2021

Monitoring Living Marine Resources in the Mid-Atlantic Bight

Northeast Area Monitoring & Assessment Program (NEAMAP)

Virginia Shark Monitoring & Assessment Program (VASMAP)

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Grant Recipient: Virginia Institute of Marine Science (VIMS)
Award Period: July 1, 2021 – June 30, 2022
Reporting Period: July 1 – December 31, 2021
Principal Investigators: Dr. Robert J. Latour, James Gartland, Christopher F. Bonzek

Northeast Area Monitoring & Assessment Program (NEAMAP)

Project Description

The NEAMAP Mid-Atlantic/Southern New England (M-A/SNE) Near Shore Bottom Trawl Survey is a fishery-independent monitoring program designed to collect information on the late juvenile and adult stages of the majority of the finfish species and several exploited invertebrates inhabiting the coastal ocean of the Mid-Atlantic Bight Ecological Production Unit (Figure 1). This survey yields indices of relative abundance, expressed in terms of both number and biomass, spatiotemporal distribution, and length-frequency data for all species collected by the sampling gear. For species of management interest (i.e., those managed by the ASMFC, Mid-Atlantic Fishery Management Council [MAFMC], and New England Fishery Management Council), additional information including length-weight relationships, sex ratio, size- and age-at-maturity, age-structure, length-at-age, and diet (to name a few) are available. Data generated from this survey have been incorporated into 28 single-species stock assessments and one ecosystem-level assessment to date, and also are now being used to generate a suite of ecosystem status indicators to support the development of Ecosystem & Socioeconomic Profiles (ESP) and Integrated Ecosystem Assessments (IEA) for the Mid-Atlantic. When used in conjunction with the information generated by the NOAA Fisheries, Northeast Fisheries Science Center (NEFSC) surveys, NEAMAP data permit a more holistic evaluation of the status of fisheries resources in the Mid-Atlantic and Southern New England. The NEAMAP survey design, sampling methods, data auditing routines, and analytical frameworks were approved through a programmatic peer review completed in February 2009. These protocols have been maintained throughout the time-series of this survey.

Project Update

Field & Laboratory Operations

As in preceding years, activities from July through mid-September centered around preparations for the fall cruise (i.e., equipment maintenance & repair, system calibrations, acquisition of supplies, receipt of sample requests, safety reviews, etc.), evaluation and improvement of sampling protocols, and processing of ageing hard parts and stomach samples in the laboratory. Efforts throughout October and into mid-November were focused on conducting the fall cruise, and primarily transitioned back to equipment maintenance and sample processing by late November.

The Fall 2021 cruise was conducted between 4 October and 7 December. The cruise was completed in full, with 150 sites sampled. Note that while 7 December represents the latest completion date for a fall

NEAMAP cruise, most of the sampling associated with this survey occurred between 4 October and 12 November. Specifically, 145 sites were sampled during that timeframe. A series of cold fronts in late November forced a suspension of operations. Rather than terminate the cruise, survey personnel (both scientific and vessel) decided to complete the remaining five tows during the short period of fair weather that occurred in early December.

It was necessary to sample 18 randomly selected alternate sites during the Fall 2021 survey, a rate which is consistent with that of previous cruises (i.e., average of 18.25 alternates/cruise). Nine of these alternate sites were sampled in Block Island Sound and Rhode Island Sound, while three were located off the coast of New Jersey, and two each occurred along the south shore of Long Island and the coast of Delaware. One alternate site was sampled off of Virginia and one off of North Carolina. Sampling alternates in place of primary sites was necessary in the Sounds and along Long Island, New Jersey, and Delaware due to obstructions (primarily rocks, boulders, and anthropogenic structures) on the bottom, while those in the southern region of the survey area were sampled to avoid fixed fishing gear and non-fishing operations (e.g., sand mining and vessel traffic) in the primary cells. It is worth reiterating that alternates are selected using a stratified random design; resulting data thus are fully compatible with and integrated into the survey dataset. No major equipment failures or losses occurred during the Fall 2021 cruise.

Field data from the Fall 2021 survey were included into the master data set within two weeks of the end of the cruise, though the actual amount of time required for post-cruise data auditing was about three person-days. Note that the Fall 2021 catch data were available to fulfill all assessment-related data requests received by the work group within requisite timelines (more information below). Currently all NEAMAP M-A/SNE data are stored in an MS SQL Server data base, which is interfaced to local users through a more user-friendly MS Access front end.

All of the stomach samples collected through the Spring 2021 survey have been analyzed, and the samples from the Fall 2021 cruise currently are being processed. It is worth highlighting that the experience gained in stomach sample processing by technical staff since the inception of this survey has yielded increased processing efficiency; the time required to process stomach samples from a given cruise continues to decrease, while data quality has been maintained. The Multispecies Research Group (MRG) NEAMAP finfish diet database currently contains records from 126,568 individual fishes.

Processing ageing structures (primarily otoliths) is generally a more time-consuming yet more time-sensitive procedure, given the routine incorporation of age data into the stock assessment process. For ageing, species are prioritized each year according to the schedule of upcoming stock assessments. Although this approach can result in age-assignments for a given species becoming somewhat back-logged for a short time if an assessment for that species is not imminent, this protocol ensures that NEAMAP age data are readily available for each assessment workshop. Note that efforts to generate age data from NEAMAP-derived samples continued throughout all phases of the pandemic, and all requisite age data have been provided to partner agencies in a timely manner to continue to support assessment activities.

