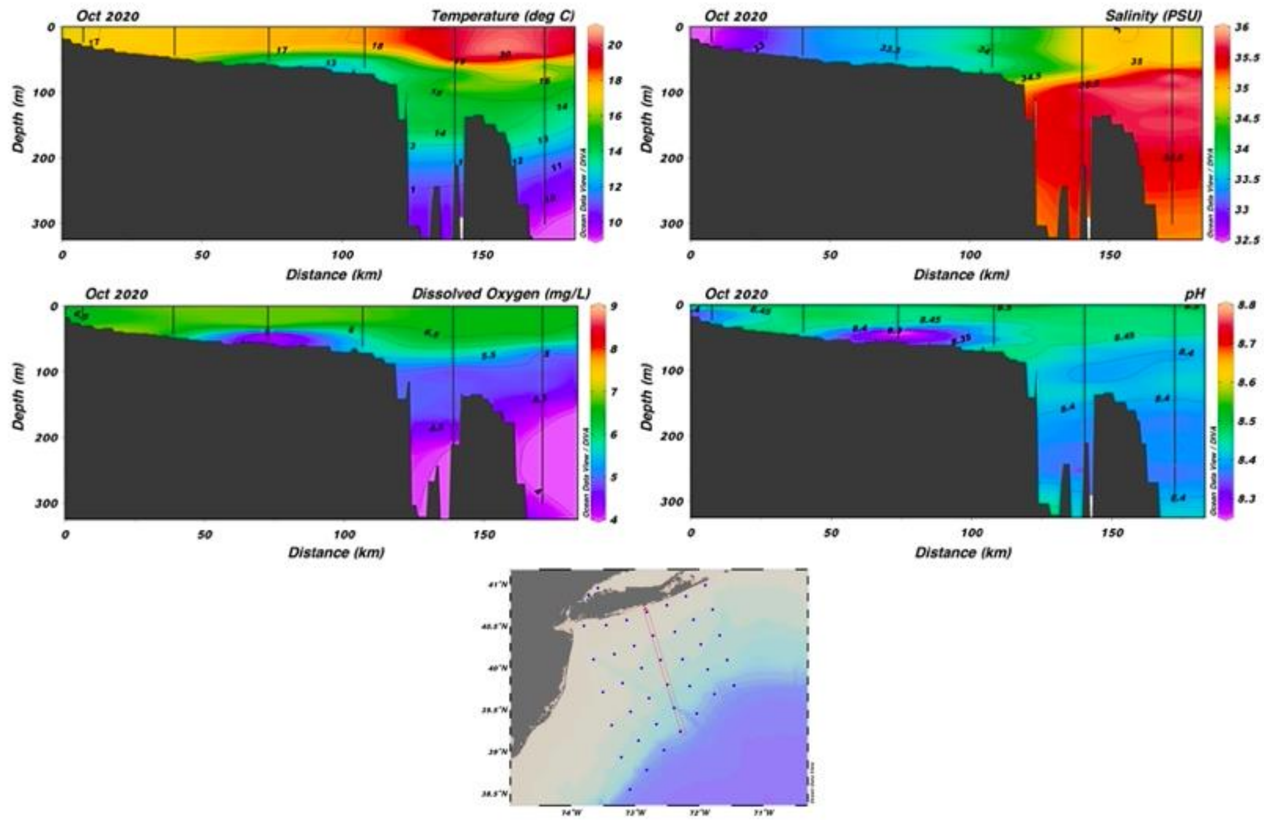

Figure 27: Vertical structure of temperature (deg C), salinity (PSU), dissolved oxygen (mg/L), and pH for NYOS2010 transect 4.

