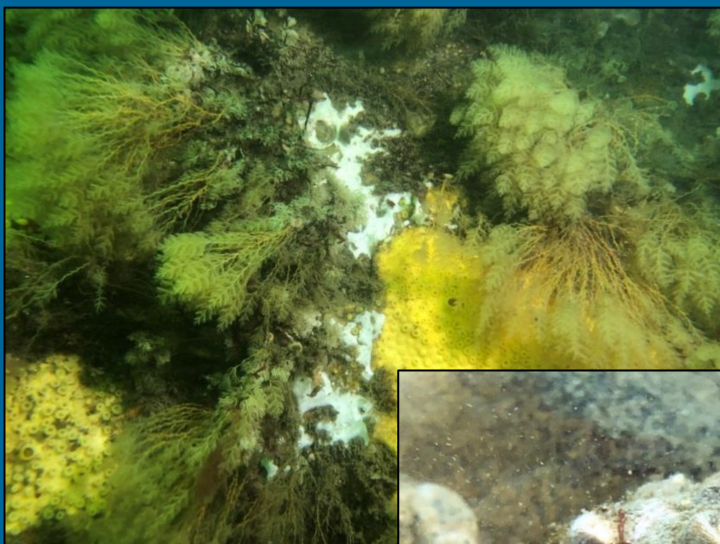
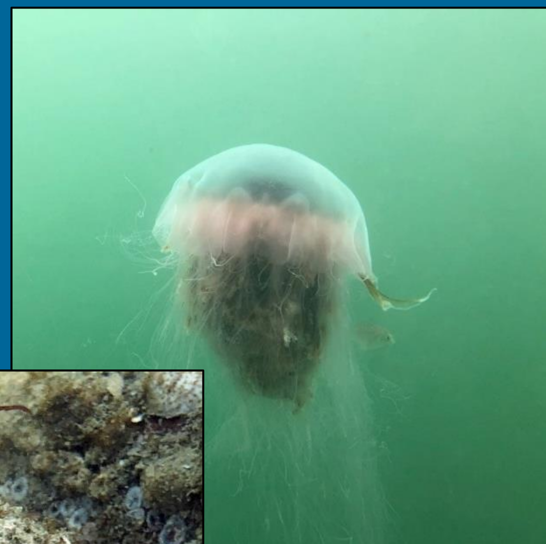
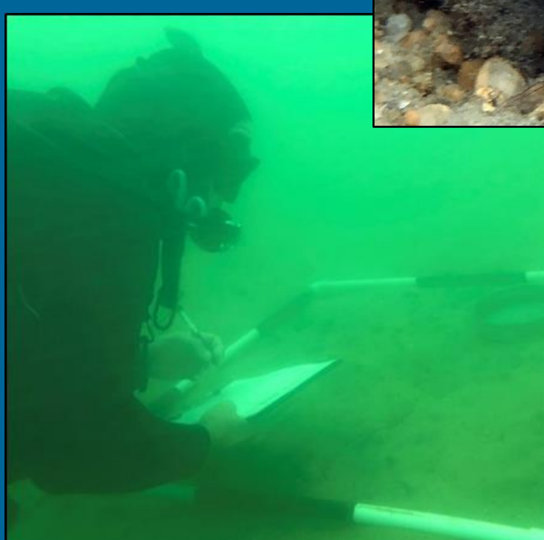
Initial Survey of Plum Island's Marine Habitats







New York
Natural Heritage
Program

INNERSPACE SCIENTIFIC DIVING
SCIENCE IN DEPTH

Initial Survey of Plum Island's Marine Habitats

Emily S. Runnells
Matthew D. Schlesinger
Gregory J. Edinger

New York Natural Heritage Program

and

Steven C. Resler
Dan Marelli

InnerSpace Scientific Diving

A report to Save the Sound

April 2020

Please cite this report as follows: New York Natural Heritage Program and InnerSpace Scientific Diving. 2020. Initial survey of Plum Island's marine habitats. Report to Save the Sound. Available from New York Natural Heritage Program, Albany, NY.

Cover photos (left to right, top to bottom): Bryozoans and sponges; lion's mane jellyfish; flat-clawed hermit crab; diver recording information from inside quadrat; bryozoans, sponges and northern star corals. All photos herein by the authors.

Contents

Introduction

The islands extending off Long Island's North Fork, including Plum Island, are known as areas of ecological importance. The Orient Point-Plum Island Important Bird Area (Burger and Liner 2005) is recognized because it supports a diversity and abundance of birds that feed in the marine environment. Plum Gut, the choppy waters between the island and Orient Point, is noted as a foraging area for endangered terns and a popular recreational fishing spot and is designated as Significant Coastal Fish and Wildlife Habitat (New York State Department of State 2005). However, there has been very little effort to gather detailed information on the benthic habitats underpinning the surrounding marine diversity. Our goal in this study was to describe and map subtidal natural communities and begin to document their resident organisms. We aimed to provide important data and methodological testing for a larger study in future years to map all of Plum Island's offshore habitats and more fully inventory their animals and plants.

The Plum Island Biodiversity Inventory (Schlesinger et al. 2016), conducted in 2015, included a brief survey of the eelgrass meadows on the west side of the island and preliminary surveys of the marine rocky intertidal community around its perimeter, but the subtidal marine habitat and benthic species around the island are largely unknown. The final report recommended additional survey work to expand the marine scope spatially and taxonomically. Coarse-scale seafloor data from the National Oceanographic and Atmospheric Administration and the U.S. Geological Survey, plus more recent benthic sampling efforts in eastern Long Island Sound, suggest extensive hard bottom and gravel substrates in the area to the north and west of Plum Island (Poppe and Seekins 2000; Reid et al. 2005, P. Auster personal communication), which may support diverse assemblages of macroinvertebrates and encrusting organisms. This may be one of the few places in New York where expanses of macroalgal communities, such as kelp beds, thrive. A variety of high-priority Species of Greatest Conservation Need (New York State Department of Environmental Conservation 2015) including the Harbor Porpoise, Kemp's Ridley Sea Turtle, American Lobster, Tautog (Blackfish), Lined Seahorse, White Shark, and Roseate Tern may be relying on habitats around the island for protection and food, and documenting their occurrence could inform management. This fieldwork is the first step in producing a detailed map of sediment type and understanding which benthic communities and at-risk species can be found in this important area.