Age-assignments have been completed for all samples collected through the Spring 2021 cruise for the following species (sample size for each species through Spring 2021 given in parenthesis):

- Atlantic Cod (3)

- Atlantic Croaker (4,856)
- Atlantic Menhaden (1,539)
- Black Drum (431)
- Black Sea Bass (4,936)
- Bluefish (6,767)
- Butterfish (16,612)
- Pollock (2)
- Red Drum (50)
- Scup (17,381)
- Spot (3,253)
- Spotted Seatrout (90)
- Striped Bass (671)
- Summer Flounder (10,754)
- Tautog (216)
- Weakfish (12,578)
- Windowpane (4,198)
- Winter Flounder (6,686)
- Yellowtail Flounder (18)

Finfish hard parts collected during the Fall 2021 cruise have been prioritized, and the preparation of these samples for age determination is ongoing. Approximately one-third of the samples collected during the Fall 2021 survey have been processed as of early-January 2022. Ageing samples from a few finfish species have not been processed since the inception of the survey due to either the lack of an accepted ageing protocol or an age-based assessment. MRG has an appreciable collection of elasmobranch vertebrae (mostly clearnose/little/winter skates and smooth/spiny dogfishes) that have yet to be processed and aged for the same reasons listed above, and also because preparation of these samples is very time consuming. However, NEAMAP staff continue to work with personnel at the NEFSC to identify efficient processing methods for these species and have employed several interns, hourly employees, and graduate students to assist in the initial stages of preparation (i.e., sample cleaning & mounting).

Survey personnel are exploring the use of computed tomography (CT) scan technology for ageing these elasmobranchs, and may attempt to acquire such a machine in the coming years. This technology also may be useful to generate age information based on daily ring counts from statoliths of both longfin and shortfin squid collected by NEAMAP. As such, project PIs reached out to the Museum of Comparative Zoology at Harvard University in October 2021 to explore the possibility of securing CT time to generate cross-sectional images of longfin squid statoliths, and researchers at the Museum agreed to this collaboration. Samples collected from 10 longfin squid were sent to the Museum in mid-December 2021, and CT images are expected to be available for evaluation by late January 2022. Regardless, the collection of unprocessed specimens includes:

- Alewife (3,839)
- American Shad (3,740)
- Atlantic Herring (1,168)
- Blueback Herring (3,330)
- Clearnose Skate (7,666)
- Little Skate (7,693)

- Monkfish (311)
- Silver Hake (7,128)
- Smooth Dogfish (5,243)
- Spiny Dogfish (3,658)
- Winter Skate (5,999)

Data Uses & Products

NEAMAP M-A/SNE data are now accepted for inclusion in nearly all assessments for which the program has appreciable data to contribute. Specifically, NEAMAP survey data have been incorporated into assessments on American lobster, Atlantic croaker, Atlantic mackerel, Atlantic menhaden, Atlantic sturgeon, black sea bass, bluefish, butterfish, longfin squid, river herring (blueback herring & alewife), scup, spot, striped bass, summer flounder, weakfish, windowpane flounder, and winter flounder. As mentioned in previous progress reports, NEAMAP data on summer flounder were incorporated into the 2018 benchmark assessment for that species (SAW/SARC 66), and data on striped bass also were included in the 2018 benchmark assessment. As part of the summer flounder assessment, NEAMAP catch data on this species were combined with those generated by the NEFSC using a vector-autoregressive spatio-temporal (VAST) model to evaluate distributional shifts (Perretti & Thorson 2019). NEAMAP data on shortfin squid have been considered informally by MAFMC and NEFSC staff, and were evaluated during a collaborative, industry/NEFSC *Illex* Summit in November 2019. Following this summit, NEAMAP catch data on shortfin squid were combined with other data sources to quantify the 'footprint' of the current fishery relative to the distribution of these squid on the continental shelf. This research effort was presented to the MAFMC Scientific & Statistical Committee in 2020 and 2021, has since been published in a peer-reviewed journal (Lowman et al. 2021), and currently is being considered for inclusion in the research track stock assessment of this species.

In 2019, NEAMAP personnel presented research to the ASMFC Atlantic Menhaden Technical Committee (TC) on the reproductive biology and fecundity of Atlantic menhaden; approximately half of the ovary samples included in this effort were derived from NEAMAP field sampling, while the remainder were provided by industry partners. This investigation found that Atlantic menhaden exhibit indeterminate batch spawning (as opposed to determinate total spawning), and in turn that age-specific annual fecundity is approximately 625% greater than previous estimates. These findings were incorporated into the 2019 benchmark assessment for this species. Additional ovary samples were collected and processed in 2019 and 2020, and a manuscript based on this investigation is in development (Latour et al., *In Prep*). Updated fecundity estimates will be provided to the Atlantic Menhaden TC prior to the next assessment for this species. NEAMAP personnel collected ovary samples from summer flounder during the Fall 2020, Spring 2021, and Fall 2021 cruises, and are in the midst of reevaluating the reproductive biology of this species using similar approaches to those applied to Atlantic menhaden.

During this reporting period, NEAMAP data on black drum, black sea bass, bluefish, and spiny dogfish were provided to the ASMFC and NEFSC in support of the assessments for those species. Further, NEAMAP PIs currently are working in collaboration with personnel at NEFSC Ecosystem Dynamics & Assessment Branch (EDAB) to develop a bluefish prey index using the VAST modelling framework in support of the research track assessment for this species. Information on Atlantic thread herring was supplied to Scientific & Statistical Committee of the MAFMC to facilitate evaluation of the development of an experimental fishery for this species in the Mid-Atlantic. Survey PIs participated in two workshops

during this reporting period that were designed to improve fisheries data collection on the US East Coast; namely, the US East Coast Data Collection Workshop sponsored by NOAA Fisheries and the Mid-Atlantic Research Set-Aside Workshop hosted by the MAFMC. NEAMAP personnel also served on a Responsible Offshore Development Alliance (RODA) panel focused on improving data sharing practices in the Northeast US.