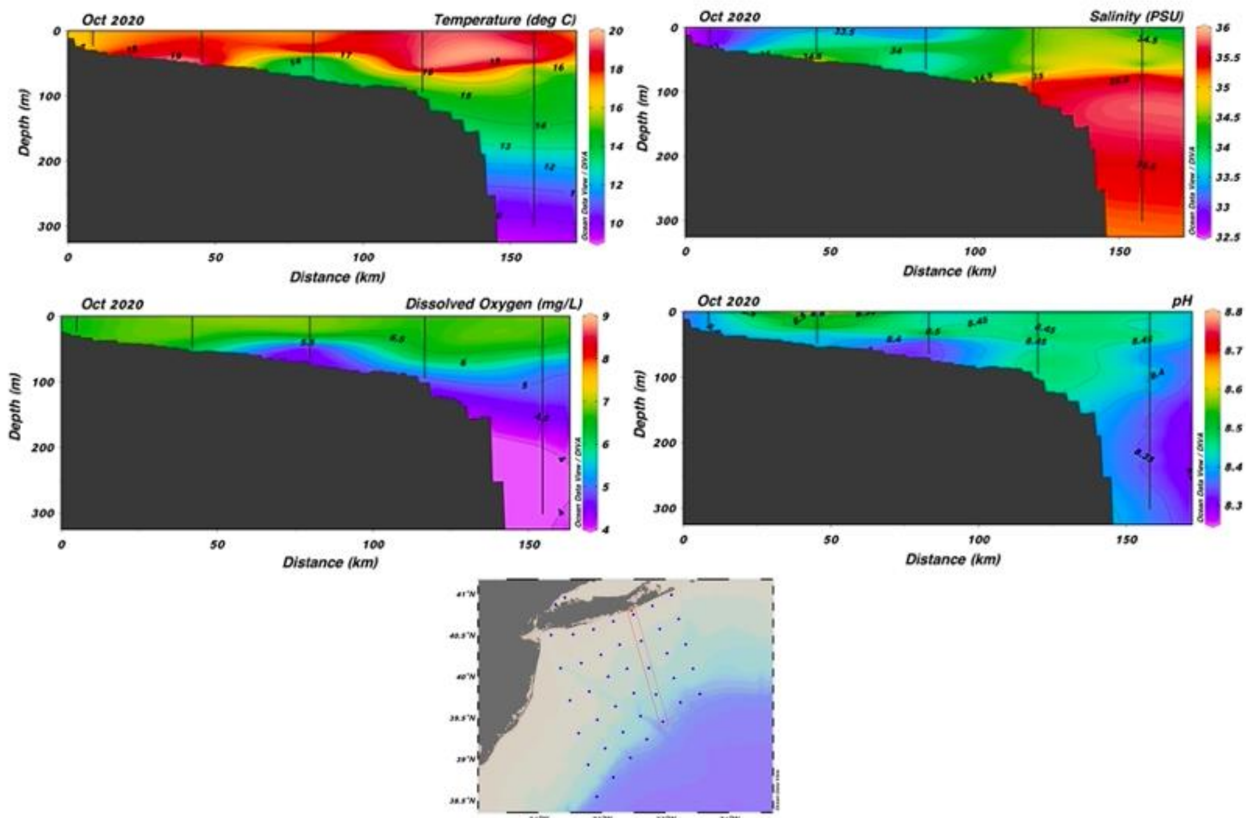

Figure 28: Vertical structure of temperature (deg C), salinity (PSU), dissolved oxygen (mg/L), and pH for NYOS2010 transect 3.