Methods

The original plan for SCUBA survey and sampling was to conduct traditional and commonly used quantitative rather than qualitative transect/quadrat diver observations and sampling at set distances apart from one another (both qualitative and quantitative transect/quadrat methods are standard practice (Joiner 2001; Heine 2011). Transects perpendicular to the shoreline with quadrats were planned around the entire circumference of the island, starting from points of approximately 3 meters deep near shore and running seaward to a depth of approximately 9 meters or a linear distance of 183 meters, whichever came first. Quadrats along physical transect lines laid along the surface of benthic substrates would be spaced anywhere from every 3–5 meters to perhaps every 10–20 meters along transects. Where and when possible, without interfering with basic survey tasks, some basic digital still and video imaging by divers would be included. We initially considered higher quality imaging but discounted the idea given the additional tasks and time involved; we determined it was a higher priority to cover and generally characterize as much area around the island as possible during the survey.

The total number of possible transects and quadrats around the island would be limited by such factors as

- numbers of possible dives per day for two scientific divers working as a team;
- weather and sea state conditions;
- bathymetry;
- geological characteristics (rocky, sandy, vegetated);
- tidal and wind-driven currents;
- in-water visibility;
- species abundance and diversity;
- availability of a suitable topside support vessel and crew, and
- if and as necessary modified based on reconnaissance dives and assessments of conditions/circumstances.

A maximum of 5 days of field work were planned, conditions permitting. The first day of in-water field work, on September 9, 2019, involved reconnaissance dives around the island for a general characterization of the areas. This was to help estimate the numbers and lengths of transects, quadrats, type and degrees of observations and sampling that might be necessary, and the type and number of in-water tasks that could be accomplished given the above limitations.

For surface support the New York State Department of Environmental Conservation's (NYS DEC) Division of Marine Resources (DMR) provided a 8-meter Boston Whaler Challenger (R/V Delphinus) equipped with SCUBA cylinder tie-down brackets, two 250 HP engines, navigation plotting, and depth display and recording electronics. DMR provided two surface support staff: Todd Glavin, DMR Fisheries Research Vessel Captain, and Jennifer O'Dwyer, DMR Diving Safety Officer). Emily Runnells, New York Natural Heritage Program (NYNHP) Marine Zoologist, was lead field researcher, also serving as topside dive and field data recorder in addition to providing topside diver and other topside support.

The R/V Delphinus.

The choices for the first day's reconnaissance dive sites were made in part based on general information derived from the United States Geological Survey and National Oceanographic and Atmospheric Administration generalized charts with depth and other bathymetric data (such as possible sediment types and rock, boulder or other projections from the bottom), and depth and related data from the topside support vessel's depth and Global Positioning System (GPS) instrumentation, which was plotted and recorded on the vessel's GPS/navigation instrumentation.

Emily Runnells (NYNHP) and Todd Glavin (NYS DEC).

The two divers used standard SCUBA life support equipment, thermal protection and related equipment. Basic survey and sampling equipment included a graduated meter square for observation/sampling quadrats along transect lines; a metal sieve for surficial sifting of sediments for benthic organisms; zippered plastic storage bags, Falcon Centrifuge Tubes, and large mesh collection bags for larger biological samples and carrying loose sampling bags and tubes; clipboards and preprinted waterproof data sheets that divers could write on to record transect and quadrat numbers, general information such as sediment type and species observed, and recording other general observations; digital imaging equipment including GoPro still/video recording cameras and an iPhone in a Kraken underwater housing with video strobe; and lead-weighted 100-meter polypropylene transect lines marked every five meters along their lengths, originally planned to be used for laying out survey transect lines along which meter square observation/sampling quadrats would be established. The polypropylene transect lines were not used (see modified method below). The NYS DEC's DMR brought a Remotely Operated Vehicle (ROV) and operator, Jesse Hornstein, on Thursday, September 12, for additional imaging. Sample and specimen trays, dissecting equipment, hand-held magnifiers, a stereomicroscope, 70% ethanol for preservative, and keys for algae, fish, crustaceans, mollusks, and other marine invertebrates were set up for use as a field lab on tables in one of the diver's hotel rooms.

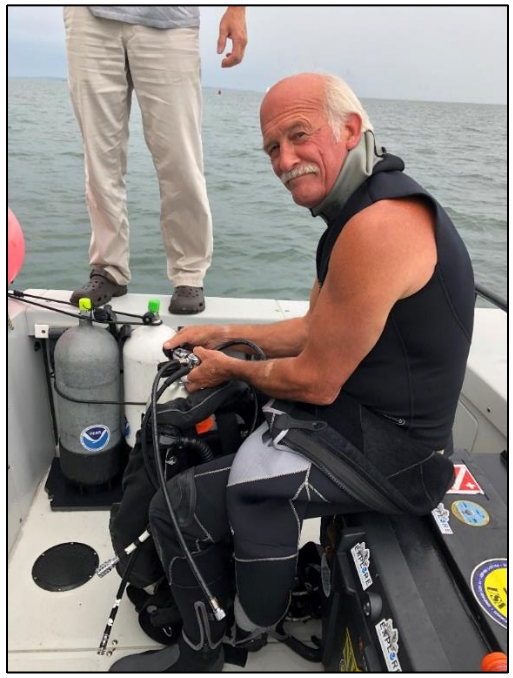
1-m^2 quadrat, clipboard, and transect line.

Left to right: Remotely Operated Vehicle, Steve's hotel room field lab, Dan and Emily at work in the "lab."