NEAMAP data were provided to a number of external research entities during this reporting period for non-assessment purposes. The full NEAMAP survey dataset was conveyed to MAFMC staff to support the ongoing Northeast Regional Marine Fish Habitat Assessment (NRHA). Subsets of these data also were submitted to Kitty Hawk Wind (NC), Coastal Virginia Offshore Wind (VA), and Atlantic Shores Wind (NJ) to underpin the evaluation of the possible environmental impacts of construction and operation of these proposed offshore wind farms. The complete NEAMAP catch dataset was provided to researchers at East Carolina University to support an investigation designed to evaluate whether species distribution shifts vary by life-stage on the Northeast Shelf. Catch data on longfin squid were supplied to Stony Brook University and on Atlantic menhaden to Cornell University to support development of distribution models for those species. Further, data on 14 species were provided to the New York Natural Heritage Museum which, in conjunction with the New York Department of Environmental Conservation, planned to evaluate the conservation status of these taxa. Weakfish stomach content data were provided to the NEFSC to support an investigation meant to compare diet composition across estuarine (i.e., Chesapeake Bay Multispecies Monitoring & Assessment Program [ChesMMAP]), near coastal (NEAMAP), and offshore (NEFSC Bottom Trawl Surveys) habitats. NEAMAP data on windowpane flounder were included in a recent publication designed to quantify the distribution of that species in Southern New England (Bell et al. 2021), and bottom temperature data were provided to the Massachusetts Division of Marine Fisheries to support an investigation into channel whelk life history (Wilcox et al. 2021). Information on NEAMAP survey gear configuration and performance were provided to the Cornell Cooperative Extension, the University of Massachusetts, Dartmouth (SMAST), and Rutgers University to support their development of monitoring efforts in offshore wind lease areas.

Project PIs have continued to work with personnel at EDAB to incorporate NEAMAP data into the annual Mid-Atlantic State of the Ecosystem (SOE) Reports. The 2021 SOE report included updates to NEAMAP biomass indicators (Figure 2), and survey data to support the development of these indicators for the 2022 report will be submitted in the coming weeks. In parallel with these efforts, NEAMAP personnel are conducting research to advance the methodology associated with the development of select ecosystem indicators using relatively novel modelling approaches (Figure 3. a-f) (Gartland & Latour, *In Prep*). Further, a VIMS PhD student is using data from both the ChesMMAP and NEAMAP surveys to investigate the exchange of several species between Chesapeake Bay and the nearshore coastal ocean ecosystems using a beta-binomial modelling framework (Figure 4) (Schonfeld et al., *In Prep*).

As noted in previous progress reports, the owner/operator of the *F/V Darana R* has invested in and installed a Simrad ES80 wideband ecosounder that enables the NEAMAP M-A/SNE survey to record valuable acoustic data from the water column. Data were collected from this system on each survey tow during the last six cruises (i.e., 900 files in total). A member of the NEAMAP survey team completed coursework on methods to process and interpret these data files, VIMS purchased the requisite post-processing software (EchoView) in December 2020, and evaluation of these acoustic files is underway. Note that the results of the preliminary evaluation of these data were used to both correct the

calibration of and remove acoustic interference from the system installed on the *Darana R*, thus improving future data collection efforts.

NEAMAP and the NEFSC received funding in December 2019 for a collaborative research project designed to use the acoustic data collected by these two programs to improve survey-derived abundance estimates of butterfish and Atlantic mackerel. Survey personnel from these organizations have worked closely over the past two years to interpret the acoustic data and compare acoustic signatures with associated trawl-based catch data. NEAMAP personnel recorded electronic measurements of fat content from 1100 butterfish during the Fall 2020 cruise, 900 butterfish during Spring 2021, and 875 butterfish during Fall 2021, and have provided those data to NEFSC personnel. These fat content measures will be used to further resolve the acoustic signature of butterfish and likely will be instrumental in the generation of estimates of capture efficiency and eventually acoustically-derived estimates of abundance for this species.

Funding

Given that the NEAMAP M-A/SNE Survey was fully funded for the June 2021-July 2022 period, personnel were able to conduct a full cruise in Fall 2021, maintain laboratory productivity at high levels, and continue to support assessment activities while expanding the suite of data products generated by this program. A full cruise is planned for Spring 2022. Project PIs will work with the directorate of the ASMFC and NEFSC to secure requisite funding for the July 2022-June 2023 sampling period, so as to ensure that both Fall 2022 and Spring 2023 cruises can occur as planned and in full.

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Figure 1. Sampling frame of the NEAMAP Mid-Atlantic / Southern New England Near Shore Bottom Trawl Survey in the Mid-Atlantic Bight Ecological Production Unit.