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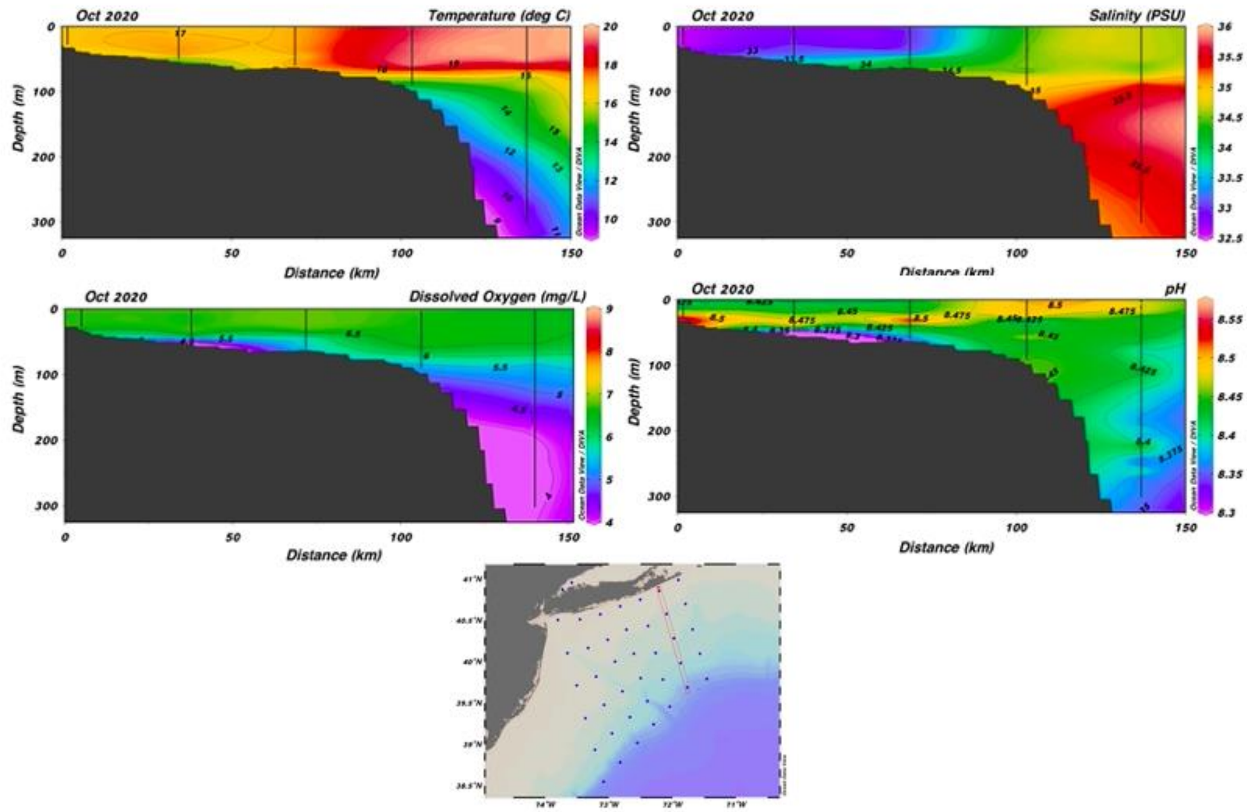

Figure 29: Vertical structure of temperature (deg C), salinity (PSU), dissolved oxygen (mg/L), and pH for NYOS2010 transect 2.