The original survey and sampling plan was modified based on the first day's reconnaissance dives. Surface and bottom currents – in some areas opposing, moving eastward along the bottom and westward at the surface – were too strong to drop and maintain transect lines in place, and in several areas the bathymetry, notably the presence of many large boulders projecting 2–3 meters and more off the bottom, made the use of physical transect lines rather than diver-held compass bearing transect lines impractical. For diver and vessel safety, and to maximize information gathered in the time available, the survey protocol was adjusted so that transects were the divers paths as they followed a compass bearing, the quadrat was placed in three unevenly spaced locations that represented the diversity near the transect, and divers moved towards the island along these transects.

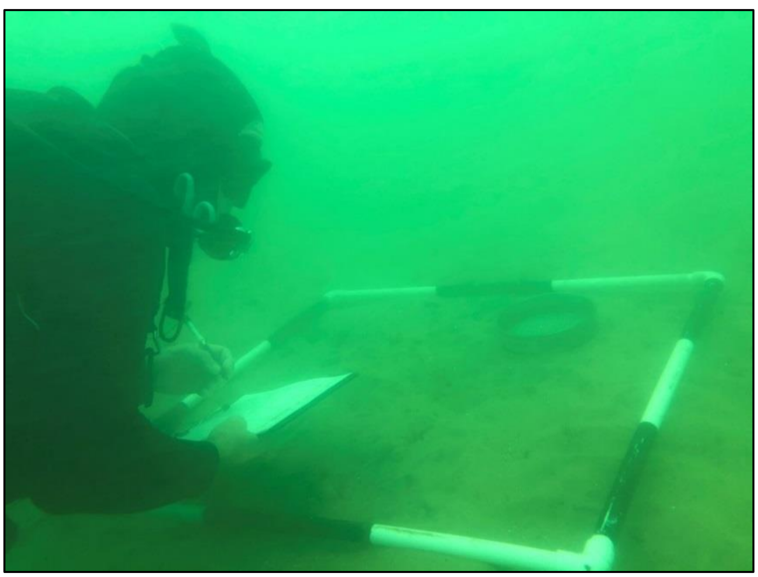
Instead of starting dive transects from shallow nearshore areas, the start and end points of dive transects were reversed, starting at seaward rather than landward points and heading landward to shallower rather than seaward to deeper depths. The divers chose that option because they would be conducting an unknown number of multiple dives per day in relatively unknown conditions and wanted to make the best use of air supplies. Air supplies last longer at shallower depths and working from deeper to shallower depths reduces the chances of ear, sinus, or other barotrauma from repetitive diving and surfacing over short periods of time. It was also safer for the divers and the survey vessel to have the divers enter the water in deeper offshore depths, swimming the transect lines to shallower nearshore areas where hazards to the survey vessel were more prevalent, and if conditions such as navigation hazards in shallower areas warranted it, swimming back after completing the transects to deeper and safer depths for the vessel and reboarding for transport to the next transect area. This was particularly necessary off the rock and boulder-strewn shallows on the north side of the island.

The daily offshore transect starting points and general direction of transects perpendicular to Plum Island's shoreline were initially chosen by a member of the dive team and the vessel captain while consulting information provided by the survey vessel's digital navigation and depth recorder for likely bathymetric conditions and substrates. They also considered tidal stages, visual observations of winds, waves, current speeds and directions, likely subsurface navigation or other hazards, and initial reconnaissance and subsequent observations and experiences by the divers and vessel captain, and the expected type and level of subsurface and topside survey tasks and difficulties. That information was briefly summarized for the rest of the crew and transect starting locations and landward directions were agreed upon by the entire survey crew before final selection and entry in the water by the divers.



Steve preparing for a dive.

Upon entering the water and being handed survey equipment by topside crew, and while at the surface, the divers both took wrist-mounted electronic dive computer or analog compass bearings toward a point along the shore of Plum Island, descended, and placed the meter square quadrat where they landed on the substrate or on aggregations of large rocks or boulders. After making and recording their observations on the preprinted data sheets they checked compass bearings for the transect line, followed those bearings as closely as possible given relatively strong currents, and, as they swam the transect line chose areas where they dropped the quadrat using their agreed upon (through hand signals) judgments of observed characteristics best representing the area along the transect or up to approximately 6 meters of either side of the transect line represented by their compass bearings. The decision to swim and survey the area in that manner was chosen rather than the much more difficult, and in some areas impractical and much more time-consuming, tasks of setting a physical transect line along the bottom, with measured and marked distances for quadrats, in strong currents. There was not enough time for more intense survey and sampling around much of the island as originally hoped.



Quadrat with diver recording on a data sheet mounted on a writing slate.

While swimming their compass bearing transects and stopping to drop the quadrat, divers recorded their observations on the preprinted waterproof data sheets and with some digital imaging and recordings, noting general physical characteristics and species observed, and collected some species for subsequent identification or verification of identification. The divers also noted general characteristics and species observed outside of the meter square quadrats to the edge of their visibility from the quadrats, which ranged from 1–5 meters. When finished recording information from the quadrat the divers continued sampling quadrats along the transect line compass bearings until reaching a relatively shallow depth of 3–4 meters, where they surfaced.

While the divers were submerged, the topside survey crew kept constant eyes on the exhaust bubbles of the divers as the survey vessel operated under power following the direction taken by the divers rather than staying at anchor farther offshore, and keeping an appropriately safe and usually downdrift distance from the divers. Both divers, while swimming perpendicular to sometimes very strong currents, had difficulties holding straight transect line positions in several instances. Given this initial survey was intended as a first time basic and general rather than detailed quantitative characterization of the area and its biota it was not necessary to hold more rigorously to absolutely straight transect lines and specifically spaced quadrats along them.

Basic observations were recorded on the diver data sheets, with collected specimens identified topside on the survey vessel, at the makeshift "field lab," or preserved and retained for identification after the field survey was completed.