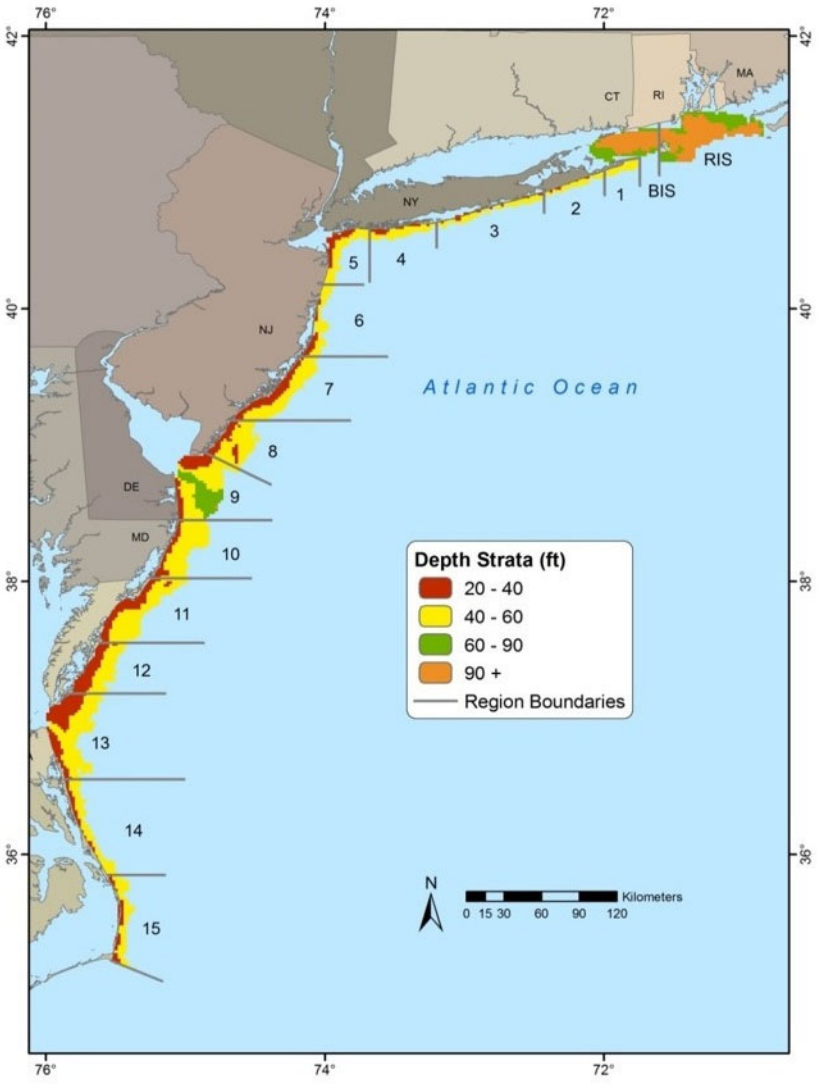

Figure 2. Spring (left) and fall (right) surveyed biomass of select trophic guilds included in the annual Mid-Atlantic State of the Ecosystem reports generated by the NEFSC and a number of collaborating agencies. Data from the NEFSC Bottom Trawl Survey are shown in black, while NEAMAP M-A/SNE data are shown in red. Statistically significant increasing trends are indicated by an orange line, and the most recent 10-year period is shaded gray.

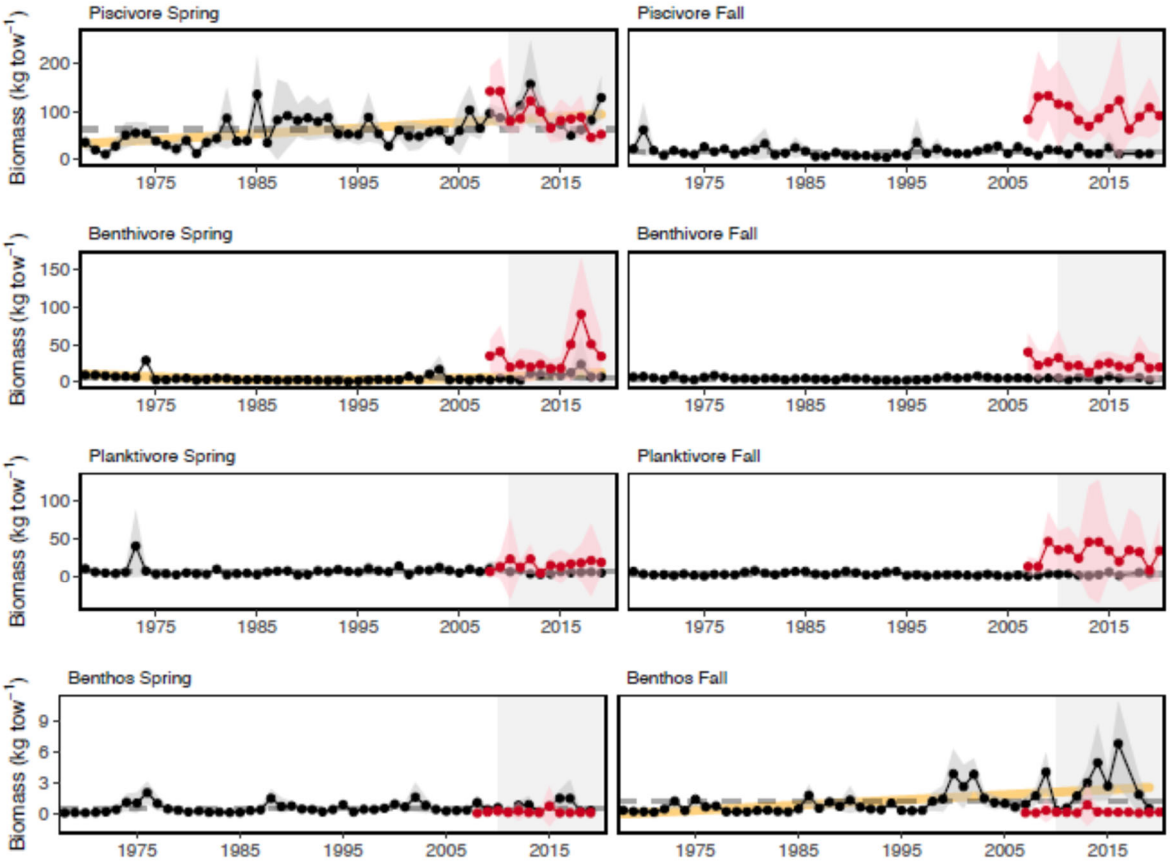

Figure 3 a-f. Model-based time-series' of relative abundance for nine aggregate species groupings (i.e., ecomorphotypes [EMTs]) sampled by the NEAMAP Mid-Atlantic/Southern New England Near Shore Bottom Trawl Survey from 2008-2018 based on dynamic factor analysis (DFA). Annual trends of relative abundance for each EMT were standardized using a delta-generalized additive modelling (delta-GAM) framework. Coherence among and estimates of these trends were quantified using DFA. (a) First common trend (solid line) and 95% confidence intervals (dashed lines) generated from DFA using annual relative abundance values derived from delta-GAMs. (b) Factor loadings for each EMT on the first common trend; statistically significant loadings are denoted by an asterisk. (c) Fits to the relative abundance time-series for each EMT with a statistically significant loading on the first common trend. [Next Page] (d) Second common trend (solid line) and 95% confidence intervals (dashed lines) generated from DFA using annual relative abundance values derived from delta-GAMs. (e) Factor loadings for each EMT on the second common trend; statistically significant loadings are denoted by an asterisk. (f) Fits to the relative abundance time-series for each EMT with a statistically significant loading on the second common trend.