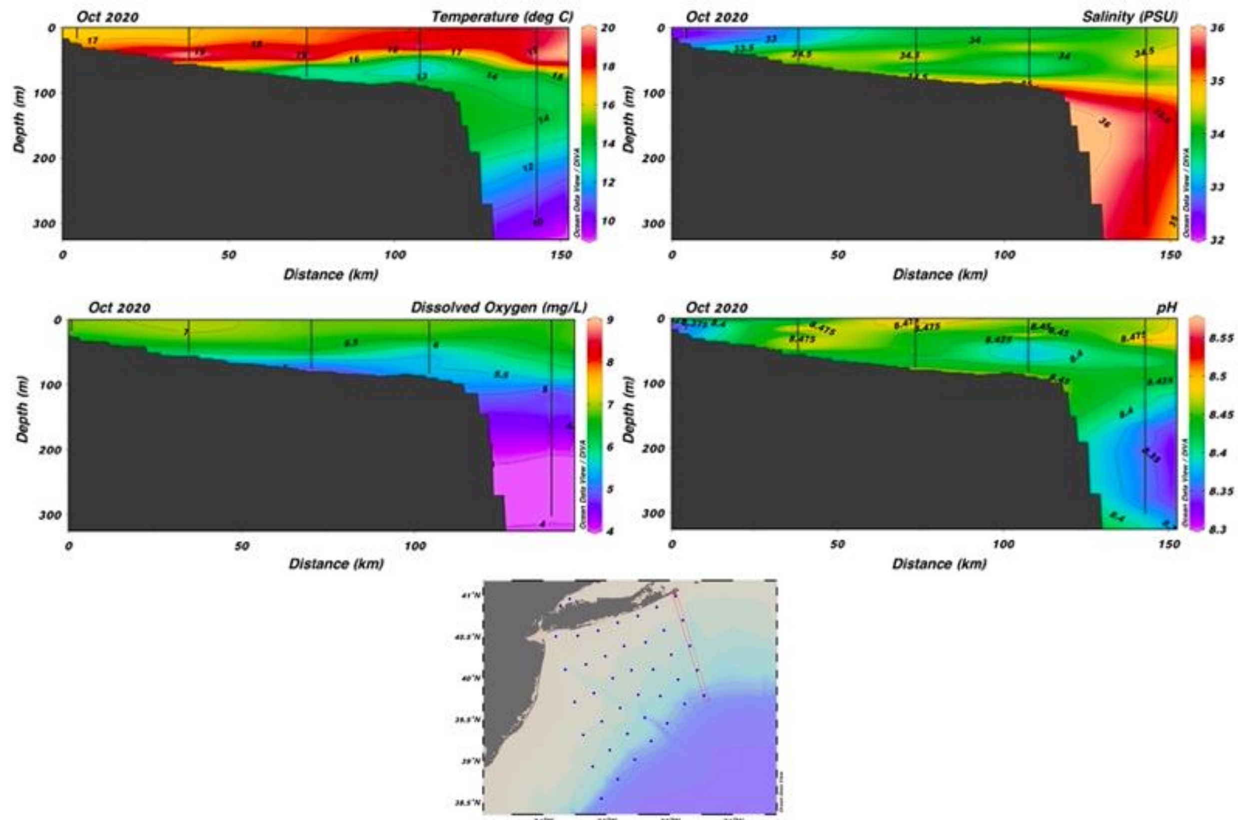

Figure 30: Vertical structure of temperature (deg C), salinity (PSU), dissolved oxygen (mg/L), and pH for NYOS2010 transect 1.

10.2 Zooplankton ring net sampling

Thirty-nine zooplankton tows were conducted throughout the survey (Figure 21; Table 6). Vertical tows sampled the top 25 m of the water column (with the exception of hauls R01, R12, R13, and R19 where depth was shallower than 25 m) with a 60 cm diameter ring net (net mesh 333 µm). The biovolume of each sample was measured, then each sample was stored in jars fixed with 10% formalin, 90% ambient seawater. Biovolume of samples ranged from 7 to 200 mL. Animals present in samples included, but were not limited to, salps, medusae, copepods, amphipods, krill and chaetognaths.

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Table 6: Zooplankton tow information for cruise NYOS2010. Time (UTC), latitude (°N), longitude (°W), and water depth (m) correspond to the start of each ring net tow.

Date	Time (UTC)	Latitude (°N)	Longitude (°W)	Station ID	Sample ID	Water depth (m)
19 OCT 2020	20:09	-73.79921	40.50088	7.1	R01	19
20 OCT 2020	00:07	-73.64803	40.10587	7.2	R02	39
20 OCT 2020	03:43	-73.5025	39.7132	7.3	R03	40
20 OCT 2020	07:24	-73.3597	39.31987	7.4	R04	45
20 OCT 2020	11:00	-73.20924	38.93314	7.5	R05	72
20 OCT 2020	14:39	-73.07728	38.54887	7.6	R06	1500
20 OCT 2020	18:15	-72.82325	38.78625	6.6	R07	1369
20 OCT 2020	22:35	-72.94585	39.13565	6.5	R08	78
21 OCT 2020	02:03	-73.07068	39.47785	6.4	R09	64
21 OCT 2020	05:36	-73.19657	39.82316	6.3	R10	43
21 OCT 2020	09:10	-73.32442	40.16937	6.2	R11	38
21 OCT 2020	12:39	-73.45038	40.51322	6.1	R12	18
21 OCT 2020	15:12	-73.13129	40.57701	5.1	R13	24
21 OCT 2020	18:29	-73.01693	40.26552	5.2	R14	39
21 OCT 2020	21:09	-72.9018	40.00041	5.3	R15	49