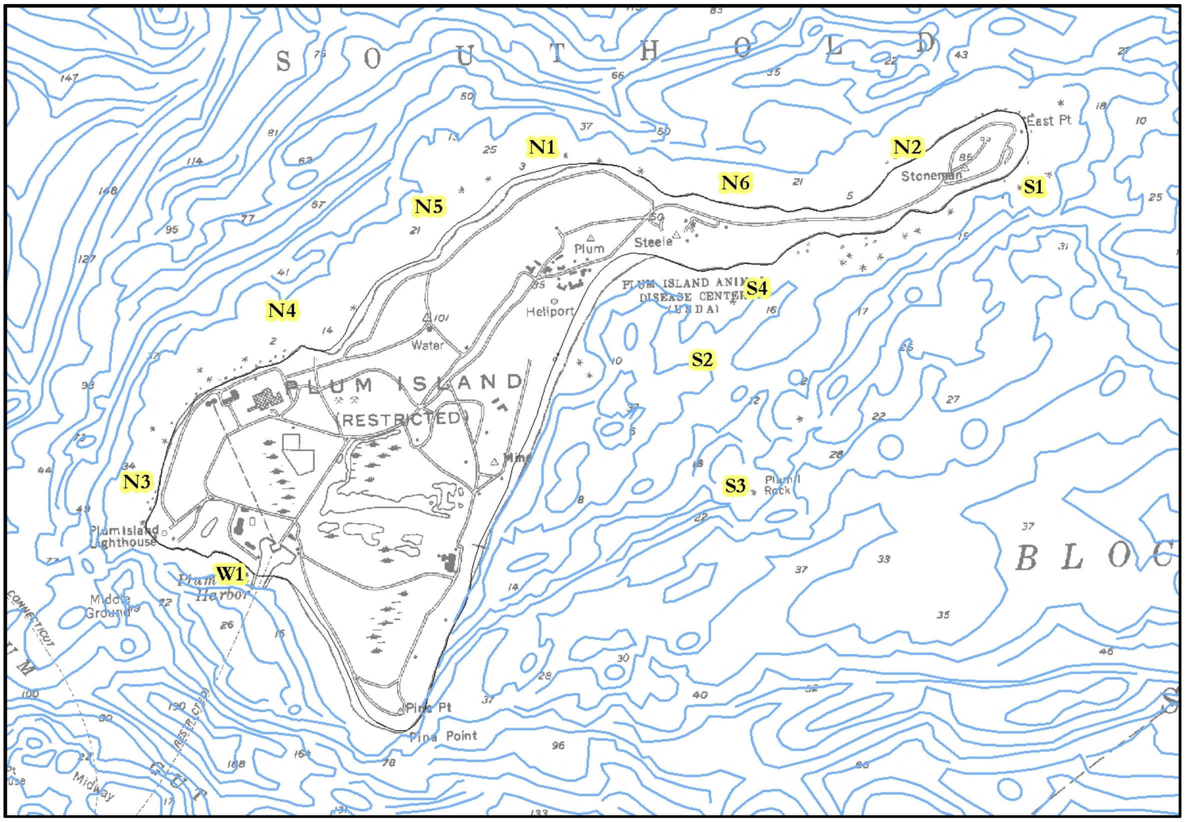
Results

The weather conditions allowed for 4 days on and in the water. We collected data in 33 quadrats along 11 transects. This field work began a few days after Hurricane Dorian passed northward off the US east coast, which left behind some ocean swells and may have influenced highly mobile species such as fish to move farther offshore, out of the area. All areas around Plum Island were influenced by strong tidally influenced currents.

Our work was intended as a pilot study to characterize the natural communities of the nearshore subtidal zone around Plum Island. To that end, we observed four generally distinct areas:

1. Relatively flat, large expanses of gently sloping coarse grained sandy areas with distinct sand ridges, primarily off the south side of the island where sandy "megaripples" were observed oriented perpendicular to the island, along with a strong current along the length of the island throughout most areas off the south side of the island's west end, especially nearer Plum Gut's outgoing tidal current, and the area offshore approximately half way between Plum Island's west and east ends. The crests of the ridges were approximately 15–30 centimeters in height from the bottom of their troughs, with their crests spaced approximately 1 meter from each other. Most of the ridges in this highly dynamic area extended for a great distance offshore along Plum Island's gently sloping, relatively shallow bathymetry. Spider crabs were highly abundant in these sandy ripple/ridge areas. Surrounded by shifting sands, there were occasional stones and shells that weren't buried or moved

about by strong currents or wave-induced pressure gradients. Algae, including some kelp, and encrusting sponges established toeholds, were growing on any scattered and occasional stone or shell substrate available. An apparent algal growth along the crests of the ridges was intriguing and worthy of further study.



Plum Island, NY, with bathymetry and primary sampling locations.

2. Dense assemblages of boulders 2–4 meters across with smaller boulders, large stones, and crevice spaces between them. These assemblages are most prevalent over large expanses off the north shore of the island. Between these assemblages of boulders and stone there are relatively small patches of sandy sediments with little to


North shore boulders.

no silt in the top 5 centimeters of sand. In some areas where the divers experienced strong currents, off the northwest part of the island, gravel overlies the sand. In almost all areas, the divers observed considerable scouring of sediments on the updrift sides of the base of boulders and large stones. Kelp, which was found along every transect around the island, was most prevalent throughout the rocky areas off the north side of Plum Island. Because of the presence of so much hard substrate, this is also where the divers observed the most diverse and abundant assemblages of other brown and red algae, sponges, bryozoans, corals and encrusting tube worms. No hard surface in these areas lacked complete coverage by biota, and there were usually multiple layers of growth.

3. Occasional assemblages of large stones and boulders unconnected with each other scattered about in large expanses of open sandy areas (gravelly areas were primarily in and near scoured sides of boulders where smaller grained and lighter weight fine sediments are scoured and swept away by strong currents). There were assemblages of very large boulders, similar to those observed along much of the area off the north side of the island, but separated by larger open expanses of sand, off the extreme southeast side of the island. This area, subject to outgoing tides exiting The Race and large incoming waves from the south, is highly dynamic, and boulders reach upward from the sandy bottom to very near the surface of the water. As with everywhere else around the island where hard substrate is available, every centimeter is covered in biota. Layer upon layer of blue mussels (*Mytilus edulis*) completely covered the tops of boulders within 1 meter of the surface, establishing a byssal mat community underneath, which mussels facilitate.