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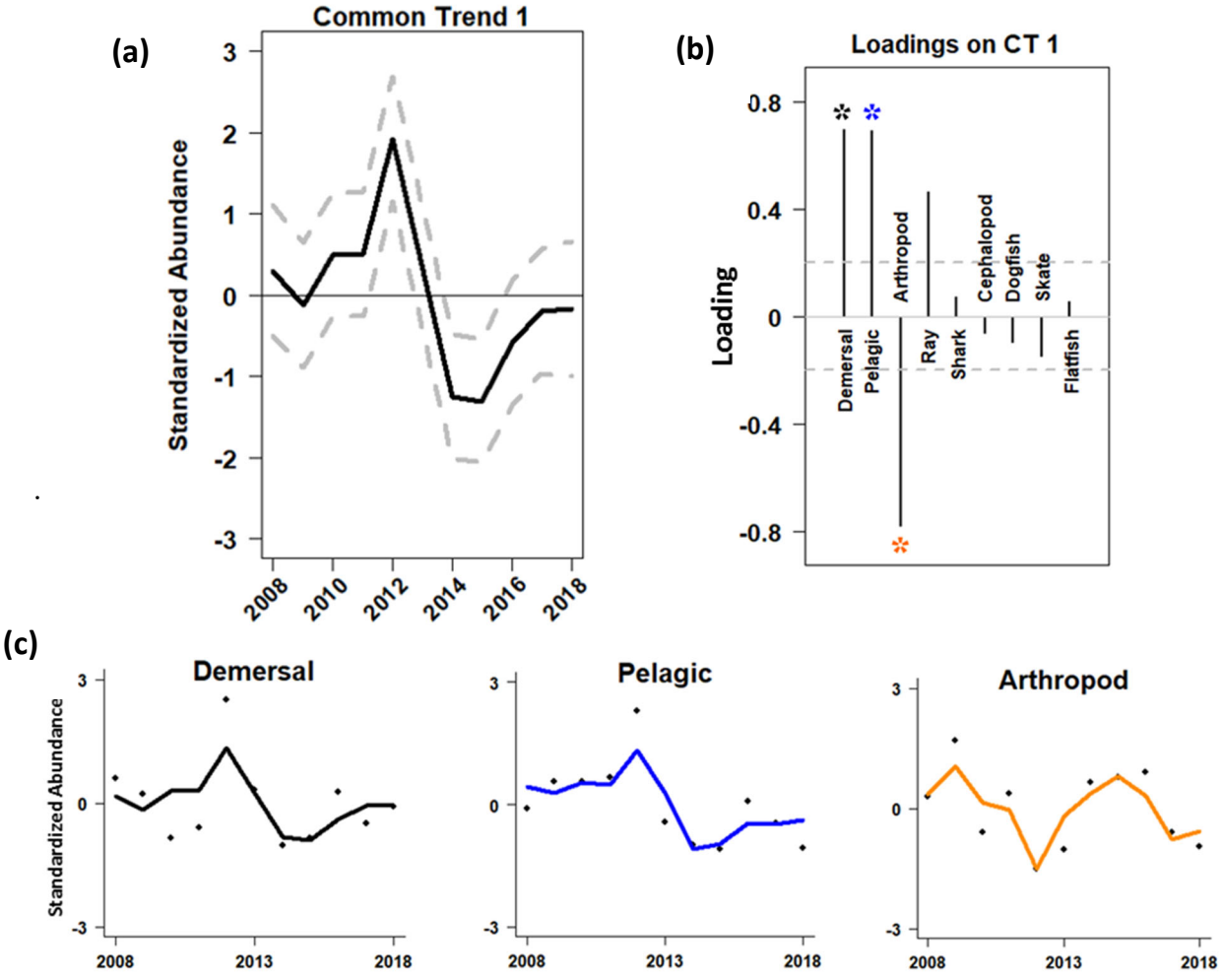