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22 OCT 2020	00:24	-72.78381	39.64272	5.4	R16	64
22 OCT 2020	03:16	-72.66824	39.33098	5.5	R17	113
22 OCT 2020	06:18	-72.55348	39.01927	5.6	R18	1142
27 OCT 2020	02:37	-72.81941	40.67224	4.1	R19	24
27 OCT 2020	05:20	-72.71258	40.38544	4.2	R20	44
27 OCT 2020	08:27	-72.60717	40.09976	4.3	R21	54
27 OCT 2020	11:22	-72.50103	39.80614	4.4	R22	63
27 OCT 2020	14:11	-72.39498	39.52867	4.5	R23	488
27 OCT 2020	17:09	-72.293	39.24816	4.6	R24	442
27 OCT 2020	20:47	-72.0341	39.45907	3.5	R25	530
28 OCT 2020	00:13	-72.1466	39.78742	3.4	R26	95
28 OCT 2020	03:12	-72.26554	40.10846	3.3	R27	65
28 OCT 2020	06:12	-72.38496	40.43155	3.2	R28	50
28 OCT 2020	09:33	-72.50477	40.75222	3.1	R29	27
28 OCT 2020	12:16	-72.20569	40.85789	2.1	R30	29
28 OCT 2020	14:54	-72.09155	40.57616	2.2	R31	50
28 OCT 2020	17:58	-71.98067	40.28272	2.3	R32	61
28 OCT 2020	21:58	-71.87214	39.98462	2.4	R33	90

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29 OCT 2020	00:55	-71.76539	39.69279	2.5	R34	560
29 OCT 2020	03:58	-71.45792	39.79739	1.5	R35	831
29 OCT 2020	07:30	-71.56885	40.09795	1.4	R36	84
29 OCT 2020	10:20	-71.6769	40.39197	1.3	R37	76
29 OCT 2020	13:13	-71.78989	40.6986	1.2	R38	51
29 OCT 2020	15:56	-71.90147	40.99283	1.1	R39	18

Figure 31: Zooplankton being transferred from the ring net codend to a 333 μm mesh sieve for further processing.

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Figure 32: Some samples comprised many salps and other gelatinous animals, such as haul R35 on 29 October 2020.

Figure 33: Copepods and other small crustaceans were ubiquitous and present in most of the net tows with varying abundances, such as haul R23 on 27 October 2020.

10.3 Acoustic echosounder fish survey

Echograms are traditionally used to visualize acoustic-trawl data where the pixel color corresponds to the nautical acoustic scattering coefficient (NASC m^2 nmi^{-2}), which represents the integrated acoustic

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backscatter for each 100 m (horizontal) by 5 m (vertical) bin used for analysis. Weak and strong backscatter is characterized by blue-gray and red-brown colors, respectively.