Diver in eelgrass meadow.

4. Eelgrass meadows are well established in a relatively shallow nearer shore area off the west side of Plum Island before the bathymetry drops deep, steeply, into the very strong and fast incoming and outgoing currents (up to approximately five knots) of Plum Gut. This area was also surveyed by the NYNHP in late 2015.

Throughout all four areas, wherever boulders or rocks are present, virtually every surface is covered in kelp, bryozoans (encrusting and branching), sponges (also encrusting and branching), or northern star corals. At the physically dynamic southeasternmost end of the island, mussels attach to the tops of boulders at or near the surface, making for layered biological communities and considerable competition for space, which is typical of hard-bottom substrates and other hard, in-water structures. Fishes also congregated around boulders and other relatively large, off-bottom, stone structures, usually on the downdrift eddy side of, in between, and under boulders where currents were weakest. The coarsest sands were observed in and adjacent to the eelgrass bed off the west side of the island and off the shallower, more gently sloping and highly dynamic south side of the island where there are fewer projecting structures above the substrate to slow currents and allow for settling of finer sediments.

Appendix A contains a list of species encountered during the surveys and discussion of basic habitat relationships.

Discussion and Next Steps

Our four days of sampling provided an enticing window into the subtidal biodiversity around Plum Island. We documented four distinct combinations of substrate and resident biota, which might form the basis for a subtidal marine natural community classification. The area around Plum Island appears to have a different salinity and temperature profile than the rest of Long Island Sound (The Nature Conservancy 2015), which may have significant influence on its biodiversity. Nearly every available hard surface was colonized by bryozoans, algae, and other organisms, demonstrating the high productivity of this marine environment. We observed high densities of bryozoans, and we expect that in other times of year there may be additional species and shifts in dominant species. The low diversity of fish may have been a result of the recent storm or the time of year; additional sampling earlier in the summer will help us better document the fish community.

This initial survey was limited and qualitative given fiscal, time, and other constraints. The oceanographic conditions around Plum Island make for challenging sampling, but our experience from our week of dives will help make a second year even more successful. In further sampling, we would propose the following:

- Sampling earlier in summer (e.g., mid- to late June);
- Additional transects intended to yield a map of substrate types;
- Accompanying draft natural community descriptions including associated fauna;
- Analysis of quadrat data and comparison to other sites;
- A possible focus on certain taxonomic groups of interest;
- Boat-based surveys of seabirds and sea turtles; and
- Higher quality imaging.

We look forward to working with Save the Sound and its donors to scope out additional surveys.

More qualitative and quantitative information is needed not only for a better understanding of the marine resources and environment housing Plum Island and its associated Great and Little Gull Islands, but for more informed and a robust management program for New York's important offshore areas. This would complement and advance some objectives of New York's 2017–2027 Ocean Action Plan (New York State Department of Environmental Conservation and Department of State 2017), especially those relating to the inclusion of information relating to important marine species and habitats tracked by the NYNHP (see page 39 of the Ocean Action Plan), and efforts to identify, designate, and manage nearshore and offshore habitats that meet criteria for designation as

Significant Coastal Fish and Wildlife Habitats pursuant to Article 42 of the Executive Law and implementing regulations in 19 NYCRR Part 602. Such a designation would advance several national objectives of the federal Coastal Zone Management Act, State coastal policies and objectives of New York's federally approved Coastal Management Program (CMP), the Long Island Sound Regional Coastal Management Program and Town of Southold Local Waterfront Revitalization Program as special area management plan elements of the State's CMP, and elements of the New York and Connecticut Long Island Sound Comprehensive Conservation and Management Plan.

In 2019, the New York State Legislature enacted and the Governor approved Title 20A, Article 11-2050 of the State's Environmental Conservation Law, establishing a Marine Mammal and Sea Turtle Protection Area in the area of and to 450 meters seaward of Plum, Great Gull, and Little Gull Islands. This new legislation recognizes the unique and significant physical and biological characteristics, qualities and values in and of the area. The purposes of the Act include providing authority to the NYS DEC to provide greater protection in the area to marine mammals, sea turtles, and associated resources.

This 2019 diver survey fell within the designated Marine Mammal and Sea Turtle Protection Area, 450 meters of the shoreline of Plum Island. While the designated protection area does not extend far offshore and is limited to relatively shallow depths, that shallow area is the most geologically varied and, given that, likely the most biologically diverse area around the island. This initial and a subsequent survey could provide the information necessary to designate the area as a Significant Coastal Fish and Wildlife Habitat in accordance with New York's Coastal Management Program.

Acknowledgments

The generosity of an anonymous donor made this work possible. We are grateful to Save the Sound for bringing this project to us, particularly Chris Cryder and Louise Harrison. Gary Mandelburg from the U.S. Department of Homeland Security at the Plum Island Animal Disease Center continues to be vital to our work in and around Plum Island. The NYS DEC was an enormous help, providing the R/V Delphinus and crew: Captain Todd Glavin, Dive Safety Officer Jenn O'Dwyer, and ROV Operator Jesse Hornstein. Thanks to Dawn McReynolds, Kim McKown, and Karen Chytalo for help securing boat and crew time and Emily's time. Debra Barnes, Chris LaPorta, and the MIPR Unit provided essential guidance, dive safety equipment, and back-up underwater video equipment. Special thanks to Bob Haase, owner of Orient by the Sea Marina, for providing a slip for the Delphinus during the surveys. Terry Keefe and family, owners of Silver Sands Motel, generously allowed us to stay in a prime location at researcher rates and didn't complain when we turned a large part of the property into a marine lab. From NYNHP, we thank DJ Evans and Fiona McKinney for administrative help and support.

References

Burger, M. F., and J. M. Liner. 2005. Important bird areas of New York. Audubon New York, Albany, New York, 352 pp.