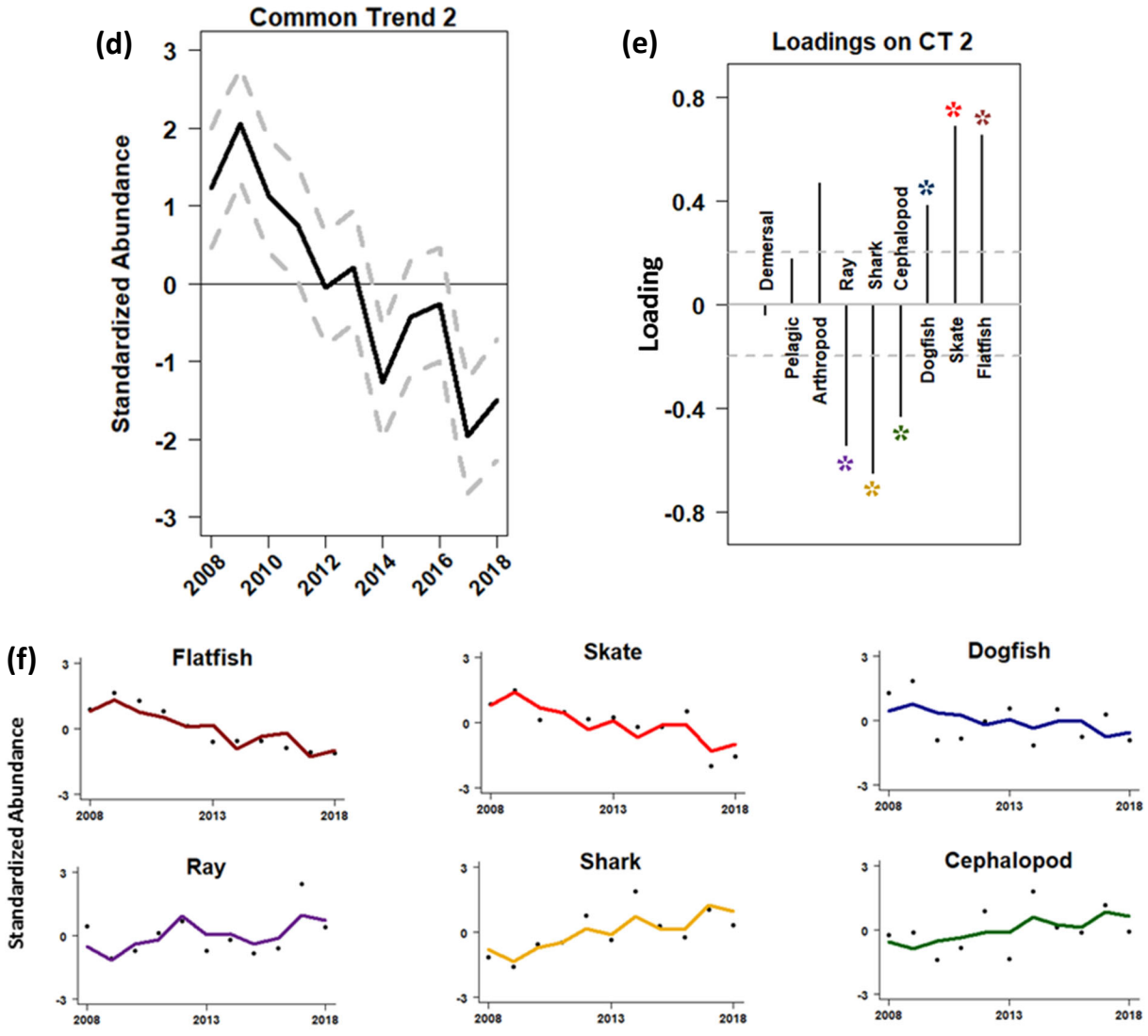
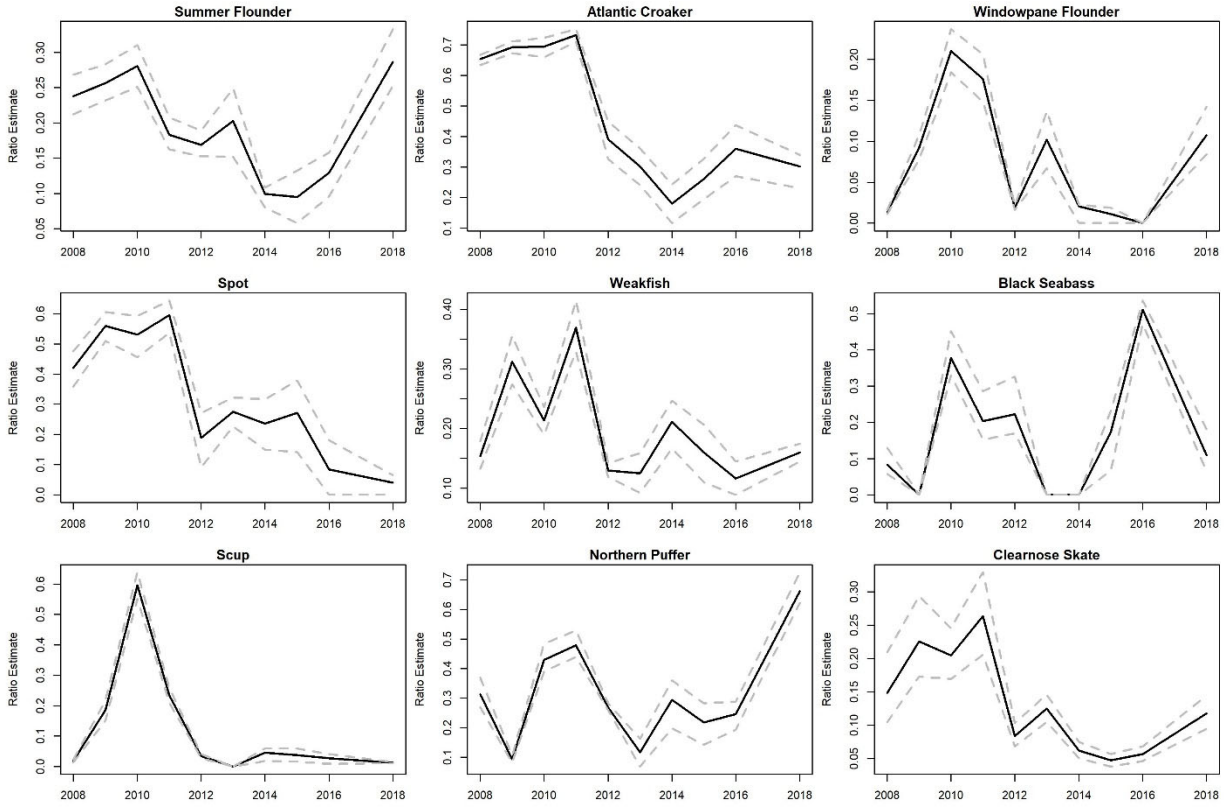

(d)
Common Trend 2
Standardized Abundance
3
2
1
0
-1
-2
-3
2008
2010
2012
2014
2016
2018
(e)
Loadings on CT 2
Loading
0.8
0.4
0
-0.4
-0.8
Demersal
Pelagic
Arthropod
Ray
Shark
Cephalopod
Dogfish
Skate
Flatfish
(f)
Standardized Abundance
Flatfish
Skate
Dogfish
Ray
Shark
Cephalopod
2008
2013
2018

Figure 4. Predicted trends in use of the Chesapeake Bay relative to the adjacent coastal ocean ecosystem for an array of finfishes from 2008-2018, derived from the implementation of the beta binomial modelling framework. Specifically, each observation of the response variable was generated from a random pairing of a ChesMMAP tow and a NEAMAP tow (restricted between Barnegat Light, NJ and Cape Hatteras, NC) and quantified as the ratio of the count of a given species in the ChesMMAP tow to the combined catch of that species in both tows. A year covariate was included as a predictor variable in this model, while additional environmental covariates will be included in alternate model formulations in the near future. Downward trends for a given species indicate that the use of Chesapeake Bay is declining relative to the use of the adjacent coastal ocean, while an increasing trend represents the opposite phenomenon. Gray dashed lines represent 95% confidence intervals.