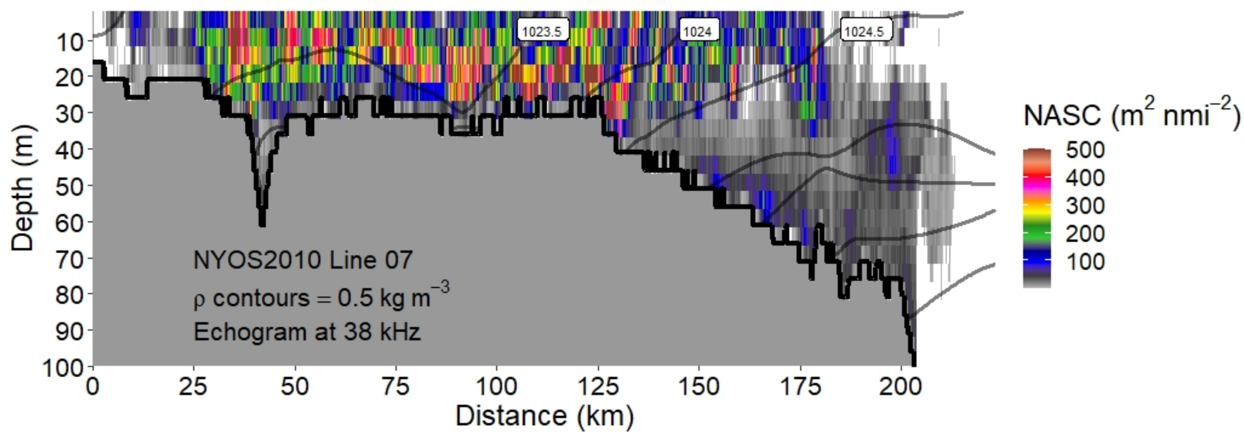

Figure 34: The echogram at 38 kHz from Line 07 from the 2020-10 survey was overlaid with interpolated density (ρ, kg m-3) isopycnal contours (0.5 kg m-3 resolution) to examine whether hydrographic features are associated with backscatter aggregations. In this transect, a diffuse aggregation was consistently present for over 150 km until the edge of the continental shelf was reached.

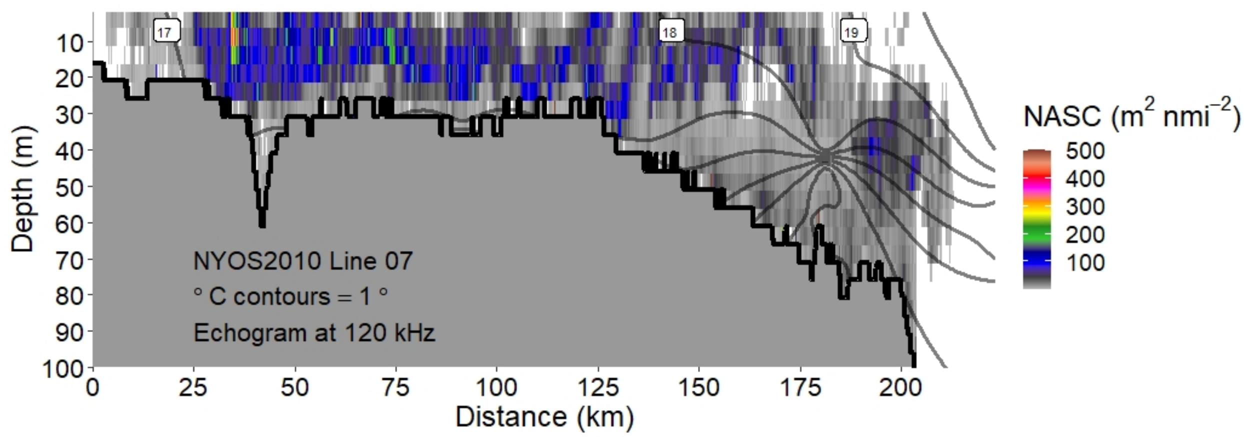

Figure 35: The echogram at 120 kHz from Line 07 from the 2020-10 survey was overlaid with interpolated temperature (°C) isothermal contours (1°C resolution) to examine how acoustic backscatter was distributed with changes in temperature. Compared to the 38 kHz echogram (Figure 1.3.1), acoustic backscatter was relatively weaker at 120 kHz, which would suggest that the aggregation comprised at least small swimbladdered fish.

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