Heine, J. N. 2011. Scientific diving techniques: A practical guide for the research diver. Best Publishing Company, Flagstaff, Arizona, 232 pp.

Joiner, J. T. 2001. NOAA diving manual: Diving for science and technology. National Oceanic and Atmospheric Administration, Office of Oceanic and Atmospheric Research, National Undersea Research Program, Office of Marine and Aviation Operations, NOAA Diving Program, 800 pp.

New York State Department of Environmental Conservation. 2015. New York State wildlife action plan. Albany, NY. https://www.dec.ny.gov/animals/7179.html/

New York State Department of Environmental Conservation and Department of State 2017. Ocean action plan 2017–2027. Albany, NY. https://www.dec.ny.gov/lands/84428.html.

New York State Department of State. 2005. New York State significant coastal fish and wildlife habitat narrative: Plum Gut. New York State Department of State, Division of Coastal Resources, Albany, NY. https://www.dos.ny.gov/opd/programs/consistency/Habitats/LongIsland/Plum_Gut.pdf

Poppe, L. J., B. A. Seekins. 2000. Distribution of surficial sediments in Long Island Sound. LISTEX polygon data. U.S. Geological Survey Open-File Report 00-304. http://pubs.usgs.gov/of/2000/of00-304/.

Reid, J. M., J. A. Reid, C. J. Jenkins, M. E. Hastings, S. J. Williams, and L. J. Poppe. 2005. usSEABED: Atlantic coast offshore surficial sediment data release: U.S. Geological Survey Data Series 118, version 1.0. http://pubs.usgs.gov/ds/2005/118/.

Schlesinger, M.D., E.L. White, S.M. Young, G.J. Edinger, K.A. Perkins, N. Schoppmann, and D. Parry. 2016. Biodiversity inventory of Plum Island, New York. New York Natural Heritage Program, Albany, New York, and SUNY College of Environmental Science and Forestry, Albany, NY. Available at www.nynhp.org/plumisland.

The Nature Conservancy. 2015. The Long Island Sound ecological assessment – final report, appendices, and GIS dataset. Anderson, M., Frohling, N. https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/marine/namera/lis/Pages/default.aspx

Appendix A. Species observed and/or collected

This list is of species observed and specimens gathered in an effort to characterize the communities in the shallow subtidal (~5–7 meters) of Plum Island. Some were identified from quadrats deployed along transects, other species were gathered as part of the general habitat observation. Because the survey did not emphasize infaunal sampling it is biased towards epifaunal and emergent infaunal species. A few infaunal animals were collected as a result of haphazard sieving of sediments.

Substrate around Plum Island consists of sand with a small amount of silt-clay in it, occasional gravel deposits and rocks ranging from 1–2 centimeters in diameter to boulders of 1 meter or more across. One site on the west side of the Island supports a coarse sand and healthy eelgrass (*Zostera marina*) bed.

Kelp with holdfasts on boulder.

Where hard substrate exists, or in some cases where a large enough shell is present, nearly every surface is covered. Primary coverage is by algae but there were also sponges, encrusting bryozoans and mussels. The algae itself is a substrate for branching bryozoans and spirorbid polychaete worms. Algae was dominated in all habitats by red algae, particularly *Gracilaria*, *Gigartina*, and *Phyllophora* but sugar kelp *Saccharina latissima* was also present.

Sponges: Sponges occurred in a variety of colors and were widely distributed. All were encrusting on rock, or in the case of *Cliona* spp., boring into the rock substrate.

Diadumene *sp. (anemone), common on boulders and large rocks offshore of the north side of Plum Island.*

Ctenophores and cnidarians: The comb jelly *Mnemiopsis leidyi* was observed at one site but this species can often be found in large quantities and is dependent upon distribution by wind and tidal currents. *Cyanea capillata*, the lion's mane jellyfish, was observed at several sites but again this species drifts with prevailing currents. Accompanying the jellyfish at one site was a juvenile Atlantic bumper. Northern star coral (*Astrangia poculata*) was observed at a number of sites in small colonies attached to rock. The white anemone *Diadumene leucolena* was seen at multiple sites attached to large rock substrate.

Sea cucumbers: One specimen of the synaptid sea cucumber *Leptosynapta tenuis* was collected from a sandy site. There are likely many more in the sediment but it would require benthic sampling to determine this.

Sea stars: The common Forbes sea star *Asterias forbesi* was observed at two sites. It can be expected to be a common subtidal resident in a variety of habitats.

Bryozoans: Ectoprocts or bryozoans occurred in two forms, as encrusting colonies on rock surfaces and as branching colonies generally attached to red algae. Both forms were widely distributed, with an especially large biomass of *Bugula* observed.

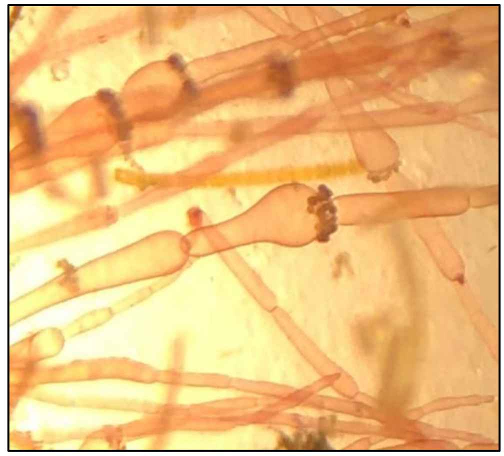
Cyanea capillata *(lion's mane jellyfish), approximately 0.6 meters in diameter, off north side of Plum Island (it was common all around the island), with* Chloroscombus chrysurus *(atlantic bumper) circling tentacles (right underside of bell).*

Polychaete annelids: Polychaete worms were observed as epifauna attached to rock or shell (mostly serpulids) and also attached to algae (mainly spirorbids). We also observed a few infaunal polychaetes, one species (*Pectinaria gouldii*) collected by sieving and the other (*Diopatra cuprea*) a dominant member of the *Zostera marina* community. Polychaetes can be expected to occur as diverse and possibly abundant members of the soft-bottom communities around Plum Island. Coarse sand environments are ideal for the "errant" species of Polychaeta.