Virginia Shark Monitoring & Assessment Program (VASMAP)

Project Description

VASMAP is a research program that focuses on advancing the scientific enterprise associated with juvenile and adult stages of several shark species inhabiting the lower Chesapeake Bay and coastal ocean of the Mid-Atlantic Bight. Key elements of the program are two fisheries-independent surveys that are designed to collect information on relative abundance, length-frequency, sex-ratio, and other demographic characteristics for shark species encountered. The first survey was initiated in 1974 and sampling targets juvenile and adult stages of small and large coastal shark species that occur in the Mid-Atlantic Bight (Figure 5a). The second was established in 2013 as part of the Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Program and sampling focuses on neonate and juvenile sandbar sharks (*Carcharhinus plumbeus*) within nursery areas (Figure 5b). Survey data are combined with information generated from other state and federal shark sampling programs and incorporated into stock assessments conducted through the Southeast Data, Assessment, and Review (SEDAR) process. Data on sandbar, dusky (*C. obscurus*), Atlantic sharpnose (*Rhizoprionodon terraenovae*), and blacktip (*C. limbatus*) sharks collected by VASMAP have been included in the respective assessments of these species. Catch data on scalloped hammerhead (*Sphyrna lewini*) currently are being evaluated for inclusion into the assessment for that species. Results of stock assessments are used to support Atlantic shark fisheries management plans promulgated by federal (HMS, NOAA Fisheries), regional (ASMFC), and state (Virginia Marine Resources Commission) living marine resource agencies.

Project Update

Coastal Survey

All planned field sampling associated with the coastal longline survey was completed during this reporting period. The July and September cruises each began during the third week of those months, while the August survey occurred during the fourth week due the inclement weather throughout the previous week. Fourteen coastal sites were sampled during July, while 12 were completed in August and 13 were sampled during September. The VIMS longline survey vessel suffered a major mechanical failure during the August cruise, which precluded sampling of all 14 sites. Operations were transitioned to a commercial vessel, the *F/V Darana R*, for the September cruise, and one site was not sampled due to weather constraints. Note that the two sites that were not sampled in August (DI & PB) and the one in September (MU) were added to the survey design in recent years to expand the spatial extent of the sampling program. All of the historical sites were sampled during both of those months, and as such the loss of the opportunity to sample the aforementioned sites will not impair the survey dataset from a stock assessment perspective.

A total of 265 sharks were collected by the coastal longline survey during this reporting period. Catches were largest in July 2021, and were primarily driven by the abundance of Atlantic sharpnose shark and blacktip shark encountered during this cruise (Table 1). Atlantic sharpnose shark was the most abundant species collected during the August 2021 survey as well, and the dominance of this species in survey catches during the warmer summer months is consistent with observations from previous years. Total catch was lowest in September, and sandbar shark was the most abundant species collected during this late-season survey. Blacknose sharks (*C. acronotus*) were collected during the July and September

cruises. This species has been encountered consistently during summer and fall surveys since 2017, and thus it is likely that the habitat range of blacknose shark now may include the coastal waters of Virginia. Sand tiger sharks (*C. taurus*) were notably absent from the catch during these cruises.

Table 1. Monthly species-specific catch summaries for coastal longline cruises conducted from July – December 2021, pooled across sampling sites.

Month	Effort (no. sets)	Sandbar	Atlantic Sharpnose	Spinner	Dusky	Blacktip
Jul 2021	14	9	55	0	0	19
Aug 2021	12	10	67	3	6	1
Sep 2021	13	31	22	9	0	7

Month	Effort (no. sets)	Blacknose	Bull	Sand tiger	Scalloped hammerhead	Silky	Tiger
Jul 2021	14	6	1	0	1	0	3
Aug 2021	12	0	1	0	0	0	1
Sep 2021	13	8	1	0	2	0	0

COASTSPAN

The July and August 2021 VIMS COASTSPAN cruises were completed in full; 20 sites were sampled in Chesapeake Bay and 15 locations were sampled in the coastal lagoons of the Virginia Eastern Shore during each month. Cruises were conducted during the fourth week of each month. Of the 240 sharks collected by this survey during these two cruises, 231 were sandbar sharks. Three blacktip sharks, two Atlantic sharpnose sharks, a blacknose shark, a scalloped hammerhead shark, a smooth hammerhead shark (*S. zygaena*), and a smooth dogfish (*Mustelus canis*) also were encountered. The overwhelming majority of the sandbar sharks caught in Chesapeake Bay and lagoons of the Virginia Eastern Shore were neonates, while small and large juveniles were encountered in near equal numbers (Table 2). Although fewer sites are sampled in the coastal lagoons, nominal catch of neonate sandbar sharks was greater in these lagoons than in the mainstem of Chesapeake Bay. Catches of sandbar shark on the seaside of the Eastern Shore typically have exceeded those in the bay since the inception of this COASTSPAN survey.

Table 2. Monthly catch summaries for sandbar shark collected by the VIMS COASTSPAN Survey in (a) Chesapeake Bay and (b) the coastal lagoons of the Virginia Eastern Shore. Neonate sandbars are <71 cm total length (TL), small juvenile are 71-90 cm TL, and large juvenile are >90 cm TL.

(a)

Month	Effort (no. sets)	Neonate (<71 cm TL)	Sm. Juv. (71-90 cm TL)	Lg. Juv. (> 90 cm TL)
Jul 2021	20	45	6	1
Aug 2021	20	47	6	0

(b)

Month	Effort (no. sets)	Neonate (<71 cm TL)	Sm. Juv. (71-90 cm TL)	Lg. Juv. (> 90 cm TL)
Jul 2021	15	62	1	2
Aug 2021	15	55	0	2

Data Uses & Products

As noted above, data from the VASMAP coastal longline survey have been used to support stock assessment and management activities associated with sandbar, dusky, Atlantic sharpnose, and blacktip sharks. PI Latour currently is involved with SEDAR 77, which is focused on resolving stock identification for and conducting quantitative assessments of hammerhead shark species. It is expected that VASMAP data on smooth hammerhead sharks will be incorporated into these efforts. In general, given that the data generated by this coastal longline survey extend back to 1974, the survey provides valuable time-series' of relative abundance on which to base stock assessment activities. Length data collected by this survey have been used to evaluate the size-structure of several shark species. Fin clips are collected from each shark captured by this survey, and as such this program has supported genetic investigations into the stock structure of several shark species that inhabit the US Atlantic Coast. This material currently is being used in an ongoing evaluation of the population structure of the sand tiger shark. Virginia COASTSPAN data on sandbar shark are routinely combined with information produced by other COASTSPAN partner agencies along the Atlantic Coast to monitor the early life stages of this species.

In addition to providing direct support to the assessment activities for several shark species, data generated by the coastal longline survey and COASTSPAN have been used to support numerous independent investigations meant to provide insight into the biology and ecology of Atlantic sharks, advance assessment methods for these stocks, quantify management trade-offs, and evaluate operational efficiency of fisheries-independent longline surveys for these species. Specifically, a recent VIMS student used data from the coastal survey in conjunction with other longline surveys to show that

several shark species are beginning to recover from low levels of abundance observed in the late 1980s and 1990s (Peterson et al. 2017a). These datasets also were used to evaluate density-dependent compensation and interspecific interactions among several shark populations at both localized and broader (i.e., coastwide) scales (Peterson et al. 2017b). This student leveraged this research to develop a dissertation designed to evaluate the utility of dynamic factor analysis (DFA) as an approach to resolve conflicting abundance indices for both sandbar and Atlantic sharpnose shark under different scenarios (Peterson et al. 2021a), to quantify the performance of DFA-derived indices in the associated stock assessments (Peterson et al. 2021b), to explore trade-offs among control rules and harvest strategies associated with the sandbar shark fishery via management strategy evaluation (Peterson et al., *In Review a*), and to evaluate the frequency at which this species should be assessed (Peterson et al., *In Review b*). She completed this dissertation work in August 2021. Project PIs also collaborated with this student to evaluate the effect of soak time on catch rate and composition for the VASMAP coastal longline survey (Peterson et al. 2017c).

An investigation of the community structure of shark species based on VASMAP coastal longline survey data and published by project PIs resulted in the development of several ecosystem indicators for these apex predators, and the findings of this study were complimentary to those based on single-species approaches outlined above; namely, measures of the diversity, abundance, and size-structure of this community were consistent with recovery (Latour & Gartland 2020). Further, a recent VIMS PhD student used Virginia COASTSPAN data to develop habitat niche models for juvenile sandbar shark in Chesapeake Bay and project changes in available habitat under multiple climate change scenarios (Crear et al. 2020). Similar efforts are underway using coastal longline data to quantify niche models for and possible responses to climate change by the adult stages of several shark species on the continental shelf, and this research is being led by a VIMS PhD student (O'Brien & Latour, *In Prep*). This student also intends to use data limited methods to develop stock assessment approaches for several small and large coastal sharks that are not currently assessed (e.g., Angel [*Squatina dumeril*], spinner [*C. brevipinna*], & sand tiger sharks), and to evaluate management trade-offs for select species. Project PIs currently are using Virginia COASTSPAN data to quantify and identify the drivers of habitat partitioning between neonate and juvenile sandbar sharks in Chesapeake Bay (Latour & Gartland, *In prep*). Taken together, these investigations provide the requisite scientific underpinnings needed to advance both the assessment and management of these apex predators.

Funding

Given that the VASMAP Survey was fully funded for the June 2021-July 2022 period, personnel were able to conduct full cruises for the coastal longline survey in July, August, and September 2021, and expect to complete a full survey in June 2022. Complete COASTSPAN surveys also were conducted in July and August 2021, and a cruise is planned for June 2022. Project PIs will work with the directorate of the ASMFC in an effort to secure full funding for the July 2022-June 2022 sampling period, so as to continue all routine sampling associated with the coastal longline survey and COASTSPAN during the upcoming year.

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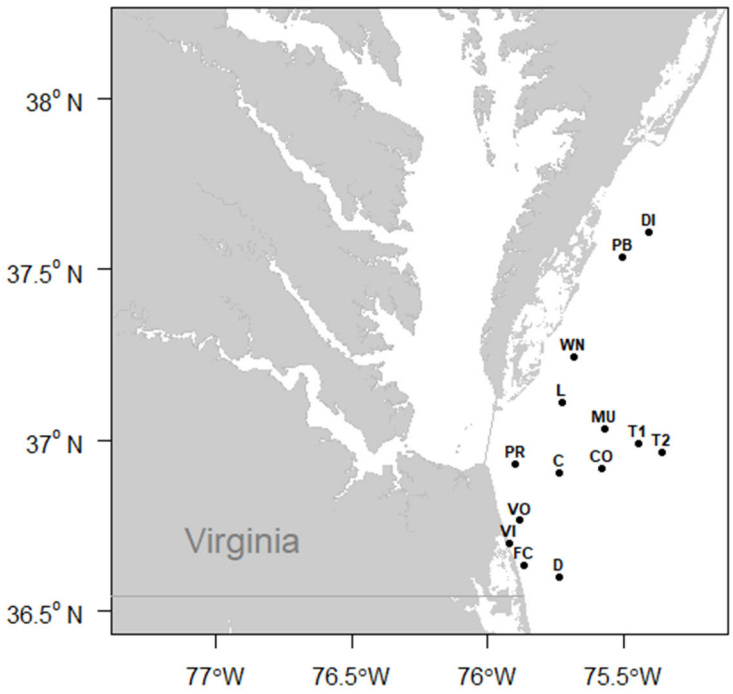
Figure 5. (a) Locations of the 14 fixed sites sampled by the VASMAP coastal longline survey monthly between June and September each year. Sites VI, VO, C, L, WN, T1, and T2 have been sampled since 1974, PR was added in 2012, and consistent sampling of the remaining sites began in 2018 to expand the spatial extent of the survey. (b) An example of the distribution of sites sampled during a Virginia COASTSPAN cruise conducted in the lower mainstem of Chesapeake Bay and coastal lagoons of the Virginia Eastern Shore. Sites are selected using a stratified random design prior to each COASTSPAN cruise, and those in the figure represent sites sampled during the August 2020 survey. Sampling has occurred monthly from June through August since 2013.

a.



b.