Bivalves: Bivalves were mostly identified by collecting empty shells on the sandy substrate since our efforts did not include a great deal of subsurface sampling. The exceptions were the blue mussel *Mytilus edulis*, which was collected in situ on transect S1, the only site where we surveyed high energy rocky substrate, and the jingle shell *Anomia simplex*, which is an epifaunal member of the hard substrate community. In one case a large, living Atlantic surf clam (*Spisula solidissima*) was pulled out of a

Live (left) and dead Astrangia poculata *(northern star coral).*

sand ridge on the south side of the island (S2). Bivalve shells were present at every site we examined, indicating that they are widely distributed and probably that active predation is occurring on the soft-bottom fauna. We would expect that the bivalve assemblage around Plum Island is both abundant and diverse because of the presence of well-sorted sediment and tidal currents providing a regular food supply to these suspension-feeding animals. Only at one site did we get into the high energy hard-bottom habitat (S1) where blue mussels, *Mytilus edulis*, dominated the community, but that type of community can be expected to occur at many places along the shore in the shallow subtidal and intertidal. Bay scallops (*Argopecten irradians*) should be typical inhabitants of the *Zoster*a bed.

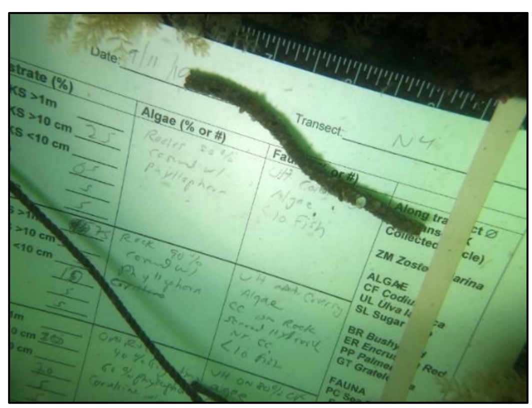


Bryozoan polyps under stereoscope in hotel field lab.

Benthic polychaetes exposed while divers sieved sediment.

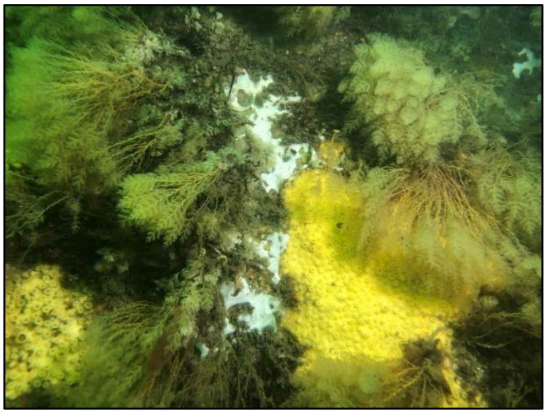
Gastropods: Snails are undoubtedly far more abundant and diverse than our collection would indicate. We very incompletely sampled the soft-bottom community where infaunal snails can be expected and we did not extensively collect patches of epifaunal growth on the hard substrates that can be expected to contain many more species of snails. The most common gastropod around Plum Island is the slipper shell *Crepidula fornicata*, particularly on the south side of the island where large aggregations of *Crepidula* were observed. The oyster drill *Urosalpinx cinerea* was predictably common in the *Mytilus edulis* bed but nowhere else. Two large predatory gastropods (the channeled whelk *Busycotypus canaliculatus* and the northern moon snail *Euspira heros* are expected to be widely distributed around the island based on evidence of dead bivalves that bore the marks of predation by these two snails; however, we observed those species only as homes for flat-clawed hermit crabs. The dog whelk *Tritia trivittata* is typical of intertidal mud flats, a rare community on Plum Island, possibly inshore of the *Zostera* meadow.

Chitons: We observed one chiton, *Chaetopleura apiculata*, on the lower surface of a rock. Chitons are probably widely distributed around the island but more typical of the high-energy subtidal, a community that we did not sample.



Benthic tube worm casing on diver data sheet.

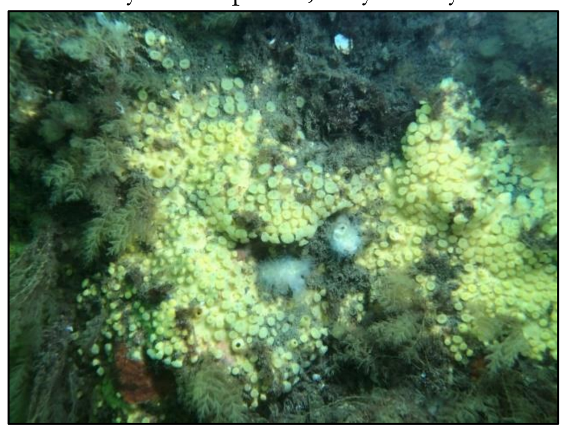
Barnacles: Barnacles (*Semibalanus balanoides*) are probably typical of high-energy intertidal and shallow



Bryozoans, Cliona celata *(sulfur/boring sponge), encrusting bryozoans on boulder*

subtidal habitats, which we did not specifically sample. We did observe barnacles at a few sites around the island.

Caprellid and other amphipods: The caprellid amphipods or skeleton shrimp are a particular interest of one of the survey team (Dan Marelli) and though the survey was not specifically designed to characterize the caprellid community of the island we did collect branching bryozoans so that they could be examined for caprellids. Caprellids occur in association with a number of epifaunal life forms, particularly hydroids and bryozoans and they are probably an important component of those life forms in addition to being fascinating animals. We found three species in one bryozoan clump so there are likely more species, very widely distributed, around Plum Island. Because we did not adequately sample infaunal sediments or the communities of the epifaunal life forms we did not adequately characterize the gammaridean amphipods. To do that would require a very different sampling approach and a lot of lab work.



Live Astrangia poculata *(northern star coral) among* Cliona celata *(sulfur/boring sponge), surrounded by bryozoans, algae and* Clathria *(*Microciona*)* prolifera *(red beard sponge), lower left and lower right.*

Hermit crabs: One species of hermit crab (the flat-clawed hermit crab) was seen in a number of places around the island. These scavengers are likely important members of the epibenthic community.

True crabs: Two species of true crabs were observed although the sampling strategy was not ideal. Spider crabs, *Libinia* spp., occurred widely around the island but were most common at the S2 site on the south side of the Island. One lady crab (*Ovalipes ocellatus*) was disturbed at site S4 and rapidly swam away.

Caprellid (skeleton shrimp) under stereoscope.

Fish: Few species of fish were observed during the survey, but numerous individuals were often seen and fish were widely distributed around the island. The most common fish were juvenile black sea bass, *Centropristis striata*, and juvenile Atlantic bumper, *Chloroscombrus chrysurus*. Every site had juvenile black sea bass and nearly every site also had juvenile Atlantic bumper. Occasionally we observed larger juvenile black sea bass and also a few adults. Both sea bass and bumper juveniles were attracted to disturbance of the sediment, suggesting that they feed opportunistically. One Atlantic bumper was observed shadowing a lion's mane jellyfish, a behavior that has been reported in the literature. A few tautog (*Tautoga onitis*) were observed during the survey, as well as one juvenile sea robin (*Prionotus carolinus*). The presence of fish around Plum Island is probably related to both season and ontogeny, but the presence of large numbers of juvenile black sea bass and Atlantic bumper suggests that the subtidal communities around Plum Island are nursery areas for these important species.

Pagarus pollicaris *(flat-clawed hermit crab), using small shell of* Busycotypus canaliculatus *(channeled whelk) covered in live* Crepidula *(slipper shell) mollusks algae, and snails.*

Seals: The gray seal (*Halichoerus grypus*), a federally protected species, was observed at a few sites during the survey. At one site a seal surprised the dive team and later grabbed the left fin of Steve Resler. Gray seals have been increasing in New York waters in recent years and have apparently pupped on nearby Great Gull Island, which also has a winter haul-out site. Harbor seals (*Phoca vitulina*) are the primary species observed hauled out near Plum Island in winter.

A gray seal in the waters around Plum Island.

Species List

Species collected only as empty shells are indicated by an asterisk (*).

Species	Locations
Rhodophyta – Red algae	
Gracilaria gracilis	Widely distributed
Phyllophora crispa	Widely distributed
Gigartina spp.	Widely distributed
Chondrus crispus Irish moss	S1, S3, N6
Grateloupia turuturu	N2, S1, S3
Polysiphonia stricta	N5, N6, S3, W1
Grinellia americana	S4
Ochrophyta – Brown seaweed	
Saccharina latissima – Sugar kelp	N2, N3, S3, S4, W1
Chlorophyta – Green algae	
Ulva lactuca	S1, S4
Codium fragile	S1
Plantae: Tracheophyta	
Zostera marina – Common eelgrass	W1
Porifera – Sponges	
Cliona celata Sulphur or boring sponge	N1, N4, S2, S3, S4
Clathria (Microciona) prolifera Red beard sponge	Regularly seen
Halichondria panicea Breadcrumb sponge	Regularly seen
Unidentified sponges	S1, S2, N5, S3
Ctenophora – Comb Jellies	
Mnemiopsis leidyi Ctenopohore	S2
Cnidaria – Jellies, Anemones, Corals	
Astrangia poculata Northern star coral	N1, N3, S3
Diadumene leucolena White anemone	N1, S1
Cyanea capillata Lion's mane jellyfish	Regularly seen
Unidentified hydroids	W1
Echinodermata – Sea stars, Urchins, Sea Cucumbers	
Leptosynapta tenuis White synapta	
Asterias forbesi Forbes sea star	N2, S1
Ectoprocta – Bryozoans or Moss animals	
Unidentified encrusting bryozoa	Widely distributed
Bugula spp.	Widely distributed

Species	Locations
Annelida: Polychaeta – Segmented worms	
Unidentified Spirorbidae	S2, N5
Unidentified Serpulidae	N1, N4, S4
Pectinaria gouldii Ice cream cone worm	S2
Diopatra cuprea Plumed worm	W1
Mollusca – Clams, Snails, Octopus, Squid, Chitons	
Anadara transversa Transverse ark*	S1, S4, N1, N4
Anadara ovalis Blood ark*	
Mytilus edulis Blue mussel	S1
Argopecten irradians Bay scallop*	
Anomia simplex Jingle shell	N2, N3, S4
Astarte castanea Chestnut astarte	
Crassinella lunulata Lunate Crassinella*	N1
Pitar morrhuanus False quahog*	
Spisula solidissima Surf clam	S1
Ensis directus Common razor clam*	S1
Periploma leanum Lea's spoon shell*	Widely distributed
Lacuna vincta Chink shell	W1
Crepidula fornicata Common slipper shell	S1, S2. S4, W1
Euspira heros Northern moon snail*	S1
Costoanachis translirata Well-ribbed dove snail	N1, N3, N6
Astyris lunata Crescent mitrella	N3, W1
Urosalpinx cinerea Oyster drill	S1
Tritia trivittata New England dog whelk*	
Busycotypus canaliculatus Channeled whelk*	
Chaetopleura apiculata Bee chiton	N1
Crustacea	
Semibalanus balanoides Common acorn barnacle	S2, N5
Caprella penantis	N5
Caprlla linearis	N5
Deutella incerta	N5
Pagurus pollicaris Flat-clawed hermit crab	S1, S2, S4
Libinia sp. Spider crab	S1, S2
Ovalipes ocellatus Lady crab	S4
Vertebrata	
Centropristis striata Black sea bass	Widely distributed
Chloroscombrus chrysurus Atlantic bumper	Widely distributed
Prionotus carolinus Sea robin	S1
Tautoga onitis Tautog	S1, N5
Halichoerus grypus Gray seal	S1